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LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROJECT PHASE II

Public Disclosure Authorized

THE NATIONAL INTEGRATED PEST MANAGEMENT (IPM) FRAMEWORK FOR RWANDA

FINAL DRAFT REPORT

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ABBREVIATIONS AND ACRONYMS

ACMV	Africa Cassava Mosaic Disease
ASARECA	Association for Strengthening Research in East and Central Africa
BBW	Banana Bacteria Wilt
CAADP	comprehensive Africa Agriculture Development
CABI	Commonwealth Agricultural Bureau International
CBD	Coffee Berry Disease
CBO	Community Based organization
CBPP	Contagious Bovine Pleuropneumonia
CDC	Community Development Committee
CDD	Community Driven Development
CDF	Common Development Fund
CDP	Community Development Plan
CIAT	Centro International d'Agriculture/International Centre for Tropical Agriculture
CIMMYT	Centro International de Mejoramiento de Maizy Trigo
CIP	International Potato Center /Centro Internacional de la papa
CLR	Coffee leaf rust (disease)
CMD	Cassava Mosaic Disease
DAREE	Directorate of Agriculture Research Extension and Education
EACMV-UgV	East Africa Cassava Mosaic Virus-Uganda Variant
ECF	East Coast Fever
EDPRS	Economic Development and Poverty Reduction Strategy
FAO	Food and Agriculture Organization
FMD	Foot and Mouth bacteria
GDP	Gross Domestic product
GEF	Global Environment Facility
GIS	Geographic Information System
GOR	Government of Rwanda
GPS	Geographical Positioning System
IARC	International Agricultural Research Centre
ICIPE	International Centre for Insect Physiology and Ecology
ICRISAT	International Centre for Research in Arid and Semi Arid Tropics
ICT	Information and Community Technology
IITA	International Institute of Tropical Agriculture
IITA-ESARC	International Institute for Tropical Agriculture-East and Southern Africa Research Centre
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
ISAE	Institute Supérieur de l'Agriculture ET d'Elevage
ISAR	Institute for Research in Agronomic Sciences
ISAR	Institut des Sciences Agronomiques du Rwanda
KIST	Kigali Institute of Science and Technology
LGB	The Large Grain Borer
LVB	Lake Victoria Basin
LVBC	Lake Victoria Basin Commission
LVEMP	Lake Victoria Environmental Management Project
LVFO	Lave Victoria Fisheries Organization

M&E	the monitoring and evaluation
MGD	Millennium Development Goals
MINAGRI	Ministry of Agriculture and Animal Resources
MINECOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Trade and industry
MINALOC	Ministry of Local Government of Rwanda
MINELA	Ministry of Environment and Lands
MIS	Management Information System
MSMEs	Micro Small and Medium Enterprises
NAP	National Agriculture Policy
NEPAD	The Partnership for Africa's Development
NGO	None Government organization
NPPO	Nation Plant Protection Organization
OCIR-Café	Rwanda Coffee Authority
OCIR-Thé	Rwanda Tea Authority
PSTA	Plan Stratégique pour Transformation d'Agriculture
RAB	Rwanda Agricultural Board
RADA	Rwanda Agricultural Development Authority
RADRA	the Rwanda Animal Resources Development
RBS	Rwanda Bureau of Standards
RHODA	the Rwanda Agiculture Development Authority
RRA	Rwanda Revenue Authority
SAP	Strategic Action Plan
SPS	Sanitary and Phytosanitary Service
TBD	Tick-Borne Diseases
TDA	Transboundary Diagnostic Analysis
TMV	Tomato Mosaic Virus
ToMV	Tomato Mosai Virus
TOT	Training of Trainers
TYLCV	Tomato yellow Curl Virus
UBPR	Union de Banque Populaire du Rwanda
UNDP	United Nations Development Programme
UNR	Universite National du Rwanda
WHO	World Health Organization
WTO	World Trade Organisation

EXECUTIVE SUMMARY

Rwanda is an important upstream catchment for the Lake Victoria and its economy is agricultural based with more than 90% of its population deriving their livelihoods from agriculture. The agriculture has been identified in vision 2020 and EDPRS as engine of economy and means to attain MDG and poverty reduction. As a result, the National agricultural policy and strategy of agricultural transformation have identified crop intensification as a mechanism to attain the above objectives. The crop intensification will include use of high yielding varieties, and increased use of fertilizers and pesticides. In order for crop intensification to be sustainable, there is a need to establish sustainable pest management plan to ensure food safety, human and animal safety, and environmental protection. This can only be achieved through development and adoption of participatory integrated pest management system for all major food and cash crops. The main crops grown in Rwanda are tea, coffee, cereals (maize, rice, wheat, and sorghum); pulses (beans, peas, soya, and groundnut); bananas; potatoes (sweet and Irish varieties); cassava, and more recently, horticultural crops (vegetables, fruits, and flowers).

The land is the most important valuable natural resource in Rwanda and about a half (52%) of the territory is arable. However, the soils have been degraded due to over-cultivation as a result of expanding population and low adoption of scientific technologies. Land productivity is declining due to multiple factors, including poor soil fertility, low external inputs use, *poor pest management*, low yielding varieties and poor seeds, low use of scientific technologies due to poor extension services to the farmers, poor marketing structure etc. Due to expanding population pressure on land, marginal lands (steep hills, wetlands etc) have been encroached to put more land under agricultural production leading to accelerated erosion problem and loss of nutrients and more pest problems as stressed plants suffer more damage than vigorous healthy crops. The severe soil erosion causes siltation and sedimentation of water systems, which directly affect riparian communities as well as downstream resource users outside Rwanda and Lake Victoria in particular.

Approximately 90% of the total surface area of 26,338 Km^2 lies within the western Lake Victoria Basin catchment. Only the western part, that is, about 10% of the surface area lies within the River Congo Catchment. The Lake Victoria Basin in Rwanda is defined by the extent of the Kagera River catchment in the country. Rwanda is therefore, key upstream riparian country of the Lake Victoria Basin. The dense network of rivers, streams, lakes and marshlands have ensured permanent availability of water or moisture in most of the valleys separating the hills, thereby affording farming communities at least two crop seasons, plus marshland cultivation during the dry season.

Rwanda is a mountainous country characterized by a diverse relief ranging from hilly volcanoes and mountain forest in the north and west, through the steep and gentle hills in the central regions and to the lowland hot and dry eastern plains. Rwandan climate is characterized by high spatial variability, mainly as a result of the country’s wide ranging terrain. The high altitude areas of the North and North West receive much higher rainfall, about 1800mmm/ year, while the lowland areas of the west, south and east receive about 1000mm/ year. The mean annual temperatures range from 16 –17 ^{o}C. In the higher altitudes, 18-21 ^{o}C in the central plateau and 20- 24 ^{o}C in the eastern and western lowlands.

Lake Victoria Environment Management Project (LVEMP-2): LVEMP II aims to implement priority interventions of the Strategic Action Programme (SAP), which address key environmental issue identified in the Transboundary Diagnostic Analysis (TDA) for the Lake Victoria basin (LVB). The higher development objective of the proposed LVEMP-2 is to contribute to the EAC's Vision and Strategy Framework for Management and Development of the Lake Victoria basin "*a prosperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits to the riparian communities*". The LVEMP-2 will be implemented within the entire Lake Victoria Basin and will enhance environmentally friendly economic growth in the Basin through knowledge generation for development, socio-economic development, promotion of effective natural resources management framework, and enhancing public participation and communication.

The LVMP-2 will be implemented through a number of institutions and organisations in Kenya, Uganda, Tanzania, Burundi and Rwanda, and also by the Lake Victoria Basin Commission (LVBC), accountable to the relevant focal point Ministries and regionally coordinated by the East African Community/Lake Victoria Basin Commission.

Integrated Pest Management (IPM) under LVEMP-2. Each implementing country under LVEMP 2 has adopted an IPM framework to reduce reliance on insecticides to control pests and diseases in agriculture, livestock production and forestry. The worldwide excessive use of pesticides has led to problems that threaten production, sustainability, health and the environment on a global basis. Such problems include secondary pest outbreaks, development of pesticide resistance and the destruction of natural enemies. The pest problem will in turn cause more losses of yield and income and fail to achieve the vision and objective for LVEMP-2.

The Kagera Transboundary Integrated Water Resources Management and Development Project of Nile Basin Initiative has commissioned a study and the preparation of this National Integrated Pest Management Framework for Rwanda. LVEMP 2 will adopt this National IPM Framework to guide project implementation activities that may involve the use of pesticides, the need to control pests, or lead to changes in the practices or intensity of pesticide use.

The study had the following specific objectives:

(i) To assess the pest and disease status in the Basin in Rwanda.
(ii) Propose appropriate Integrated Pest Management strategies so as to reduce risks of pest attacks and associated damage.
(iii) To develop an integrated pest management/control strategy/regime that uses appropriate arrays of complementary methods – natural predators and parasites, pest-resistant tree/crop varieties, cultural practices, biological controls and other physical techniques.
(iv) To assess the capacity to design and implement IPM regimes.
(v) To define clear profile of the institutional or partnerships mandates in the implementation of IPM within the basin in Rwanda.
(vi) To define/outline outstanding relevant researchable areas.
(vii) To provide clear policy recommendations on how to address any risks related to pests that the project may stimulate, and
(viii) To develop a comprehensive pests monitoring and evaluation regimes.

Following the specific objectives of the study, this report on Integrated Pest Management (IPM) identifies the major crops in Rwanda including: maize, rice, potato, beans, cassava, banana, tomato, and coffee. . Each crop has major insect pests and diseases reported in its section in this report. Rwanda does not use large amounts of pesticides of great concern to the environment, 75% of which are fungicides, 23% insecticides, and 2% herbicides. The coffee crop is the main sink of fungicides, taking 90% of all imported fungicides.

In addition, crop diseases are of great concern. Some are recently introduced and are causing a threat to food security and income to farmers. These include banana bacterial wilt (BBW) and Cassava Mosaic Disease (CMD) which destroyed local varieties. For CMD the GOR had to support replacement, while for BBW, there is insufficient information about its epidemiology and control, as a result initial scientific information available are mainly cultural practices. In general, the quantified data for different major pests are lacking and research in this field is an urgent issue. Similarly, pesticides and agrochemicals data are scarce, because the pesticide trade is liberalized and importation and distribution not coordinated; moreover, there is no strict regulation on pesticides use apart from a list of allowed agrochemicals. Up to the time of this study, Rwanda did not have law for plant protection or pesticides regulation as a result the protection of farmers, consumers, environment and trade is not assured. The development of sustainable IPM should be ideally supported by functional legislative system in plant protection; therefore, it is desired to hasten the process of enacting law for plant protection and pesticide regulations which were still at draft bill stage.

The major livestock in Rwanda is cattle, mostly local breed, Ankole type. The livestock major diseases are tick borne diseases and FMD. The tsetse fly disease is normally limited to cattle keepers bordering the Akagera National Park in Eastern Province.

The IPM strategy, implementation, legal and institutional framework for execution for the eight major crops is proposed in the basin in Rwanda. The execution will follow the decentralized structure at District and sector level, however, currently these structures are understaffed, and agricultural unit does not exist. Since the implementation of IPM will require total commitment for sustainable agricultural development, the issue of staffing would require special attention. In order for IPM implementation to be successful, it will have to adopt participatory approach (as it is also proposed by MINAGRI draft extension strategy and PSTA-2). Similarly the monitoring and evaluation will adopt participatory monitoring and evaluation (PM&E) approach. The section for monitoring and evaluation gives details of proposed framework.

The report is divided into 14 chapters including reference and annexes. The first chapter is the background of LVB and Rwanda as important upstream watershed of the basin. The second chapter deals with suitability and distribution of major crops covered in the report. The third chapter is about the current pests and diseases control strategies; however, it also includes the national policies and strategies linked to agriculture and role of agriculture in national economy; and also institutions and legal framework. It is interesting to note that, till December 2008, Rwanda did not have law on plant protection and pesticides use in the country. Chapter 4-6 reports the current major pests and diseases for major crops, impact of some selected major pests of current concern and impact of current control methods. Rwanda has limited data based on yield loss and the impact of pests and diseases is rarely reported. This is an area needing much focus in research.

The seventh chapter is about the IPM proposal for the major pests in the major crops in the basin. Where possible, the report covers individual crops and individual pest management. Chapters 8, 9 and 10 give report about the capacity to design IPM, the profile of institutions to implement IPM and researchable areas. It is worth to indicate that under decentralized structures, there is under-staffing, and for success of IPM implementation, MINAGRI agencies, will need to decentralize some of staff to District level to re-enforce the existing capacity while developing sustainable mechanism.

The chapters 11 and 12 propose the needed policies, strategies and regulations, and monitoring and evaluation process. Here also, the idea of PM&E is proposed as the only option to make IPM a success. The last two chapters (13 & 14) are about references and annexes.

In conclusion, there is a strong political will in Rwanda to develop IPM, and apply participatory decentralized extension system. The strategic plan for agricultural transformation recognizes the need for IPM policy. However, the producer and consumers in Rwanda has not been fully protected, and the market for pesticides is not regulated. The immediate action may be required.

1.0 Background of Lake Victoria Basin in Rwanda

Rwanda hydrology is dominated mainly by Nile basin with 90% of flowing water coming together to form the River Nyabarongo which ultimately becomes Akagera. The Akagera River flows into the Lake Victoria from which comes the Nile river. The Lake Victoria and its Basin are shared transboundary resources, which have received a lot of attention over the last decade. The Lake Victoria Basin is shared by Burundi, Rwanda, Kenya, Tanzania and Uganda and is part of the Nile River Basin system, which is shared by ten countries: Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Eritrea, Kenya, Rwanda, Sudan, Tanzania, and Uganda. Rwanda and Burundi are part of the upper watershed that drains into Lake Victoria through the Kagera river. In addition to its environmental values, including biodiversity and the hydrological cycle, Lake Victoria supports a large fishing industry for export and for local consumption, hydropower production, drinking and irrigation water, lake transport, and tourism.

The Lake Victoria Basin benefits are threatened by environmental degradation manifested in reduced fish stocks, decline of biodiversity, variable water levels, increased sedimentation, eutrophication and proliferation of Water weeds, especially the Water Hyacinth. Efforts to regulate and manage the activities threatening the Lake and its Basin clearly need upscaling, and widespread poverty in the basin exacerbates environmental stress. Even in its current parlous state the lake is a valuable asset supporting the livelihoods of approximately three million people directly, and indirectly the entire population of the basin of over 30 million.

The LVEMP-2 to be implemented within the entire Lake Victoria Basin will enhance environmentally friendly economic growth in the Basin through knowledge generation for development, socio-economic development, promotion of effective natural resources management framework, and enhancing public participation and communication. LVEMP-2 is to contribute towards the achievement of the regional Lake Victoria Development Vision of having “a posperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits to the riparian communities”.

The project will be implemented through a number of institutions and organisations within Kenya, Uganda, Tanzania, Burundi and Rwanda. These institutions will be accountable to the relevant focal point Ministries. They will be regionally coordinated by the East African Community/Lake Victoria Basin Commission. LVEMP-2 is a broad programme and will have four components.

2.0 .LVEMP-2 Components and Sub-Components

The identified priority project interventions in the LVB region of Rwanda have been conveniently clustered into four components:

- **Component 1:** Strengthening institutional capacity for managing shared water and fishery resources;
- **Component 2:** Point sources pollution control and prevention;
- **Component 3:** Watershed Management;
- **Component 4:** Project coordination and management.

The components of LVEMP II are designed to: (a) assist the participating countries to implement their joint commitment to harmonize policies, legislation, and standards for shared natural resources and environmental management in the LVB; (b) strengthen the capacity of regional, national, local, and community-level institutions responsible for lake basin management; (c) update information on ecosystem health, especially on the water and fishery resources, which underpins resource management decisions; (d) refine and implement analytical tools for ecosystem monitoring; (fe scale up successful community-driven pilot interventions to control point and non-point sources of pollution; (f) mobilize new communities and build their capacity to prepare CDD natural resources management and income generating subprojects; and (g) prepare a plan of investments aimed at reducing sewage pollution from selected urban centers.

This project will achieve its development objectives by supporting generation of relevant information for improved management of the trans-boundary resources in the five countries, while simultaneously promoting economic development in the Lake Victoria Basin. It is within this context that LVEMP II is viewed as a catalyst to foster long-term investments as a contribution to the Lake Victoria Basin's Vision of *having a prosperous population living in a healthy environment.*

The project will be implemented in ten Districts, in which two are of Kigali city, three of Southern Province and three of Northern Province, and two in the Eastern Province in the LVB part of Rwanda. Expected outputs and proposed activities under each component are detailed below.

Component 1: Strengthening institutional capacity for managing shared water and fisheries resources

This component will focus on strengthening relevant institutions to improve governance of natural resources. Its objective is to foster transparency, accountability, and voice, as well as improve performance of key regional and national institutions in respect to prudent natural resources management. The component will strengthen national institutions that regulate, monitor and enforce sustainable utilization of natural resources and environmental standards. Mechanisms for resolving disputes over natural resources management and environmental impacts will also be developed. Target institutions include government ministries and parastatals such as REMA, RADA, RARDA, NAFA, OGMR, RURA, RECO-RWASCO and the National Land Center. Active NGOs and community-based organizations promoting governance of natural resources will be supported. Such institutions include Nile Basin Discourse Forum, etc.

This component will directly or indirectly contribute to the country's goal on social development and equity. To contribute to this goal adequately, the component will have two sub-components: Harmonization of policy, legislations, and regulatory standards; and Ecosystem monitoring and applied research.

Sub-component 1.1: Harmonization of policy, legislations and regulatory standards

The main objective of this sub-component is to create an enabling policy, legal and regulatory environment for the management of Transboundary natural resources of the Lake Victoria basin. The project will finance efforts to harmonize national policies, laws, and regulations governing sustainable utilization of land, fisheries, forest, and water resources. Given the width and complexity of these regulatory frameworks, efforts in particular will focus firstly on the identification of those that require harmonization and secondly on the establishment of nationally harmonized environmental regulatory standards and mechanisms for enforcement.

This sub-component will finance the development and implementation of regional natural resources and environmental management frameworks, which are critical for successful implementation of the Integrated Lake Basin Management (ILBM) and Ecosystem Approach to fisheries management, and watershed management interventions. The management frameworks will be based on the harmonized policies, legislations, and standards and include:

- a Water Resource Management Plan (WRMP) for the LVB;
- an updated Lake Victoria Fisheries Management Plan (FMP); and
- a basin-wide Watershed Management Strategy (WMS).

The sub-component will further finance the development of sustainable financing mechanisms. This will include studying options for establishing the Lake Victoria Environmental Trust Fund (LVETF) to provide long-term financing for management of natural resources.

The expected outputs under this sub-component include: (i) National policies, laws, and regulations governing the utilization of water and fisheries resources are reviewed and harmonized; (ii) Regional environmental regulatory standards, especially for water, and fish resources; and the mechanisms for their enforcement are developed; (iii) Regional standards for industrial and municipal effluent discharges into sewerage and river systems are developed and uniformly applied in all five Lake Victoria basin countries; and (iv) Integrated water and fisheries resources management participatory approaches are mainstreamed in the regional and national policies and programs.

The expected outcome of this sub-component is that the LVB countries use harmonized policy, legal and regulatory standards (water and fish quality) and management (water and fisheries) frameworks for the sustainable use of shared Trans-boundary natural resources.

Sub-component 1.2: Ecosystem Monitoring and Applied Research

This sub-component will build on the results of LVEMP I and will support ongoing and targeted new areas including: **(i)** applied and adaptive research programs that explore ecosystem health, and develop management and technological responses; **(ii**) monitoring, control, and surveillance systems; and **(iii)** sharing of information using regionally agreed protocols. The component will go a long way towards contributing directly to the country's goal on enhancing economic growth by providing the necessary scientific basis for various investments.

The sub-component will finance the development of the scientific and socio-economic data gathering protocols, monitoring and evaluation framework, and data sharing mechanisms. It will also support the monitoring of key environmental and socio-economic parameters, using process, stress reduction, and impact indicators. The ILBM framework components, including the performance of policies, institutions, stakeholder participation, technologies, information systems, and financing arrangements will also be monitored. Results from research and monitoring will guide management decisions on selection of investments required under Components 2 and 3. Specifically, this sub-component will finance the development of the following ecosystem monitoring tools as its principal outputs: (i) the Water Information System (WIS) for monitoring surface water, groundwater, and water quality; (ii) the Decision Support System (DSS) for water resources in the Lake Victoria basin; (iii) the atmospheric deposition monitoring network in Lake Victoria basin; (iv) the GIS-based database for the land use, hydrology, and biodiversity, and Lake Victoria Dynamic Information Framework (LVDIF); (v) ecological model for the Lake Victoria basin; (vi) Water hyacinth surveillance and control strategy and (vii) the regional framework for fish stocks assessment.

Main research institutions operating in the basin and mainstream government departments traditionally involved in data and information collection and synthesis will implement the sub-component. (Such institutions include national agricultural, forestry, industrial development, and fisheries research institutes; institutions of higher learning, and Ministries of Water, Energy, Agriculture and Livestock and Finance and Planning).

In addition this sub-component will finance continuation of research to generate relevant environmental, social, and economic related findings and outcomes to guide Lake Basin management decisions. Particular attention will be placed on promoting aquaculture and stocking and restocking inland satellite lakes in the LVB part of Rwanda. The above research areas will incorporate appropriate socio-economic activities in order to meet the outcomes of this sub-component.

The expected outcome of this sub-component are: (i) the country is using reliable environmental health data of the Lake Victoria basin ecosystem for planning sustainable economic development; (ii) Lake Victoria basin countries sharing data and information from the Geo-referenced database amongst themselves, and disseminating it at regional and global scales; and (iii) LVBC and the Lake Victoria basin countries are using scientific and socio-economic knowledge generated to inform policy decisions on the sustainable management of the Lake Victoria basin ecosystem.

Component 2: Point Sources Pollution Control and Prevention

Poverty, population growth and environmental degradation are intertwined in the Lake Victoria Basin, which supports a large portion of rural and urban populations. The population depends on multiple livelihood activities, which result into numerous resource use conflicts and environmental degradation especially soil and water in the upper catchment and in the lake itself. The RTDA studies for the Lake Victoria Basin indicate that human population and poverty in the Basin have led to degradation of land and wetlands, poor water quality, loss of forest cover, decreasing biodiversity and fish stocks and poor living standards among the local communities. This component will identify high priority areas and hotspots for direct intervention, while catalyzing resources to control point-source pollution in the priority hotspots and sub-catchments.

This component will help to reduce the costs of doing business in the basin in environmentally friendly ways, through defraying expenses for competent assessment of environmental impacts of proposed investments, and sharing the costs of ecologically friendly choices of technology. Interventions will be implemented by public institutions, private sector, and through public-private partnerships at the community, district, and national levels.

This project will support carrying out a master plan, feasibility study and detailed design and Environmental Impact Assessment (EIA) for Kicukiro, Gasabo, Rwamagana, Huye, Musanze, Kayonza, Muhanga and Nyagatare Districts .

The main objective of this component is to reduce environmental stress in the LVB, through the implementation of mitigation and prevention measures. This component will finance investments aimed at reducing: (a) point sources of pollution in priority hotspots; and (b) industrial pollution. The control of point sources of pollution will focus on major polluting cities/towns and industrial sites identified to-date. These investments will complement on-going activities supported by other development agencies in water and sanitation.

The component will have two sub-components:

Sub-component 2.1: Planning for sewage system and wastewater treatment facilities;
Sub-component 2.2: Promotion of cleaner production technologies;

Sub-component 2.1: Planning for sewage system and wastewater treatment facilities

The project will target highly eutrophic hotspots identified in the project designing stage. It will finance:

1. Consultancy services for carrying out a detailed study and Environmental Impact Assessment (EIA) for centralized sewerage systems in Kicukiro and Gasabo;
2. Carry out a master plan, feasibility study and detailed design and Environmental Impact Assessment (EIA) of centralized sewerage systems for Rwamagana, Musanze, Huye, Muhanga, Kayonza and Nyagatare Districts;
3. Carry out pollution level assessment and develop Pollution Control Plan for eight (8) Districts (Kicukiro, Gasabo, Rwamagana, Musanze, Huye, Muhanga, Kayonza and Nyagatare).

The Pollution Control Plans for hotspot areas will be developed, and used to prioritize specific intervention measures. The major factors influencing the priority-setting of point sources management interventions in the LVB will include: (i) stress reduction impacts during the project period on inland lakes, wetlands and Rivers that flow into Lake Victoria; (ii) environmental status change beyond the project period; and (iii) sustainability of the LVEMP II interventions beyond its closing date.

The project will complement investments by the jurisdictions, with the intent to ensure consistent application of effluent standards across boundaries. Thus, in order to maximize synergies, LVEMP II support to point sources pollution control will be closely coordinated with the planned and ongoing urban water and sanitation projects financed by other development agencies. The sub-component will be implemented by City and municipal councils of the selected urban centers.

The specific outputs of this sub-component are: (i) a detailed feasibility study and EIA for centralized sewerage systems in two districts; (ii) a master plan, feasibility study and detailed design and EIA of centralized sewerage systems in six districts and (iii) Pollution Control Plans for eight districts.

The expected outcome of this sub-component is an enabling environment for leveraging resources for wastewater treatment activities, and for the design and construction of selected sewerage treatment systems in some of the major urban centers in the Lake Victoria Basin.

vi) Sub-component 2.2: Promotion of cleaner production technologies

The objective of this sub-component is to reduce industrial pollution, by promoting onsite pre-treatment of wastes from factories and efficiency in raw material utilization through sorting, reuse, and recycling activities. The major polluting industries located mainly in and around Kigali City, will be targeted for demonstration of low cost options, such as WSP and connection of pre-treated industrial effluents discharge to constructed and/or restored wetlands.

This sub-component will finance interventions aimed at reducing pollution loads from industrial effluents through: (i) adoption of Cleaner Production Technologies (CPT); (ii) compliance enforcement on regional effluent standards; and (iii) public education and awareness campaigns. The main activities to be supported include: (a) training of targeted industries on cost-effective measures of reducing wastes; (b) undertaking cleaner production in-plant assessments; (c) facilitating environmentally sound technology assessments and transfers; and (d) assisting industries to prepare bankable projects for upgrading their production lines to reduce pollution and wastes.
To enhance compliance with effluent standards and increase transparency, this sub-component will support: (i) updating of the inventory of factories and their pollution loads identified through prior initiatives; and (ii) posting of the information on the LVBC’s and Focal Point Ministries’ websites. These activities will be coordinated by the Kenya National Cleaner Production Centre and will be financed by the Swedish Government, through SIDA.

The expected output of the sub-component is the reduced untreated industrial wastes discharged into the lake and river systems in the basin. The expected outcome is increased adoption of cleaner production technologies by targeted industries.

These interventions will be undertaken through the national Cleaner Production Center and Rwanda Environmental Management Authority and regionally coordinated by Kenya Cleaner Production Centre.
Initially, the project will work with the major polluting industries identified in the pilot Cleaner Production programme under the Kigali Industrial Environment Project (KIEM).

The project will complement investments by the jurisdictions with the intent to ensure consistent application of effluent standards across boundaries. Investments should be prioritized based not only on potential for nutrient reduction but also for the public health benefits that may accrue. Promotion of Cleaner Production in the industrial sector will be intensified and enforced with potential future standardization across the East African Community countries.

ix) Component 3: Watershed management

The utilization of the natural resources is centered on modernization of agriculture by increasing the productivity of land and improving the farmers' income, adding value to fish production without affecting the environment in doing so, the activities have to be selected mindful of the potential environmental and social impacts. This component seeks to reduce environmental stresses from the Lake Victoria Basin through mitigation and prevention measures. The reduction of non-point source pollution (sediment loads, nutrients, and agro-chemicals) will directly contribute to the achievement of the second PDO/GEO. Scaling up successful models of watershed management practices piloted under other national and regional programs will improve water use efficiency, and generate positive downstream externalities.

The component seeks to reduce environmental stresses from the lake basin, through the implementation of non-point sources pollution mitigation and prevention measures. The project will support community-driven investments in rehabilitating the catchment areas of Rivers Nyabarongo. The main focus will be on: (a) up-scaling successful interventions piloted under Decentralized Environment Management Project (DEMP) and Integrated Management of Critical Ecosystems (IMCE); (b) mobilizing new participating communities; (c) building capacities of selected local authorities and communities; and (d) preparing Community Driven Development (CDD) subprojects, which will be up-scaled during the last phase of the project. This will enable the country gain enough experience on community-driven watershed management and the use of participatory approaches in Environment and Natural Resources Management (ENR).

The component will have three sub-components:

Sub-component 3.1: Restoration of wetlands/river banks and hillside intensification;
Sub-component 3.2: Community driven development for livelihoods improvement;
Sub-component 3.3: Community capacity building and participation

Sub-component 3.1: Restoration of wetlands/river banks and hillside intensification

Community-driven approaches will be used to scale up watershed rehabilitation interventions, such as integrated management of soil and water, reforestation and forestation, catchment protection, and rehabilitation of degraded wetlands. In keeping with the principle of subsidiarity, where existing instruments can be used to address the watershed rehabilitation and other problems, LVEMP-II will seek to boost and top-up those instruments. The project will provide matching grants to riparian communities, with particular emphasis on the poor, marginalized groups, women, and young people, to promote local partnerships in addressing degradation of the watershed. It will ensure that existing CDD approaches (e.g. Haute Intensité de Main d'Oeuvre (HIMO) and Travaux d'Intérêt Général (TIG)) are used. These approaches will be used to scale up community-driven watershed management interventions, introduction of aquaculture, and water hyacinth control measures.

The interventions will focus on sustainable soil and water management. The interventions will be implemented largely by communities. The public and /or community land will be brought under conservation using CDD approaches in the targeted sub-catchments of the 4 Provinces around the country. The interventions will especially target that both the upper watershed and littoral zone which predominantly generate public goods or benefits. Typical activities will include:

- Protection of steep slope farm land;
- Reforestation and Afforestation;
- Sediment retention structures;
- Rain harvesting and storage;
- Small water reservoirs;
- Village infrastructure (drinking water boreholes, improvement of access roads and protection of natural springs);
- Catchment or forest protection;
- Biological and manual Water hyacinth control;
- Wetlands rehabilitation; and
- Aquaculture and stocking and restocking of inland satellite lakes for enhanced Fisheries Resources.

Sub-component 3.2: Community driven development for livelihoods improvement

The interventions will be financed to provide benefits to communities at household and with substantial private benefits. The private or family owned land will be brought under the livelihoods improvement interventions, aimed at intensifying natural resources use and reducing harvesting pressure on forests and wetlands resources in the targeted sub-catchments of the selected Districts. The interventions will include support to income generating activities benefiting the poor such as:

- Terracing and contouring of farms on gentle slopes;
- Horticulture and economic trees, forage and livestock development;
- Small scale Irrigation and drainage activities;
- Livestock development;
- Aquaculture, small scale fish processing, and cold storage facilities.

The livelihoods improvement interventions will be financed to provide incentives for communities to participate in the natural resources conservation activities, and to help improve their livelihoods.

The main outputs of these sub-components will be:

Sub-component 3.1: Natural resources conservation and livelihoods improvement

- District and community levels capacity and knowledge for planning and implementing sustainable watershed management intervention developed;
- Participatory watershed management plans developed and implemented by communities in the targeted catchments and micro-catchments; and

Sub-component 3.2: Community driven development for livelihoods improvement

- Sustainable community-driven livelihood improvement subprojects developed and implemented.

The expected outcomes of implementing these sub-components are:

- Increased adoption of sustainable land management (SLM) practices and natural resources conservation practices by participating communities in the targeted sub-catchments;
- Reduced harvesting pressure on the fisheries and other natural resources.

Indicative activities/Interventions will be to:

Sub-component 3.1: Natural resources conservation and livelihoods improvement

- Rehabilitation of selected degraded catchments (Nyabarongo and other tributaries).
- Support community based investments in afforestation programs, catchment rehabilitation and conservation in targeted sub-catchments in selected Districts around the country;
- Pilot and establish incentives-based mechanisms to address non-point source pollution in selected Districts around the country

Sub-component 3.2: Community driven development for livelihoods improvement

- Promote and invest in soil and water conservation technologies in targeted sub-catchments in selected Districts around the country;
- Promote community participation in good environmental management practices.

Sub-component 3.3: Community capacity building and participation

Significant change in the management of the natural resources will only be achieved through direct community involvement in natural resources management leading to community empowerment and action. Community participation is designed to encourage ownership, and enhance awareness and knowledge on sustainable management of Lake Victoria Basin resources. It is evident that there is low awareness about mechanisms for sustainable utilization of LVB resources. The public is not sensitized on environmental and natural resource management issues in the LVB. Existing information is not readily available to the local population in user-friendly forms for use by policy makers, implementers and communities.

This sub-component will focus on mobilizing communities and building their capacity in the preparation and implementation of the CDD-type subprojects in the watershed. The capacity building includes areas such as participatory subprojects identification, implementation and monitoring plus the community-based procurement and financial management.

Further, the project will lay emphasis on creating communities' awareness of the key environmental issues of the Lake Victoria basin and the benefits of their participation in the watershed management interventions. In particular, the project will organize public awareness meetings for local communities to promote: (a) adoption of non-point pollution mitigation and prevention measures, including soil erosion control and the use of ecological toilets; and (b) change of unsustainable natural resources utilization behaviour.

This sub-component will finance: (i) Translate and disseminate guideline for preparation and implementation of community sub-projects into Kinyarwanda language; (ii) Support community exchange programmes (study tours) in natural resources management; (iii) Create community awareness in implementation of watershed management activities (iv) Training of local governments, farmers and extension personnel on climate change mitigation and adaptation measures
(v) Hiring project watershed management officers; and (vi) Training of farmers, extension personnel on soil and water conservation and water hyacinth reuse

The expected outcome of this sub-component is enhanced communities' ability to plan, implement, and monitor watershed management interventions in the targeted sub-catchments.

xvii) Component 4: Project coordination and management

This component will provide resources necessary for the effective coordination and communication, and monitoring and evaluation of the project activities. At the national level, these tasks will be carried out by the National Project Coordination Team (NPCT). This component will have two sub-components: (i) Project coordination and communication; and (ii) Monitoring and evaluation.

xviii) Sub-component 4.1: Project coordination and communication

This sub-component will finance the incremental operating costs of the various organizations responsible for project implementation, including the National Project Steering Committee (NPSC) and the National Technical Advisory Committee (NTAC). It will also meet the capital and operating costs of the NPCT to be mainstreamed in the National Focal Point Ministry/Office (NFPM). The National Project Coordinator (NPC) will be employed on competitive basis to coordinate project implementation activities during the first two years. This sub-component will also strengthen the financial and procurement management functions in the NPCT to enhance project's resources management and accountability. Funds will be available to recruit need-based additional staff, such as accountant, procurement specialist, administrative secretary and drivers, under the operational costs category.

In addition, this sub-component will finance the development of a communications system for improving decision making and planning, through sharing of data and information among the main implementing agencies. This will enhance sharing of existing technical knowledge and implementation experiences, at the regional, national, local, and community levels. Specifically, this sub-component will finance the development of: (i) an internal communications system to facilitate information sharing; and (ii) information sharing protocol to enhance exchange of data among LVBC, NFPM, and main implementing agencies.

The sub-component will also finance the national outreach program. It will focus on delivering Lake Victoria's environmental education programs to the policy-makers and public at large. The objective is to ensure an understanding of the key environmental issues for the sustained public support and long-term funding commitment to mitigation and prevention measures. Therefore, the outreach program will target the Parliament, local politicians, donor community, and the general public. The sub-component will support: (i) development and implementation of national public awareness and education materials for the sustainable use of LVB resources; and (ii) outreach activities to seek the support of key policy-makers, including parliamentarians and senior government officials.

The NFPM will lead the implementation of the national outreach program and will contract the appropriate print and electronic media channels of communications to deliver key messages to specific target audiences. The project will provide the information to be communicated, while the media houses will package it to suit specific audiences. The expected outcome of this sub-component is increased accountability of both regional and national institutions responsible for managing the LVB resources.

xix) Sub-component 4.2: Monitoring and Evaluation (M&E)

This sub-component will provide resources for: (i) establishing the national GIS-based M&E and Management Information System (MIS); and (ii) collection, analyses, storage, and dissemination of data and information on the project's implementation performance, outcomes, and impact, based on the indicators provided in the Results Framework.

Sources of data for feeding the M&E system will include: (a) Administrative data collected through the project MIS, such as progress, technical, and financial reports; (b) specially designed qualitative and quantitative household survey instruments; (c) existing and newly collected geo-referenced data; and (d) scientifically collected environmental and ecosystem health data. The monitoring and evaluation plan developed for LVEMP II will serve two purposes: (i) periodic assessment of project implementation and performance; and (ii) evaluation of their results in terms of relevance, efficiency, effectiveness, impact, and sustainability. Both (i) and (ii) will contribute to improved policy and the LVB management decision-making towards achieving the project development and global environmental objectives.

The communities participating in implementing watershed management interventions will also be involved in project monitoring and evaluation. Community-based M&E activities will regularly track the performance of the CDD subprojects. To accomplish the M&E functions, the NFPM will hire a qualified M&E specialist. The project will ensure that monitoring reports, including quarterly and annual project implementation progress, procurement, financial and audit reports are produced regularly. Further, the outcomes of research and ecosystem monitoring will also be stored and disseminated through the GIS-based regional and national Management Information Systems (MIS).

The expected outcome of this sub-component is that implementing agencies and local communities are utilizing the M&E and GIS-based MIS information for management decision-making and development planning.

3.0 Background of the LVB in Rwanda

Rwanda is an important upstream catchment for the Lake Victoria but faces severe land degradation, leading to severe soil erosion, causing siltation and sedimentation of water systems, which directly affect riparian communities as downstream resource users outside Rwanda. The large part of country, approximately 90% of the total surface area of 26,338 $Km^{2,}$ lies within the western Lake Victoria Basin catchment. Only the western part about 10% of surface area lies within the River Congo Catchment. The Lake Victoria Basin in Rwanda is defined by the extent of the Kagera River catchment in the country. Rwanda is therefore, key upstream riparian country of the Lake Victoria Basin.

Rwanda economy is agricultural based with more than 90% of its population deriving their livelihoods from agriculture. The arable lands are the most important natural resources and about a half (52%) of the total land is arable. The main crops grown are tea, coffee, cereals (maize, sorghum, and rice); pulses (beans, peas, soya, and ground nuts); bananas; potatoes (sweet and Irish varieties); cassava, and more recently, horticultural crops (vegetables, fruits, and flowers). However, the soils have been degraded due to over-cultivation as a result of expanding population and low adoption of scientific technologies. Production is declining due to multiple factors, including poor soil fertility, low external inputs use, poor pest management, low yielding varieties and poor quality seeds, low use of scientific technologies due to poor extension services to the farmers, poor marketing structure etc. Due to expanding population pressure on land, marginal lands (steep hills, wetlands etc) have been encroached to put more land under agricultural production leading to accelerated erosion problem and loss of nutrients and more pest problems as stressed plants suffer more damage than vigorous health crops.

Since agriculture has been identified in vision 2020 and EDPRS as engine of economy and means to attain MDG and poverty reduction, the National agricultural policy and strategy of agricultural transformation has identified crop intensification as mechanism to attain the above objectives. The crop intensification will include use of high yielding varieties, increased fertilizer, pesticides use and proper use of available water resources. In order for crop intensification to be sustainable, it needs to establish sustainable pest management plan to ensure food safety, human and animal safety, and environmental protection. This can only be achieved through development and adoption of participatory integrated pest management system for all major food and cash crops.

Moreover, during EDPRS period 2007-2012, the agricultural sector has fixed an objective of attaining an annual growth of 7%. Some of the performance indicators include the following: land protected against soil erosion will rise from 40% to reach 100% (increase of 60%), households with cattle rearing will rise from 16% to reach 60% (increase of 44%), the use of mineral fertiliser will increase from 11% to be 17% (6%), importation of mineral fertilisers will increase from 14 000 tons to 56 000 tons, the use of organic manures will attain 18% from 7%, use of good quality seeds will increase from 24% to 37%, use of insecticides will increase from 24 % to 37%. (13% increase). The increase of insecticide use is of great concern and safe use of pesticides should be reinforced at all levels. In order to safeguard environment and protect producers, consumers and sustain production, pesticides should be applied in a way that minimizes adverse effects on beneficial organisms, humans and the environment. In this case it would mean investing in alternative pest management technology development and adoption.

3.1. Rwanda bio-physical environment

Landscape**:** Rwanda is a mountainous country characterized by a diverse relief ranging from hilly volcanoes and mountain forest in the north and west, through the steep and gentle hills in the central regions and to the lowland hot and dry eastern plains.

Congo-Nile divide: Rwanda is sandwiched between two of the world's greatest river systems, the Congo River that drains the western parts of the country (10% of surface) and the Nile River that drains the Eastern parts (figure 1). The Nile river system accounts for 90% of the drainage system in Rwanda (UNDP/GEF/World Bank 2001), and it is this, through the Akagera River that makes Rwanda a critical component of the greater Lake Victoria basin.

Dense drainage river network: The dense network of rivers, streams, lakes and marshlands (figure 2) have ensured permanent availability of water or moisture in most of the valleys separating the hills, thereby affording farming communities at least two crop seasons and availability of pastures for livestock.

The double cropping system practiced in rice grown in marshlands will in long run favour fast multiplication of pests and diseases population. In addition, the use of pesticides destroys more natural enemies than pests and at the same time induces development of insect resistance against insecticide resulting in more yield loss.

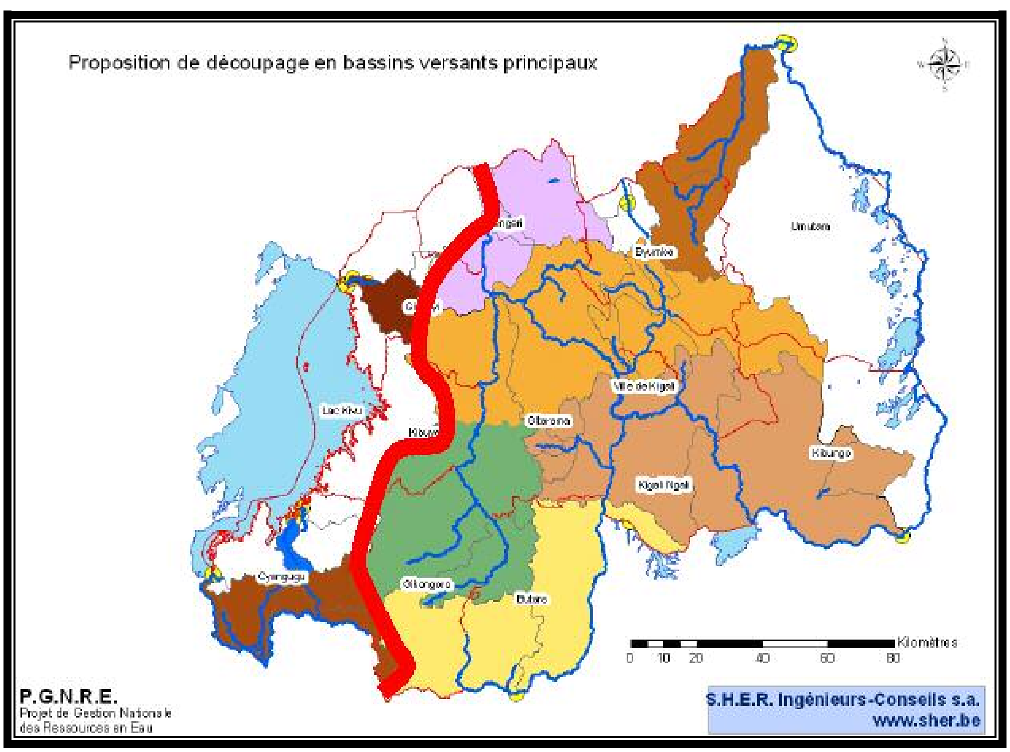

Figure 1 **Congo-Nile divide** (Source: SHER ingenieur)

Favourable climatic condition - The Rwanda climate is characterized by high suitability for agriculture with mean annual rainfall ranging above 1000 mm due to high altitude. From 4,500 meters in the volcanic ranges of the North West to 900 meters in the east (MINELA, 2003a; and 2004). The high altitude areas of the North and

North West receive much higher rainfall (averaging 1800mmm/ annum), while the medium altitude areas of the west, south and east receive much less (generally about 1000mm/ annum). The mean annual temperatures range from 16 –17 ^{o}C in the higher altitudes, 18-21 ^{o}C in the central plateau and 20- 24 ^{o}C in the eastern and western lowlands. Thus, weather information manifests little diverse changes. This climate is also suitable for the development of pests and diseases in the country.

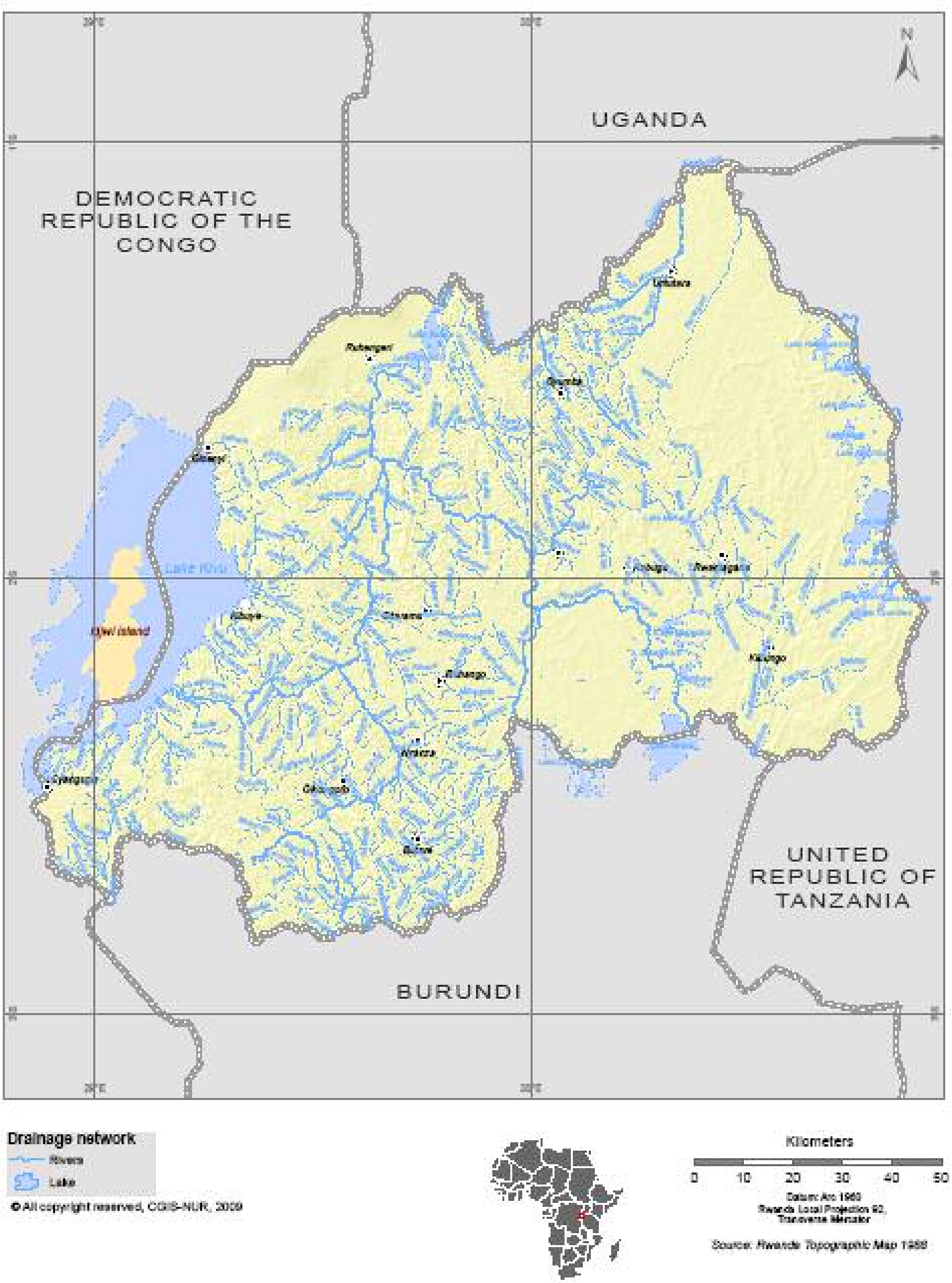

Figure 2: River network in Rwanda

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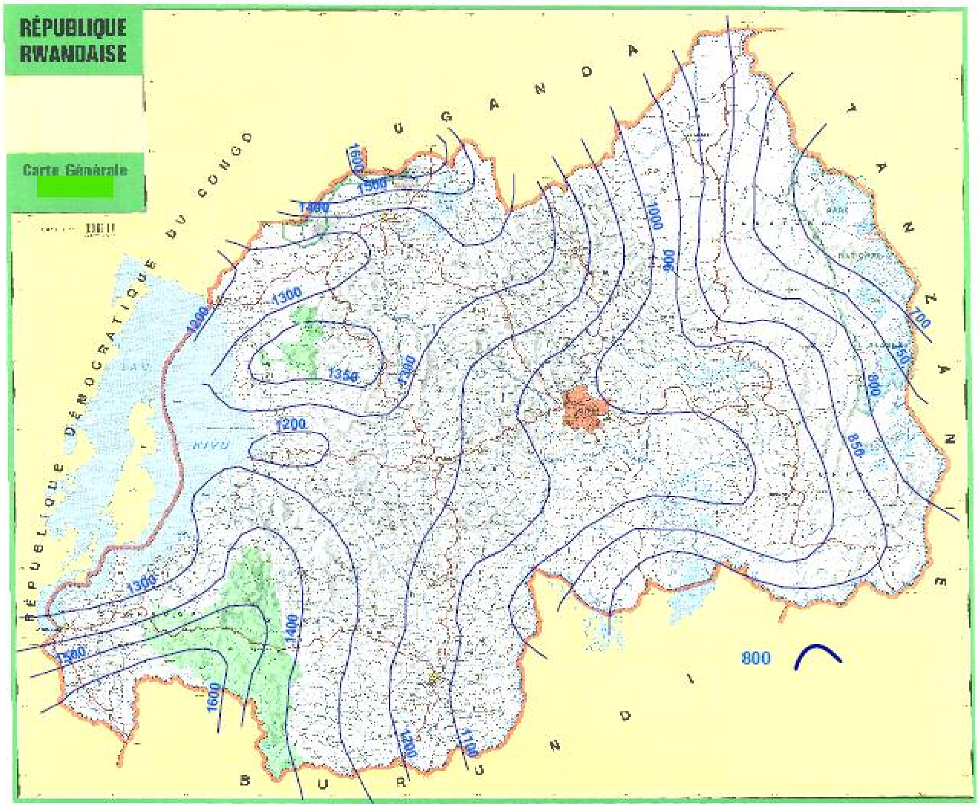

Figure 3: Rainfall pattern in Rwanda from the period 1929 to 1987 (*Source: MINAGRI/RADA and SHER Ingenieur)*

3.2 Demographic and Socioeconomic Characteristics

The Population and Housing Census in 2002 indicated that Rwanda's population was 8,128,553 persons of whom 3,879,448 (47.7%) were male and 4,249,105 (52.3%) were female (MINECOFIN/NCS, 2005). The density was 378 persons per sq. km while the annual growth rate was 3.1%. The same census indicated that the population was predominantly rural (83%). Rwanda has one of the highest population densities in Sub-Sahara Africa. About 76% of the population in Rwanda is in the LVB.

3.3. Integrated Pest Management (IPM) in LVB in Rwanda

The term "integrated pest management (IPM)" in relation to LVEMP-2 was started by scientists in USA out of problems arising from pesticides use in alfalfa pest control. It was originally developed as *Integrated Pest control* in 1959, focusing on pest scouting to determine threshold for application of pesticide. However, this approach was changed in 1970's to integrate farm and natural resource management, after realising that the agricultural practices influenced pest development, and that crop intensification often leads to increased pest problems. Therefore the pest management measures have to fit into farming system. This was followed by third generation in 1990's which integrated life sciences and social sciences. The involvement of farmer in decision making became evident and took into consideration site specific agro-ecological and socio-economic conditions. The current approach to IPM is therefore more participatory and the farmers have to participate in the technology development or adaptive studies in order to determine site specific solutions. Both farmers and experts focus on producing a healthy crop which in turn produces high yield and profitability.

Therefore in order to implement a successful IPM, we have to think on how to grow healthy plants on healthy environment and find out what they need in order to grow and give high yield profitably. All crops need fertile soils, enough water, and sufficient sunlight and usually suffer from pests, diseases or weeds at any stage of crop growth. Under the favorable conditions, crop plants will grow and produce abundant fruits and seeds. Therefore, in the absence of insect pests, diseases, weeds, poor soils and water shortage, crops will grow healthy and strong. We can now agree on how to define IPM in simple words as a strategy or system that combines all available methods to ensure that crop plants are growing healthy so that they produce high yields according to their genetic potential. This is why the fundamental principle of IPM is to grow healthy crops through application of crop health management practices. This is the best approach to effective pest and disease management in the field and in storage which leads to healthy environment and sustainable agriculture for development.

The Government of Rwanda (GOR) is guided by vision 2020 in long term and EDPRS in medium term. Under both documents, agriculture has been identified as an engine for national development for alleviation of poverty through revitalizing the rural economy, thereby increasing rural income and reinforcing national stability. The agricultural intensification and commercialisation of products together with diversification of economic activities has been identified as a means to revitalize the rural economy. LVEMP-2 will play key role in assisting GOR to achieve vision 2020 and EDPRS.

The intensification of agriculture would require the correct use of external inputs, their timely availability and affordability by the majority of farmers involved in the production process. The external inputs include pesticides, industrial fertilizers, high yielding varieties and crop management knowledge. Rwanda being at the upper part of LVEMP-2, with its water feeding into Lake Victoria, proper and safe use of pesticides is very important. This would be achieved through application of Integrated Pest Management (IPM) principles in the fight against pests and diseases.

Since the overwhelming majority of the population of Rwanda live in rural areas where the prevalence of poverty is extremely high, and the application of modern agricultural technologies is very rare, the promotion of Integrated Pest Management (IPM) will be needed at all levels. IPM should be identified and adopted as a national tool to fight pests and diseases and should be promoted at different structures of rural communities to ensure successful application. The development of IPM intends to assist LVEMP-2 and beneficiaries to achieve proper application of improved agricultural technologies and protection of environment for sustainable development.

Integrated Pest Management is applicable because under the component 3 - watershed management, LVEMP II will support CDD-type sustainable land management activities, which may use pesticides. The IPM framework supports safe, effective, and environmentally sound pest management. It promotes the use of different methods such as biological, cultural methods, etc.

3.4 Suitability of crops production in basin in Rwanda

Banana production: Banana is the most important crop in Rwanda occupying 23% of arable land (Mpyisi *et al*. 2000) and contributes 60-80 % of household income in banana growing area. The country produces about two millions tons per year (Mt/yr), making it the 6th in production in Africa and 11th in the world, while in consumption it is the 2nd in the world with about 144 kg/pers/yr after Uganda with 223 kg/pers./yr. Highland bananas (*Musa AAA-EA*) are traditional food and cash crop in the East and Central Africa highlands; where they are largely produced and remain unique in the world. The banana fruit is available fresh throughout the year, thus an important food security crop and reliable household income. The crop is produced in all provinces, especially in Eastern and Western provinces zones. Banana is mainly produced by the subsistence farmers using traditional indigenous technologies, without use of external input, resulting into low yield of about 5.6 t/ha/year. The decline in production may be due to both the biotic and abiotic factors. The biotic factors being pests, diseases and weed infestation, while the abiotic factors being mainly poor management and lack of adequate pruning/desuckering which induces competition between plants for nutrients and water.

Cassava Production: Cassava plays an important role in the food security and livelihoods of millions of people in Rwanda mainly in the Eastern and Southern Provinces. As a result, the country is the 5th in the World in consumption of root and tubers. Cassava occupies 27%t of the cultivated lands and is consumed under different forms in Rwanda: as fresh tubers, products from flour, and cooked leaves.

The production of this important crop is constrained by many abiotic and biotic factors. In the past, the major biotic factors have been the cassava mealbug, (*Phenacoccus manihoti)*, cassava green mite (*Mononychellus tanajoa*), and cassava mosaic disease pandemic in the great lake region. The first two were controlled using classic biological control using efficient natural enemies namely, a wasp *Epidinocarsis lopezi* and a predator mite *Typhlodromalus aripo* respectively and the pests are no longer a problem. Mass rearing of *E. lopezi* at IITA was stopped in 1992 when the pest control was assured; however, the control of cassava green mite is still going on in some countries and wherever an outbreak is observed, the IITA Biological Centre at Cotonou in Benin give support. Currently the major and severe problem and threat to cassava as a crop is the cassava mosaic disease (CMD) and it is controlled through an integrated approach using phytosanitary, resistant varieties and farmers training.

Coffee production: Rwanda possesses ideal growing conditions for Bourbon Arabica production. Coffee is produced mainly in the three out of four provinces of the country, in the western part of the country along entire shore of Lake Kivu, eastern, and southern provinces, at an altitudes ranging from 1350 to 1850 meters above sea level.

Rwanda has rich volcanic soils, fairly good rainfall regimes and moderate year long temperatures favour the slow maturation of the coffee beans, creating a distinctive taste in the cup. Rwandan coffee is produced using few chemical fertilizers and insecticides. Soil fertility is maintained using traditional mulching and manure application techniques. Coffee is harvested between the months of March and June. Coffee production is indeed a smallholder activity. Today some 430,000 households produce coffee, and the typical family farm has about 200 trees.

Beans production: Common bean (*Phaseolus vulgaris*) is the second most important source of human dietary protein and the third most important source of calories of all agricultural commodities produced in eastern and southern Africa (Pachico, 1993). This region also has the highest per capita bean consumption in the world, an indication of its importance in rural and urban livelihoods. For example, in Rwanda, bean contributes over half of dietary protein and a large part of the calories intake. Annual consumption in some areas in western Kenya, Rwanda and Burundi exceeds 60 kg per person. (Jaetzold and Schmidt, 1983). Beans are also a valuable source of vitamin-B complex, iron, zinc and other essential minerals. The crop is grown by smallholder farmers, especially women, and plays an important role in the sustainable livelihoods, providing for both food security and income generation. Beans are produced mainly in Eastern, Southern and Western Provinces; however, climbing beans are also produced in the Northern Province.

Maize production. Maize crop is produced in all provinces of the country, either on the hill side or in the marshland. In the Southern Province, maize is mainly produced in the marshlands and largely along Akanyaru river and its tributaries; and is usually grown during the dry season, followed by a rotational crop or flooding during the rainy season. This cropping system reduces stem borer population build up and other pests as we will see in the later sections of this manual. Similarly in the North province, the farmers produce maize on the upland as rain feed crop and is rotated with potatoes and maize stalks are used to feed livestock. This is also a good practice which reduces stem borer population build up. Therefore, the local crop systems should be studied and their effect on pests understood, before making decision on control method.

Potatoes production: The potato *(Solanum tuberosum)* is one among temperate crops which are generally grown successfully in the high altitude of the tropics where optimum temperature for tuber development is about 15^{o}C and not above 27 ^{O}C. In Rwanda, it is well established itself in the Northern Province (Virunga zone).and is one among priority crops in the country and important food and cash crop. It is an annual, herbaceous, branched plant with a height of 0.3-1 m, which produces the swollen stem tubers containing 2% protein, 17% starch.

The potatoes are propagated vegetatively from tubers and the production of healthy 'seed tubers' is a major aspect in pest management. Generally potatoes production in the cooler regions of the tropics has greatly diminished pest load and spectrum in relation to the numbers encountered in temperate countries.

Rice production: Rice is an important cereal, widely cultivated after wheat. However, in Rwanda, it was recently introduced, and widely promoted during the last five years, after the year 2000; and it is normally grown in the mid altitudes, in the East, South and West Provinces (mainly Rusizi District). Rice is an annual grass with erect stems and a terminal panicle bearing hermaphrodite flowers, 98-99% self pollinated.

The primary roots growing from the radicals are short-lived, and the adventitious roots are produced from the underground nodes of the young stem and from the upper nodes. The development of the root system depends on soil type. In general the abundant roots are found in the top 20-25 cm of soil, however, in the heavy soils they can remain in the top 15 cm, while in the light soil they reach 50 cm depth. The rice stem produces tillers from node buds, and the 1st order tillers can produce 2nd order tillers which in turn can produce 3rd order tillers. A rice plant can produce 3-10 productive tillers depending on variety and growing condition.

The major pests and diseases observed in the field and reported by farmers include: a) Rice blast *(Pyricularia oryzae*, b) Stalk-eyed borer **(***Diopsis thoracica*, Diopsidae), c) birds, and d) rats. This report will only address the first two problems.

Tomato production: Tomato is the most important vegetable, relatively easy to grow, important source of nutrition (vitamin A and C) and income for smallholders. They are produced in all four Provinces of Rwanda (Eastern, Southern, Northern and Western). Tomatoes are members of the *Solanaceae* family, together with potatoes, egg plant, peppers, and tobacco. These related crops cannot be used in rotation. Tomato varieties can be divided into two main types. (i) *bushy varieties* (also called *determinate* cultivars) which can usually grow without support (e.g. Roma variety), and (ii) *vine varieties* (also called *indeterminate* cultivars such as Money maker) which need to be supported, a process known as *staking*, and usually *pruned* to leave only one or two main stems. Staking helps to avoid diseases by improving air circulation in the crop and preventing plant parts and fruits touching the soil.

Tomatoes are usually grown in seedbeds and then transplanted when they have grown to a height of about 10 to 1 5cm. As with many crops, it is better to sow seeds thinly and remove competing weeds to produce vigorous plants which are more likely to withstand pests and diseases.

Tomato crop is attacked by a variety of insect pests that chew or suck their leaves, flowers and fruit. A wide range of diseases also attack the leaves, fruit and roots, particularly in the rainy season when high humidity favors pathogen development and transmission. In general tomatoes production is constrained by diseases and insect pests.

3.5. Agriculture in National policies, institutional and legal framework

3.5.1 Achieving Millennium Development Goals

Under the seven Millennium Development Goals (MDGs), a number of targets have been set for Rwanda and the country is committed to reaching them by 2015 (NISR & MINECOFIN, 2007). Only a small number of the 49 indicators that were drawn up to chart the progress toward each of the goals relate specifically to the agricultural sector. Those that do are contained in Table 2 below. However, the realisation of the MDG1 is heavily dependent upon the growth of the agricultural sector, given its importance in the economy of the country-as noted, it currently accounts for almost 40 per cent of the GDP while an additional 4 per cent is provided through agro-processing and more through agricultural commerce. In addition, as noted, the sector provides employment for over 80 per cent of the workforce and for many years now (with the exception of 2006), the sector has provided more than one-half of the country's exports, in some years much more than half.

3.5.2. Vision 2020

The vision 2020 and EDPRS have identified agriculture as an engine for economic growth and poverty reduction. The government's agricultural policy 2004 (NAP) and Strategic Plan for Agricultural Transformation 2007 (SPAT-II) were created with ultimate objectives to contribute to national economic growth, improve food safety and nutrition, and increase rural households' revenue. To achieve these objectives, there has been an institutional restructuring to provide stakeholders with a comprehensive support system that is accountable at decentralized levels.

Rwanda's *Vision 2020* describes the basic development objectives of the country over the long term. It seeks to transform the economy by bringing about a rapid increase in growth and a significant reduction in poverty. By the year 2020, the target date, it is expected that the country will have, among other things, reached middle-income status with per capita GDP having grown to US$ 900 from an estimated US$ 220 in 2000. The other goals include a reduction by more than one-half in the incidence of poverty and extreme poverty and improvements in a range of more general standard of living indicators.

The vision 2020 establishes the modernisation of agriculture and animal husbandry as one of six pillars supporting its aspiration to "build a diversified, integrated, competitive and dynamic economy, which could raise the country to the level of middle income countries." The agricultural sector is to be accorded a high priority in the Government's programme of development, with a fundamental transformation of the sector being required and planned for. This will, it is foreseen, involve the sector moving from subsistence to a commercial mode of production, thus attracting a substantial increase in investment. It will result in an increase in household incomes and a reduction in poverty levels, by 50 per cent over twenty years. Agriculture is seen as a major engine of growth for the economy and its modernisation is one of the six components (pillars) of the *Vision.* Thus by 2020, the sectoral contribution to GDP is projected to comprise 42 percent from services, 33 percent from agriculture and 26 percent from industry. Industry, including agro-processing, currently represents only 14% of GDP but has promising growth prospects.

The key national and agricultural sector-related goals, or targets, presented in the *Vision 2020* document, are listed in Table 1. More recently, in September 2007, the Government of Rwanda developed its second poverty reduction strategy, known as the Economic Development and Poverty Reduction Strategy (EDPRS). The Government of Rwanda has also committed itself to the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa's Development (NEPAD). This is a framework, reflected in a set of key principles and targets, which aim to help African countries reach a higher path of economic growth through agriculture-led development. Most notable among the principles and targets are: the pursuit of a 6% average annual sector growth rate in agriculture, and the allocation of 10% of national budgets to the agricultural sector. CAADP also lays out paths toward achievement of the targets that have been incorporated into this Strategic Plan.

The intervention areas identified include: (i) significant increase in the value of both coffee and tea exports, (ii) marshland and hillside irrigation, (iii) horticulture, (iv) agricultural research, (v) the provision of agricultural inputs (seeds and fertilisers), (vi) livestock development (milk in particular), (vii) land and water conservation, (viii) the rehabilitation of degraded soils, (ix) agro-forestry, (x) rural infrastructure such as electrification and feeder road upgrading, (xi) the diversification of agricultural exports and (xii) the provision of market information. The reform of the land-tenure system is seen as being essential to underpin these interventions and to ensure that an enabling environment for private sector investment and job creation in agriculture is put in place. It is clearly indicated in vision 2020 and EDPRS that *"Enormous efforts must be made in order to ensure that agriculture changes its nature and that Rwandan professional farmers change their vision, mode of work and mode of life."* However, experience the world over has shown that this is a lengthy process.

Table 1. Selected national and agriculture-related goals in the Rwandan Vision 2020

Indicator	**2000**	**2010**	**2020**
Population (million)	7.7	10.1	12.71
GDP/capita (constant 2000 US$)	220	400	900
Poverty (%)	64	40	30
Agricultural GDP growth (%)	9	8	6
Agriculture as % of GDP	45	47	33
Agriculture as % total population	90	75	50
Land under "modernised" agric (%)	3	20	50
Fertiliser application (kg/ha/annum)	0.5	8	15
% banks' portfolio to agric. Sector	1	15	20
Soil erosion protection (% total land)	20	80	90
Coffee exports (tonnes)	19,000	44,160	*n.a.*
% of coffee production fully washed	1 *(2001)*	63	*n.a.*
Coffee export earnings (US$ m)	22.0 *(2002)*	117.1[1]	*n.a.*
Tea export earnings (US$ m)	26.8 *(2003)*	91.0	*n.a.*
Agricultural exports	*n.a.*	*n.a*	*"5-10 times yr 2000 value"*

Source: Ministry of Finance & Economic Planning, 2003.

3.5.3 The Economic Development and Poverty Reduction Strategy (EDPRS)

The basic macroeconomic context of this Strategy is the EDPRS, which is the country's medium-term economic development plan, providing the framework within which the Government seeks, over the 2008-2012 period, to consolidate the process of changing the structure of the economy and moving towards achieving the long-term targets, both laid down in Vision 2020 and that are the Millennium Development Goals. It aims both to increase economic growth and to reduce the incidence of poverty-the latter to 46 percent from its rate of 57 percent in 2005/06.

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The agricultural targets found in the EDPRS are drawn from those listed in the PSTA-I and they also appear in the plans that are drawn up each year by MINAGRI for the PSTA's implementation. It therefore follows that the agricultural policy objective, targets and programmes of the EDPRS are fully aligned with the goals of Vision 2020 and also of CAADP. In short, then, PSTA-I and II represent the operational framework through which the agricultural component of the EDPRS is implemented. Four higher-level indicators to be realised by the sector during the EDPRS implementation period have also been drawn up. They are:

(a) 7% annual real rate of growth of agricultural GDP;
(b) 4% annual real growth rate of per capita agricultural GDP;
(c) 20% decrease in people reporting agriculture as their main source of income; and
(d) 50% reduction in the proportion of the population receiving less than the minimum food requirements (to 16 per cent).

Agriculture is explicitly recognised in the EDPRS as being one of the four priority sectors of the economy that will both stimulate economic expansion and make the greatest contribution to poverty reduction-the other sectors being health, education and road maintenance. The overriding policy objective for the sector is for rural household incomes to be increased in a sustainable manner and for the sources of income to be diversified while, at the same time, food security is to be strengthened. It is forecast that agriculture will contribute 28 per cent towards the growth of overall GDP over the five-year period, down from the 33 per cent that the sector contributed between 2003 and 2007.

One of the functions of the EDPRS is to guide budget allocations. Thus, with the modernisation of agriculture being one of the areas it identifies as being critical to overall economic growth, the resources allocated to the sector are to be increased to average 6.9 % of the national budget over the five-year period. Detailed figures presented in the EDPRS show that an average of 4.1% of the national recurrent budget and 11.5 % of the capital budget are to be earmarked for the sector.

In this way, it is projected, a faster rate of growth of the sector will be generated than the 4.6 % per annum that was realised between 2001 and 2006; between 6 and 8 per cent is projected. However, the projected MINAGRI budget for 2008 is approximately RwF 26.00 bn, which may indicate a need to strengthen the implementation capacity of the Ministry and the agricultural service agencies and their projects, as well as to review national budget priorities.

In order to increase agricultural productivity, key interventions under the EDPRS framework will include increasing soil fertility, reducing soil erosion and improving land use, land management and land administration. Farmers are to receive intensive training in the optimal use of external inputs-improved seeds and inorganic fertilisers in particular. In addition to coffee and tea, crop and livestock enterprises that are projected to contribute significantly to the sector's growth include hides, skins and other livestock products,[2] horticulture (including floriculture), pyrethrum and sericulture. In this way, the production base will be significantly broadened with new agricultural exports making an important contribution. At the same time, both production and value added for the traditional exports of coffee and tea are projected to increase rapidly. Thus, the sector as a whole is expected to remain a reliable source of export earnings.

Over the period 2007-2012, EDPRS for agricultural sector has fixed as objectives, as earlier indicated, of an annual growth of 7%. Performance indicators retained in this sector for the period of EDPRS attest that many efforts will be necessary to achieve expected results: Land protected against soil erosion will increase from 40% to 100%, households with cattle rearing will increase from 16% to 60%, the use of mineral fertilisers will increase from 11% to 17% with importation of mineral fertilisers rising from 14 000 tons to 56 000 tons, the use of organic manures will increase from 7% to 18%, the use of good quality seeds will increase from 24% to

37***%, the use of insecticides will increase from 24 % to 37%***; reclaimed and exploited marshlands with irrigation will increase from 1% to 1,6% (from 15 000 ha to 30 000 ha) of total arable lands area, irrigation on hillside will pass from 130 ha to 3 200 ha.

As for food security, production of most food security crops for local consumption (maize, rice, beans, sorghum...) will increase by 30% from 2005 baseline, while cover rate of food needs will pass from 1,734 to 1,856 kcal, from 49 g to 53 g of proteins and from 8.8 g to 17 g of lipids. International standards are respectively 2,100 kcal, 59 g of proteins and 40 g of lipids per day per person.

Regarding proximity services, it is expected that ratio extension worker/farmer household will pass from 1:3 000 to 1: 2 550, while number of agricultural cooperatives will pass from 1 105 to 2 242. The financing of agricultural sector by micro finances institutions, development and commercial banks is expected to rise from 3% to 7% of total amount of credits granted by these institutions

The agricultural products for export will increase as follows: green export will increase from 73 000 to 123 000 tons, green coffee will increase from 26 000 to 40 000 tons, pyrethrum will increase from 3 183 to 6 366 tons, and leathers and skins will increase from 1 041 to 1600 tons.

Table 2. Agricultural sector-related targets in the EDPRS and MDGs

Indicator	2006	2012
(i) EDPRS		
Ag. land protected against erosion (%)	40	100
Area under irrigation (ha)	15,000	24,000
of which hillside irrigation (ha)	130	1,100
Reclaimed marshland (ha)	11,105	31,105
Fertiliser application (kg/ha)	4	12
Inorganic fertiliser use (% households)	11	17
Improved seed use (% households)	24	37
Rural households with livestock (%total)	71	85
(ii) MDGs		
Poverty prevalence (%)	56.9	34.7
Child 0-5 yrs stunted (%)	45	27.2
Child 0-5 yrs wasted (%)	4	2.5
Child 0-5 yrs under-weight (%)	23	16.3
Protein needs available/head (%)	*n.a.*	*n.a.*
Proportion of land area with titles (%)	1	*n.a.*

3.5.4. Decentralization and local development policy

Another major pillar in policy framework of the Government of Rwanda is the Decentralization Policy adopted in 2000 in order to involve local administrations more directly in the development process. It was complemented by a Local Administration Reform, initiated in 2002 and implemented in 2006, which made the administrative structure lighter by creating 30 districts, in place of the earlier 106 districts, and four provinces plus the City of Kigali to replace the former 12 provinces. The execution of the decentralized policy was followed by the revision of various laws that defined the organization and functions of districts and below the districts, the sectors and cells (*cellules*). The major objective for most forms of decentralization around the world is to enhance the participation of citizens in planning and strengthen, through various means, the “voice” of citizens in influencing service delivery providers.

Decentralization has therefore both a political and a technical angle. The political (or democratic) decentralization is expected to offer citizens, including the poor, the possibility of increased participation in local decision-making processes, either directly or indirectly through elected leaders, which is expected to result in better quality of and more easy access to services. At the same time, and still on a political plane, decentralization is believed to offer a way of sharing power more widely within a country, among regions and among various groups, thereby providing grounds for political consensus and stability. The technical argument in favour of decentralization is based on the principle of subsidiary where planning and decision-making is taken down to the lowest area- level feasible, whereby this is supposed to increase the accuracy in the specification of problems and opportunities; and increase the commitment of people involved to implement their plans (gain a sense of ownership over the plans) and hence for them to experience participatory, as opposed to representative, democracy.

The argument hence is that decentralization enhances both the effectiveness and the efficiency in the use of public funds; firstly, because when immediate beneficiaries (either directly or through representation) are involved in planning for allocation of public resources, the planned activities are likely to better suit local needs and priorities as compared to a situation where the Central Government agencies plan and deliver on their behalf. Secondly, decentralization is expected to increase efficiency with regard to the use of public funds mainly through improved governance that in turn should result partly from increased local ownership of programmes, partly from better fine-tuning to local circumstances, and partly from enhanced and more direct mechanisms of accountability.[3]

As a result of the decentralization framework, almost all Districts and all Provinces in the country possess a Community Development Plan (CDP) designed on a participatory basis. Results from this process were used in the elaboration of the definition of the agricultural strategy.

Districts are legal decentralized entities responsible for coordinating local economic development and service delivery at the sector levels, as well as promoting cooperation with other local governments. An elected council, a mayor, and an executive committee will run the districts.

The *Sector levels* coordinate and manage local development planning, tax collection, statistics, education and social affairs, land planning, housing, and infrastructures. Sectors will be run by an executive secretary and supported by several employees. The *Cells* retain their main responsibility for community action mobilization.

3.5.6. The Rwandan agricultural policy and planning environment

3.5.6.1. Agriculture under decentralized system

The empowerment and capacity building of farmers and professional organizations, as well as the forging of new partnerships between civil society and the public and private sectors, are all important factors in delivering client-oriented, demand-driven agricultural services.

In order to improve and contribute to better service delivery and accountability in the agricultural sector: The Government of Rwanda (GOR) and Ministry of Agriculture and animal resources (MINAGRI) in particular established semi autonomous institutions: RADA (the Rwanda Agricultural Development Authority) and RARDA (the Rwanda Animal Resources Development Authority) to provide agricultural and animal production advisory, outreach, and extension services to new regions, districts, sectors, nongovernmental organizations, farmers and farmer organizations, and private entrepreneurs.

They operate through satellite centres in various agro-ecological zones. The restructuring of the Institute of Science and Agricultural Research, which focuses on the scientific and technological development and capacity building of Rwanda agriculture and animal production, now operates through satellite centres. In order to improve agricultural sector, the MINAGRI is in process to merge DADA, RARDA and ISAR into an autonomous organization namely Rwanda Agricultural Board (RAB) and improve service delivery to the farmers by bringing researchers and extension staff together and create team work instead of isolated discipline focused services. There has been a gap between research and extension services.

It should be noted that MINAGRI projects also tend to operate in a highly decentralized manner because they involve local communities and farmers intimately in the process of designing the actions to be carried out. This kind of decentralization, in which beneficiaries are also participants, is an important ingredient for project success

The IPM activities will be coordinated at cell level, where possible or at cooperative level where members of cooperative comes from different administrative areas.

3.5.6.2. The Rwandan agricultural planning environment

The historical evolution of agricultural exploitation system in Rwanda is characterised on one hand by the institutional factors connected to the interests of the colonial administration and the development of export crops and demographic factor on another. After independence 1962, the broad strategies and policies tended to remain approximately the same as before independence, emphasizing above all improvement in productivity, regional specialisation, market-led development, crop-livestock integration, better soil and water management, and diversification of export crops. The focus on food crops and cash crops, which appeared in the colonial agricultural policy system, continued to characterize the sector post independence till to-date, since the rural population is dominated by subsistence farming and commercial agricultural opportunities are minimal or rare.

In spite of the changes in the approaches utilized for policy formulation and planning over the decades, the main hurdles to more rapid agricultural development continued to be: (i) scarcity of land, (ii) small farm size, (iii) overpopulation, (iv) poor productivity in terms of both land and labour inputs, (v) degradation of the land endowment, and (vi) use of an approach to agricultural extension that has not been effective.

While most of the rural population cultivated food crops for their own family with surplus sold in the local markets, the agricultural policy promoted and is still promoting cash crops for export (especially coffee, tea and pyrethrum) on fragmented land, making cash crops and food crops compete on the same piece of land. As a result a large proportion of farmers are producing coffee and tea, for example 500,000 rural families are engaged in coffee growing, while over 60,000 are growing tea. What has been lacking until recently has been an emphasis on improving productivity, product quality and diversification of quality. For example, while Rwandan tea is among the best in the world, it was recently that the Rwanda Tea Authority started packing tea bag. Furthermore, the development of other components of agriculture like horticulture was not done. The agricultural policy did specify the capacity needed, as a result, the capacity development and skill development in the field of horticulture and floriculture is very poor, and it will take time to develop, because knowledge institution, both universities and research institutes are still not yet well equipped and facilitated.

However, there are some fundamental changes that have occurred in recent years in the institutional environment of the country. In addition to decentralization, strategies and implementation plans are being defined with the participation of the beneficiaries. Mobilising and involving rural people so that they take responsibility in the formulation and implementation of programmes and projects is a cornerstone of lasting agricultural development. Together with the amount of resources directed toward the improvement of technology and productivity, and a shift toward market-driven development, this new participatory orientation should make a significant difference as compared with past conditions.

Recent agricultural policy has been articulated through two documents published by MINAGRI: a National Agriculture Policy (NAP) issued in early 2004, followed by the PSTA I in October 2004 and PSTA-II in 2008. The NAP spells out the main areas of agriculture that need to be transformed and lays down guidelines for government intervention in the sector. The PSTA I document intended to provide the basis for implementing the NAP.

3.5.6.3 The National Agricultural Policy (NAP)

The principal thrust of the 2004 National Agriculture Policy (NAP) is that by supporting the agricultural sector to move from subsistence to market-oriented production, it will result in both economic growth and increased food security. The Policy foresees the development of a professional and profitable sector underpinned by active agricultural research and extension services. The comparative advantage of cash crop production by region is to be promoted enabling economies of scale to be realised, while mixed crop and livestock farming is to be a national priority in all regions.

While acknowledging the important role to be played by increased production of traditional export crops (coffee and tea, for example), the Policy stresses the need to increase the cultivation and export of horticultural produce and other non-traditional agricultural exports in order to create a more-diversified export sector. Other areas of focus identified in the Policy include soil and water conservation, encouraging private sector involvement in all aspects of the commodity chain and marshlands management.

The weak state and inappropriateness of much of the work carried out in the past by both the research and extension systems is recognised as a major constraint to the development of the sector. Similarly, the lack of implementable land law and tenure system hindered the sector development.

To address these and other issues, the strategies proposed under the NAP include adaptive research, involving a more decentralised approach linked to commodity-chain analysis. This is to be the focus of publicly funded agricultural research in the future. Agricultural extension will continue to be carried out by government agencies but will be geared to training members of co-operatives and farmers' associations. In other words, there is to be more participation by farmers in both agricultural research and extension in the future. Increased use of external inputs and improved water management are other key themes. At the same time, work is to be undertaken to improve the efficiency of post-harvest operations, including processing, marketing, market information and storage. Interventions are also to be made to improve livestock production. They will include zero grazing approaches and disease control using private-sector service providers.

According to the NAP, commodities on which efforts are to be focussed in the first instance include *rice, maize, beans, Irish potatoes, floriculture, sericulture, hides and skins, coffee, tea, horticulture and wheat*. They were selected on the basis of the contribution they make to exports, food security and import substitution, as well as their potential contribution to sector growth and diversification. A detailed assessment of the feasibility of supporting other possible agricultural enterprises is to be undertaken prior to any public sector support being provided to them.

The need for integrated pest management is highlighted in the Policy while the public sector will address sanitary and phytosanitary issues. This will involve, among other things, updating legislation and regulations, setting standards, carrying out training and strengthening the capacity of quality-testing laboratories.

The Policy also underlines the need for the Government to adopt a more restricted, strategic role in developing the sector. From 2004 onwards, the work of the Ministry would, the NAP states, be limited to planning, regulation, promotion and co-ordination. The private sector would be supported and reinforced wherever possible in its work of transforming agriculture into a commercially oriented sector. The task of putting these guidelines into effect is a continuing one, and it requires close coordination with the private sector and care in developing the specifics of implementation programmes.

Five areas on which particular emphasis is to be placed are identified in the NAP, namely: (i) regions experiencing chronic food insecurity; (ii) soil and water conservation; (iii) small livestock (sheep and goats) acquisition by farmers and the provision of training in animal production; (iv) crop and livestock disease control; and (v) input distribution-mainly fertilizers-by private entrepreneurs, farmers' associations and co-operatives that will be closely monitored by MINAGRI. Other areas of intervention include mechanisation, strengthening agricultural education and the enactment of a new land law.

3.5.6.4 The Strategic Plan for Transformation of Agriculture in Rwanda, 2004 (PSTA)

The PSTA which was drawn up in 2004 covers the 2004-2008 period and is the means by which the NAP is to be made operational, guided by the path laid down in Vision 2020. The principal challenges that agriculture was seen to be facing included the need for it to be transformed into a commercial sector, with income-generation and employment creation being key requirements; for food security to be enhanced; and for environmental degradation to be halted.

That Strategy's objective, based on that of the NAP, was stated as being for agriculture to contribute in a sustainable manner to poverty reduction and to support economic growth. The document was developed in a highly participatory manner. It foresaw that during the second-half of its period of implementation the private sector would become the dominant partner in the development of agriculture, but that the role of Government would be critical until then. It was envisaged that the role of the State would be refocused in order to support this transition, to encourage partnerships with the private sector and to facilitate the decentralization process.

The Strategy developed a framework based around four Programmes directed toward releasing key bottlenecks in the sector, and it established Sub-Programmes designed to implement the main thrusts of the Programmes. This framework is retained, reinforced and amplified somewhat in this current version of the Strategy.

MINAGRI drew up a series of ambitious physical and/or production targets to be realised under each of the sub-programmes. Some of these targets have since then been revised in the light of the experience gained in implementing the first version of the Strategy. Most of them have been incorporated into the *Economic Development and Poverty Reduction Strategy* and are to be achieved by 2012, with interim targets having been established for each year. Some of the key indicators and their targets are detailed in Table 5 below. The projections in Table 5 have been obtained from several official MINAGRI and MINECOFIN publications, including the PSTA I and the EDPRS. However, in many cases different targets are given for the same year, since they are revised on a regular basis. Hence, Table 5 contains more recent projections for some of the target areas than can be found in the PSTA I document.

Major crops: One of the means by which agricultural production is to be boosted is the development of the commodity chains of a number of agricultural enterprises. These are separated into those destined for export (in particular ***coffee and tea, pyrethrum, sericulture and horticulture***) and those linked to the development of the internal market. The enterprises in this latter group were prioritised through a process of consultation at the provincial level; ***potatoes, wheat, beans, milk and meat*** have thus been selected for attention. The key support needing to be provided by the agricultural research services for the development of each of these commodity chains is emphasised in the Strategy. In addition, stronger efforts are need to bring together producers and markets, including agro-processors.

Strengthening agricultural cooperatives: Cooperation has been important in the agricultural sector in all countries of the world, and it has taken many forms, depending on the historical, cultural and economic context. In present-day agriculture formal farmer organizations often play a vital role in purchasing inputs, procuring farmer advisory services, and marketing outputs. The Government of Rwanda considers now the cooperatives as full partners in efforts for alleviating poverty. To harmonize and coordinate the interventions in that sector, it has been decided to design a national policy for promoting the cooperatives and to gather in a single document the strategies chosen and the priority activities retained for the years 2006-2008.

Table 3. A selection of targets for PSTA-I to be realised by 2010

Indicator	2006-07	2008	2010
Agricultural land protected (%)	40	*n.a.*	100
Radical and progressive terraces (ha)	12,000	20,000	32,000
Hillside irrigation (ha)	130	350	700
Marshlands rehab./developed (ha)	11,000	19,100	27,100
Households receiving cows	3,500	11,000	95,000
Households using improved seed (%)	24	29	34
Fertiliser application (kg/ha)	4	7	10
Households per extension worker	3,000	2,920	2,740
Horticulture exports (tonnes)	2,000	11,400	20,000
Producer orgs. specialising in District's priority commodity chain	*n.a.*	*n.a.*	3

Source: MINAGRI-PSTA-2 (Sept.2008)

This MINICOM sector strategy sets out the following goals for strengthening the cooperative sector (p.11): (i) to implement a legal and statutory framework favourable to the launching of a great number of really autonomous cooperatives and to their functioning and growth, (ii) to implement an institutional framework adapted to the cooperatives' needs, especially in implementing a consultation forum among all the partners, (iii) to facilitate the structuring of cooperatives in the intermediary organizations (unions, federations and confederations) and their membership to the international cooperative movement; these organizations will serve efficiently the members' interests and will contribute to the poverty alleviation accordingly, (iv) to strengthen the active participation of the youth, women, disabled persons and demobilized soldiers in the cooperative movement and to value their role, (v), to reinforce the effective ownership of the cooperatives by their members and the professionalism of the cooperatives management by the cooperative education, training and human resources development, (vi) to facilitate the access of cooperatives' members to Information and Communication Technologies in order to help them acquire the required knowledge for the promotion of good practices in cooperative management and to be connected to the national and international markets.

At present more than 1,100 registered cooperatives exist in rural areas, including those that work outside of agriculture. Many of them are large, with 700 to 1,000 members each, and accordingly smaller organizational units at the village and cell level are integrated into this cooperative structure.

A clear lesson from international experience is that cooperatives function best when they arise at the local level out of perceived needs of farmers and villagers, rather than being organized in a top-down fashion. It will be important to incorporate this lesson into the cooperative programmes and to encourage the simplest and most local cooperatives that have well-defined purposes, such as marketing given agricultural products or purchasing inputs on a larger scale, and thus at a lower unit price, than individual farmers could do. It will be equally important to strengthen the training of cooperatives in financial management, since they are conduits for credit lines, especially in the area of working capital.

Linkages between the central (national) and the decentralized levels: According to PSTA-II, it will be very necessary to strengthen the relatively new linkage between the central (national) level and the decentralised levels. Decentralised entities, that is, provinces, districts, municipalities (cities, sectors and cells) will take increasing responsibility for drawing up their development plans and their implementation. *This linkage is crucial for IPM implementation.*

Different challenges will require different modalities of financing and of sharing costs between the centre and local entities. The subsidiary principle will guide the delegation of responsibility from the central level to the decentralised levels. It will also lead to progressive withdrawal of central government entities where and when the local public sector, the private sector and/or the civil society can take over management of development activities. It is a major and important challenge to find appropriate financing mechanisms to support these new local development partners and assist them to implement activities at decentralised levels.

MINAGRI itself has undergone decentralization with the devolution of technical field-level responsibilities to the semi autonomous agencies that will act as service providers under decentralised system. These agencies in turn are mandated to play a supporting role to the districts and other local entities, and to respond to requests for services from the district and local level. Separate three agencies have been created for separate fields: (a) agriculture (the Rwanda Agriculture Development Authority-RADA), (b) animal resources (the Rwanda Animal Resources Development Authority-RARDA) and (c) horticulture (the Rwanda Horticulture Development Authority-RHODA). These three agencies together with the National Agricultural Research Institute (ISAR) and the recently added Marketing boards for tea and coffee, OCIR Thé and OCIR Café from the Ministry of Trade and Industry form six agencies for agricultural development.

The first three agencies namely, RADA, RARDA and RHODA have some staff representing them at the provincial level, but no staff at district level. These agencies have responsibilities in regard to policy formulation, creating an enabling environment of their respective sub-sectors, as well as monitoring tasks to ascertain that, for example, districts keep to the nationally set norms and standards. Since in view of both agricultural policy and the process of decentralization, the above guidelines mean that MINAGRI agencies will refrain from activities which, can be undertaken (or should be undertaken) by districts. In cases in which districts currently are not able to undertake those activities, the agencies are supposed to assist districts in undertaking those activities, rather than undertaking them themselves. In the light of PSTA I and the decentralisation reform, *the major role of these agencies will be to train and facilitate the actions of farmer communities, farmer organisations, local governments and the private sector to gradually take up their roles*. Hence the agencies have facilitation responsibilities, and no direct implementation responsibilities. Apart from this facilitating role, the agencies will have a role in the implementation of particular activities (e.g., large irrigation schemes) that are too big to be handled by an individual district council or activities that run across various councils. As such, the agencies could also manage certain projects. The ISAR and OCIR The and OCIR Café both have significant numbers of decentralised staff, in the form of researchers at research stations, agronomists in coffee producing areas and the actual ownership of tea factories and plantations.

3.5.7 Legal framework for extension service and plant protection in Rwanda

Currently, the crop protection is governed by an existing presidential order dates from 1975 (The Presidential Order No. 252/11 of 13 November 1975 *on the phytosanitary inspection of plants and plant products for import and export, and findings concerning quality and damage*) and is an inadequate and out-of-date framework. There is no existing plant protection law in the country. However, this order is old and outdated, as it does not address all currently issues of trade. The country does not have specific laws or regulations governing the protection of plants and plant products, except the presidential decree mentioned above. As a result, there is a draft bill to update it and meet current needs in agriculture and agricultural products trade. Rwanda is a signatory of SPS agreement, but was not signatory to IPPC till recently. To-date, the plant protection and quarantine are governed by the framework of the *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS Agreement) of the World Trade Organisation (WTO) which came into force in 1995. The SPS Agreement sets rules for biosecurity measures to protect human, animal and plant life and health to ensure that the impact of international/cross-border trade is minimised. The SPS Agreement covers the protection of the life and health of the human population of a country, its animals and plants. Therefore the regulatory sectors on which the SPS Agreement operates are food and feed safety (to protect people and livestock), veterinary services and protection of plants.

The SPS Agreement has given rise to the concept of biosecurity which briefly may be described as ‘border controls to protect a territory from organisms, food, feed and other imports and introductions that endanger human, animal and plant life and the environment’. Therefore, Biosecurity is the implementation of all measures to protect human, animal and plant life from harmful influences that might enter a territory across international borders. Included in biosecurity are measures to protect habitats, endangered species, conservation areas, etc. The harmful influences include pests and diseases of animals, plants and humans and food, feed and other products that are dangerous because they contain harmful contaminants or pathogens.

Because of the Biosecurity approach to plant health, it is concerned with more than the protection of agriculture, horticulture and commercial forestry. First, plants are the major component of habitats and therefore any ‘pest’ that damages plants may damage habitats and reduce biodiversity. Therefore some pests may be regarded as environmental pests. Second, some plants may be pests themselves, either because they are ‘weeds’ or because they are invasive in and destroy natural habitats (e.g. water hyacinth). A modern plant health Law is therefore necessary to protect Rwanda’s natural environment alongside actually environmental protection laws. Therefore the Daft Bill for a Law on Plant Health does not address agriculture protection, but also address also environmental issues.

The need for a new Law on Plant Health arose with the need to achieve exports of horticultural products from Rwanda, as any other exporting country, must meet plant requirements and standards of importing countries. Since the advent of the WTO, the standards for phytosanitary import requirements and controls have been provided within the framework of the IPPC.

However, it must also be remembered that the government of Rwanda is also obliged to protect its agriculture and environment from harmful organisms not found in the country (i.e. operate its own phytosanitary import controls).

3.5.7.1 Institutional arrangement for extension and plant protection services

Roles of different actors in Decentralized agricultural extension system: The crop protection falls in the mandate of the Ministry of Agriculture and animal resources. According to new draft of strategic plan for extension (2007), MINAGRI will use decentralized extension system. As result the extension staffs at District and Sector falls under mandate of MINALOC (Ministry of Local Government). The Ministry of Agriculture and Animal Resources roles remain minimal. MINAGRI itself has undergone decentralization to a degree, with the devolution of technical field-level responsibilities to the agencies that are collectively known as service providers: RADA, RARDA, RHODA and ISAR. These agencies in turn are mandated to play a supporting role to the districts and other local entities, and to response to requests for services from the district and local level.

Separate agencies have been created for agriculture (the Rwanda Agriculture Development Authority-RADA), animal resources (the Rwanda Animal Resources Development Authority; RARDA) and horticulture (the Rwanda Horticulture Development Authority-RHODA), the Agricultural Research Institute, ISAR and the recently added Marketing boards for tea and coffee, OCIR Thé and OCIR Café from the Ministry of Trade and Industry. *These agencies together with OCIR-cafe and OCIR-The are also in the process to be combined under organization named: Rwanda Agricultural Board (RAB).*

The three agencies, RADA, RARDA and RHODA have some staff representing them at the provincial level, but no staff at district level. ISAR, OCIR The and OCIR Café both have significant numbers of decentralised staff, in the form of researchers at research stations, agronomists in coffee producing areas and the actual ownership of tea factories and plantations. In the light of PSTA I and the decentralisation reform, *the major role of these agencies will be to train and facilitate the actions of farmer communities, farmer organisations, local governments and the private sector to gradually take up their roles*. Hence the agencies have facilitation responsibilities, and no direct implementation responsibilities. Apart from this facilitating role, the agencies will have a role in the implementation of particular activities (e.g., large irrigation schemes) that are too big to be handled by an individual district council or activities that run across various councils. As such, the agencies could also manage certain projects. The staff at Province or District will become members of advisory committee and co-coordinator of IPM activities to enable direct links with the national coordinator.

Moreover, the agencies have responsibilities in regard to policy formulation, creating an enabling environment of their respective sub-sectors, as well as monitoring tasks to ascertain that, for example, districts keep to the nationally set norms and standards. Since in view of both agricultural policy and the process of decentralization, the above guidelines mean that MINAGRI agencies will refrain from activities which, can be undertaken (or should be undertaken) by districts. In cases in which districts currently are not able to undertake those activities, the agencies are supposed to assist districts in undertaking those activities, rather than undertaking them themselves.

In most cases IPM activities during initiation stage will take more time in organizing and training farmers. Since each District has only one agricultural officer (agronome) responsible for both agriculture and livestock, it may be difficult to coordinate IPM activities without assistance.

.3.5.7.2 Ministry of Agricultural and Animal Resources

Formerly, the Ministry for Agriculture and Animal Resources was directly responsible for extension function through agricultural extension workers at Sector (Monagris), District and Province level accountable to the Ministry of Agriculture and Animal Resources.

After decentralization and administrative reform 2004-2005, extension function passed under direct responsibility of decentralized entities and performance and problem reporting system goes from Sector to District and from District to Province and to Ministry of Local Government.

In the new context of decentralized extension, main functions of the Ministry for Agriculture and Animal Resources are as follows: (i) coordination and planning of agricultural development programs, (ii) agricultural sector information function, (iii) monitoring and evaluation function, (iv) regulation and control function, (v) resources mobilisation function.

The absence of functional relationships between the Ministry of Agriculture and Animal Resources and decentralized entities (Districts and Sectors) make it difficult to fulfill above mentioned functions. Establishing pilot agricultural sector by the Ministry for Agriculture and Animal Resources cannot be successful without bottom up reliable information flow from local administration giving general situation and required action needed, its evolution and problems of producers.

This observation shows that functional dependence between the Ministry of Agriculture and Animal Resources and Districts is necessary. Indeed, the Ministry of Agriculture and Animal Resources needs information from Districts to be able to properly plan the development of agricultural sector, while Districts, without piloting and support of the Ministry of Agriculture and Animal Resources, the coherence of their activities will be badly ensured and their effectiveness limited.

This observation shows also the necessity for the Ministry of Agriculture and Animal Resources (i) to set up and fund consultation platforms to enable him to pilot agricultural sector, (ii) to strengthen the capacities of decentralized entities through its specialized Agencies and (iii) to develop strong functional relationship with Districts.

The role of MINAGRI specialized agencies is to coordinate the implementation of development programs. In particular, they are expected to produce extension materials for extension workers and farmers, provide technical and capacity building support to decentralised extension services and promote participative research aiming at solving real problems of farmers.

3.5.7.3 Local Administration Authorities

The role of Local Administration is very important in social mobilisation and organisation of farmers in decentralized extension system. In particular, Local Administration is responsible for:

- **(a)** Local communities mobilisation;
- **(b)** Coordination of extension activities at District, sector, cell and Umudugudu level;
- **(c)** Training needs assessment and supervision of farmers training by extension service providers;
- **(d)** Facilitation for local communities in the process of identification of strength, weaknesses, constraints or opportunities;
- **(e)** Organization of producers in farmers associations and co-operatives;
- **(f)** Collection and diffusion of information to relevant authorities;
- **(g)** Facilitation and collaboration with other partners in agricultural development (NGOs, private Sector)

3.5.7.4 Functional relationship between MINAGRI Agencies under decentralization-District

With decentralization, staff and budget management at District and Sector levels is under the responsibility of Districts authorities. In that regard, agricultural extension workers, as well as all staff affected to Districts has hierarchical relationship only with Districts authorities. These hierarchical relations which result in acts of administrative management include giving them directives, to approve their work plan, to follow-up the implementation of decided work plan and to evaluate the results. In addition to these hierarchical relations, extension workers at District and Sector level need to have functional relationship with all public and private institutions from which they can find technical information and advises they need to achieve successfully their functions.

Agricultural extension workers need more particularly to work closely with MINAGRI Agencies (RADA, RARDA, ISAR and RHODA). It is why they need to have with them functional and interactive relationship allowing a collaboration and a partnership based on their complementarily to achieve a common objective of providing the most effective possible supports needed by farmers and by all actors of agricultural development in the Districts.

Here after a no restrictive list of activities in which functional relationship between MINAGRI Agencies and Extension workers at District level is needed:

(a) Basic technical and economic information ;
(b) Agricultural planning;
(c) Counselling and technical support;
(d) Technical control and regulation;
(e) Capacity building ;
(f) Monitoring and evaluation of activities.

Coordination, monitoring and evaluation: The coordination of extension activities is under the responsibility of the Ministry of Agriculture and Animal Resources through its Agencies (RADA, RARDA, RHODA, ISAR). To accomplish this function, consultation platforms will be set up at all levels, with the participation of all stakeholders including MINAGRI Agencies.

At District level, four consultation meetings (one per Quarter) will be organised each year. All agricultural sector stakeholders at District level will be expected to attend those meetings including MINAGRI Agencies. The main agenda for those meetings are: (i) to plan agricultural activities, (ii) to prepare agricultural campaigns, (iii) to discuss each one responsibilities in implementation of agreed District action plan, and (iv) activities progress evaluation. At National level, two consultation meetings with all partners' representatives will be organised each year.

To ensure the successful implementation of the extension strategy, annual agricultural action plans of the Districts should contains activities for all stakeholders institutions present in the District. All stakeholder institutions are expected to collaborate through this agric forum as a condition to accept its interventions in the District.

A reporting system will be established. In addition to reporting to financing institutions, all stakeholders' institutions will be asked to report to Districts so that one agricultural District report is produced under the coordination and responsibility of the agent in charge of Agriculture and Animal Resources in the District. This report will be transmitted to the Ministry of Agriculture and Animal Resources to be analysed by MINAGRI Agencies and Districts realisations be integrated in MINAGRI annual report. The report form will be agreed upon in one of all stakeholders' consultation meetings at national level.

There is no agricultural unit at District level. Agriculture falls under director for economic development and there is only one staff for both agriculture and livestock at District level; similarly there is only one staff at sector level responsible for agriculture, livestock, economic development, cooperatives, infrastructures, forestry and environment. The responsibilities allocated to these staffs at District and Sector level are very important and critical for rural economic development. It is not clear whether they have sufficient time to concentrate on time demanding activities. In most cases IPM activities during initiation stage will need more time in organizing and training of farmers. Since each District has only one agricultural officer (agronome) responsible for both agriculture and livestock, likewise each sector has only one staff responsible for activities including agriculture, it may be difficult to coordinate IPM activities effectively without assistance of additional staffs.

3.5.7.5 Farmer organizations

Farmer organisations contribute much in organizing production and marketing structures. They provide proximity services needed by farmers, contribute to problem and solutions identification, supervise experimentations in farmer fields, and supervise rational utilisation and maintenance of agricultural infrastructures in rural areas.

It is expected that farmers organisations will be organised by commodity chains, and their role in decentralised extension system will be reinforced: supervision of farmers fields schools and/or farmers to farmer extension, quality seeds multiplication, agricultural inputs supply, marketing of agricultural produce through Unions and Federations of Farmers Organisations.

The promotion of partnership between farmers' organisations and extension and research services will enable the first to be on one hand end users of extension services, but also to be active extension service providers on the other hand.

3.5.7.6 NGOs and Civil Society

Local and international NGOs are not only funds providers but also service providers for local communities (agricultural inputs supply, marketing and processing of agricultural production, counselling, facilitation in problem and solutions identification, facilitation in farmers organisations in commodity chain, capacity building of farmers organisations, lobbying and plea for local communities). To this role will be added capacity building of farmers' organisations through contracts as service providers with public and private institutions funding agricultural sector.

3.5.7.7 Private sector

The private sector is active in all steps of commodity chain starting from inputs supply, production, marketing, processing and commercialisation of the final product. Its role in decentralised agricultural extension will be reinforced for better ensuring the linkage between production and markets.

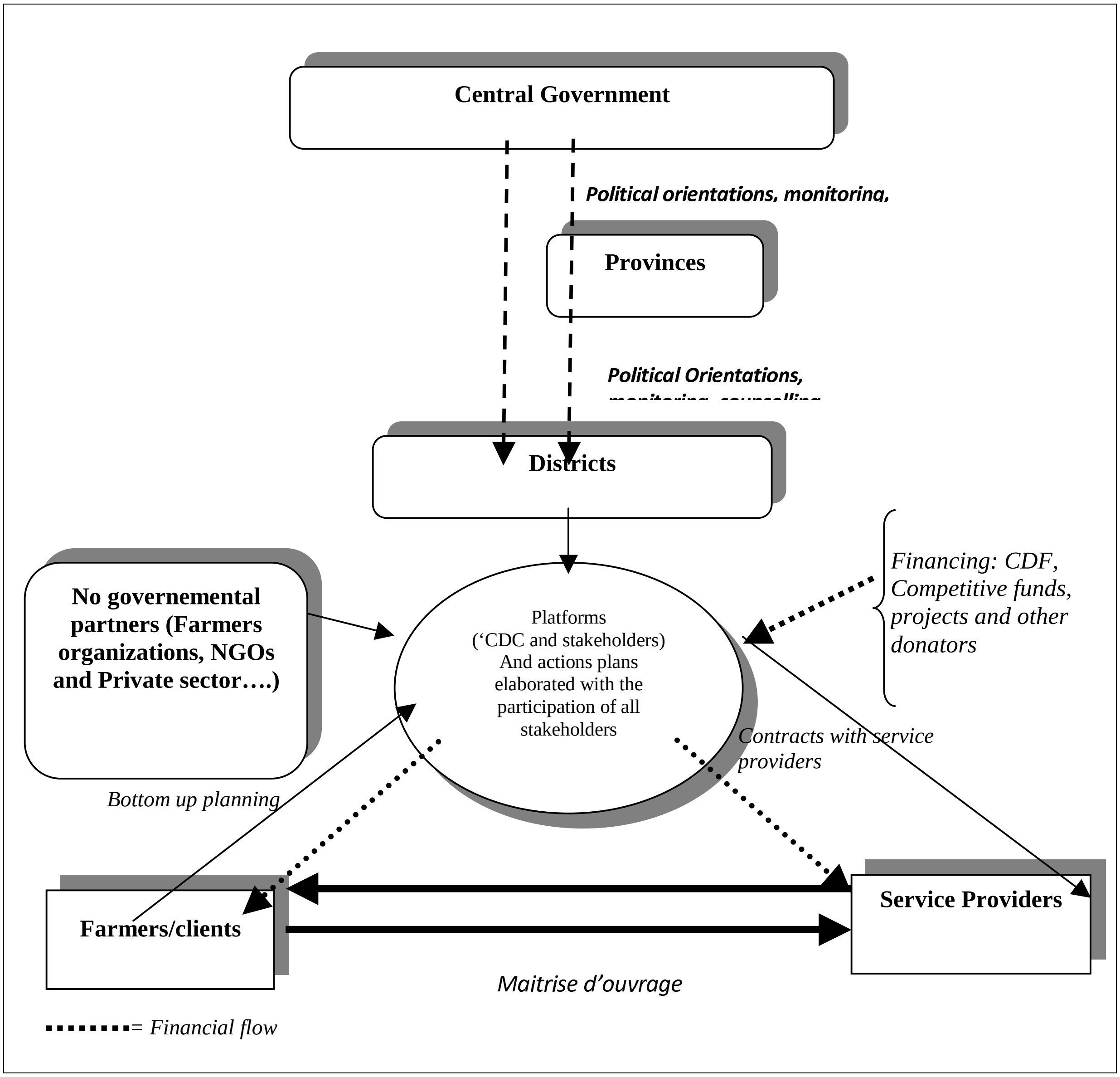

Figure 4. Roles of different actors in decentralised agricultural extension system in Rwanda
Source: MINAGRIC Extension service strategic plan (draft)

4.0 Major pests and diseases on priority crops in Rwanda

According to the NAP, commodities on which efforts are to be focussed in the first instance include rice, maize, beans, Irish potatoes, floriculture, sericulture, hides and skins, coffee, tea, horticulture and wheat. They were selected on the basis of their contribution to exports, food security and import substitution, as well as their potential contribution to sectoral growth and diversification. A detailed assessment of the feasibility of supporting other possible agricultural enterprises is to be undertaken prior to any public sector support being provided to them

4.1 Major insect pests and diseases on rice in Rwanda

The production of rice is done in the marshlands of the distributaries of Akanyaru and Nyabarongo rivers on the upstream part of Nile basin of Rwanda. With increasing urbanization in the country, the rice crop is becoming an important major staple crop which is gaining more importance in many parts of the country where it is grown; moreover, it is both food and cash crop, having a reliable market and source of family income. Because of development of irrigation infrastructures, and possibility of double crops per year on continuous cropping system, pests and diseases are expected to increase. The current major pests and diseases problems observed and reported by farmers include: (a) Rice blast *(Pyricularia oryzae)*, (b) stalk-eyed borer (*Diopsis thoracica*), (c) birds, and (d) rats. The first two are often controlled using pesticides.

The pest status of rice blast is very high. As disease of significant economic impacts it attacks all aerial parts, leaves, culms, branches of panicles and floral structures. Its main host is the rice plant (*Oryza* spp) and a few wide ranges of other Graminaceous plants, and is widely distributed in all rice growing areas in Rwanda. The current management of rice blast is mainly by use of resistant varieties Kigori, Yuni and Zongeng or moderately tolerant varieties like"Intsinzi, Gakire, and Intsindagirabigega" combined with varietal rotation. The application of cultural practices is also possible but not sufficient by itself and sometimes it is combined with fungicide use (e.g., Kitazine/IBP). The pest status of stalk-eyed borer (*Diopsis thoracica*) is not clear, as it depends on age of attack. The early infestation stimulates tillers production and as a result increases crop yield. It is required to establish pest status of stalk-eyed borer in Rwanda.

4. 2. Major insect pests and diseases on maize in Rwanda

Maize crop is an important staple crop in Rwanda both as a food and source of income. It is mainly produced in the marshlands along Akanyaru river and its distributaries, Eastern and Northern provinces. All these parts are in the basin part of Rwanda. The crop has a list of pests and diseases which are generally considered to be major constraint in production; however, their pests status (economic importance) varies according to environmental conditions and cultural practices applied by farmers. The major pests and diseases of maize include maize stalk borers (eg *Busseola fusca)*, maize streak virus, leaf blight, striga weeds and storage pests. The diseases like maize streak, leaf blight are currently controlled using resistant varieties and cultural practices.

The storage pests like greater grain weevils *(Sitophilus* spp.) and tropical warehouse moth (*Ephestia cautella*.) are not yet a threat, probably because of low maize production which does not need to be stored for long period. The surplus production which needs storage can be handled by hermathic.

In addition, there is also striga weed (*Striga asiatica* or *Striga hermontheca)* which is expanding in the Eastern province where it is reported to cause up to 100% yield loss, and is renamed as Kulisuka (meaning zero yield). This will be controlled by using "push-pull" technology as an IPM tool.

Nevertheless, maize pests and diseases are manageable using cultural practices and resistant varieties as components of IPM tools. The current maize production systems, such as crop rotation with legumes or potatoes, flooding in marshlands "like "Akanyaru" where large quantities are produced" reduce pests and diseases problems. In addition, the current hermetic grain storage (renamed known as "cocoons") promoted by Rwanda's Ministry of agriculture and Animal Resources helps to reduces storages losses from pests through suffocation, in *Sitophilus zeamais* in maize, bean bruchids in beans etc. It is a good IPM tool. However, storage of grains of maize or beans which are not well dried may lead to the growth of moulds and destroy the whole stock. Care must be taken to ensure moisture content of lower than 12%.

4.3 Major insect pest and diseases on potato

The current major pests and diseases problems of potatoes in Rwanda are (1) Late blight, (2) Bacterial wilt, (3). Potato tuber moths, (4). Aphids are serious during low rainfall season. The potato crop is one of the major crops in the country and it is produced in rotation with maize in the Northern Province. Among the major pests and diseases, the late blight is the most serious and is continuously controlled using fungicides (e.g., Dithane M45 or Ridomil) in combination with resistant varieties. It is a major disease which cause up to 100% yield loss when no control measures are applied. To date there is no record of resistance to Ridomil because it is not used regularly. It is applied only when rainfall is continuous and heavy rains can wash out protectants on leaves.

4.4. Major insect pest and diseases on Cassava

In Rwanda cassava production is currently constrained mainly by cassava mosaic disease (CMD) which has devastated major growing areas in the country. Therefore, among the biotic factors, the cassava mosaic disease (CMD) is the most important. Epidemics are particularly ravaging with root yield losses as high as 100%. CMD is caused by at least three geminiviruses, which include the African cassava mosaic virus (ACMV), the East African cassava mosaic virus (EAMV) and the Uganda variant of the EACMV (EACMV-UgV), which is a hybrid virus of EACMV and ACMV. The CMD is commonly found in many fields of cassava, and farmers who cannot follow good crop management such as rogueing out of the infected plants and cannot access the CMD free cuttings are at high risk.

The use of resistant cassava planting materials would be the best alternative for the smallholder farmers in Rwanda. Currently these varieties are still not enough and are most expensive to buy, as each hectare would need 10000 cuttings. Combined efforts of ISAR, LVEMP, and farmers organizations (Ingabo and Imbaraga) are ongoing to avail to farmers, sufficient amount of healthy cuttings.

4.5. Current major insect pests and diseases on tomato

Tomato crop is attacked by a variety of insect pests and a wide range of diseases attack leaves, fruit and roots, particularly in the rainy season when high humidity favours insects and pathogen development and transmission. The major insect pests include***:*** Bollworm (*Helicoverpa armigera**)***, Leafminer (*Liriomyza spp*.)**,** and Cutworm (*Agrotis spp*.) African Spider Mites (*Tetranychus spp**.)***, Aphids (*Myzus persic**a**e* & *Aphis gossypii*)**,** Whitefly (*Bemisia tabaci*)**,** Root-Knot Nematode (*Meloidogyne spp*.)***;*** while the major diseases include***:*** Late Blight (*Phytophthora infestans*), Damping Off (*Pythium spp*. & *Rhizoctonia solani*), Early Blight (*Alternaria solani*), Fusarium WiIt (*Fusarium oxysporum f. sp.lycopersici*), Verticillium WiIt (*Verticillium dahliae*), Powdery Mildew (*Leveillula taurica*), Septoria Leaf Spot (*Septoria lycopersici*), Anthracnose (*Colletotrichum spp*.), Leaf Mould (*Fulvia Fulva*), Bacterial WiIt *(Pseudomonas solanacearum* also known as *Ralstonia solanacearum**,*** Tomato Yellow Leaf Curl Virus (TYLCV), Tomato Mosaic Virus (TMV) and Blossom End Rot. Farmers possess little knowledge of these pests. It is important to monitor the use of pesticides on tomatoes otherwise farmers may overuse them. Among these diseases, the late blight (*Phytophthora infestans*) is much more the most serious and is currently controlled using fungicides Such as Dithane M45/Mancozeb or Ridomil/Metalaxyl. Both fungicides are category U and III respectively which are acceptable and are unlikely to cause major problem to farmers, consumers and environment.

Tomato is one of the most important vegetables, relatively easy to grow, important source of nutrition (vitamin A and C) and income for smallholders. Tomato varieties can be divided into two main types. (1) First are *Bushy type varieties* (also called *determinate* cultivars) which can usually grow without support (e.g. Roma variety), (2) Second are *Vine type varieties* (also called *indeterminate* cultivars such as Money maker) which need to be supported by *stakes*, and usually *pruned* to leave only one or two main stems.

Staking practice helps to avoid diseases by improving air circulation in the crop, and preventing plant parts and fruits from touching the soil. Tomatoes are usually grown in seedbeds and then transplanted when they have grown to a height of about 10 to 15cm. As with many crops, it is better sowing seeds thinly and to remove competing weeds to produce vigorous plants which are more likely to withstand pests and diseases. .

4.6. Major insects pests and Diseases on banana

The banana production in Rwanda is found in highlands, above 1500 masl**.** Currently, the major threat of bananas in the basin in Rwanda is the banana bacterial wilt, which is spreading in all banana growing areas and its management does not require the use of pesticides. The second most important disease in the country is the Fusarium wilt (*Fusarium oxysporum fs musae*) which is soil borne disease and remain in the soil up to 30 years. It is not easily controlled by pesticides. It is very serious on exotic banana cultivars such Gros Michel etc. However, there are resistant new exotic cultivars under dissemination by MINAGRI and ISAR.

The others pests of banana are not important, however, they require close monitoring since their severity is limited by temperature due to high altitude above 1400 masl. Basing on climate change threat which may adjust local climate, it is important to establish robust pests and disease monitoring. These pests include banana weevils (*Cosmopolites sordidus*), nematodes (like *Pratylenchus goodeyi*, *Helicotylinchus multicinctus*, and *Radopholus similis* and *Meloidogyne spp*.) and leaf spots (yellow sigatoka, black sigatoka and cladosporium etc) are not a threat because of altitude effect. These pests are threat below 1400 m above sea level, while major banana growing areas in Rwanda are above this altitude. Even if they occur, the use of pesticides is not economical.

4.7. Current major insects pests and Diseases in beans

The beans (*Phaseolus vulgaris*) are among the major crops produced in Rwanda. It is the major source of protein for majority of people (both urban and rural areas). Bean crop has many pests (insects and diseases) both in the field and in the store. Some diseases are seed born and are easily transmitted through infected seeds. The major insects pests and diseases attacking bean are as follows: (i) beans fly or bean stem maggot (*Ophiomyia spp*.), (ii) Angula leaf spot (*Phaeoisariopsis griseola*), (iii) bean anthracnose (*Colletotrichum lindamuthianum*), (iv) common blight (*Xanthomonas campestris pv phaseoli*), (v) halo blight (*Pseudomonas syringae pv phaseolicola*), (vi) bean common mosaic virus. These diseases are seed born and are managed through clean seed or treated seed, (vii) bean bruchid (Bruchid spp.) as storage pest.

4.8. Major insects pests and diseases in coffee

Coffee is an import cash crop for Rwanda. It is attacked by many pests (about 850); however, only few of them are major pests which needs control. They include coffee leaf rust (*Hemilea vastatrix*) and coffee berry disease.

Coffee leaf rust (*Hemilea vastatrix*) The coffee leaf rust causes damage on leaf, and as a result, it reduces photosynthetic capacity of infected leaves and causes premature defoliation or leaf drop associated with high infection levels. Vegetative growth and berry growth and size are reduced depending on the amount of rust in the current year. The impact of rust, however, can be long lasting. Leaf rust associated defoliation and the strong carbohydrate sink of the berries cause shoots and roots to starve and consequently to dieback, thereby reducing the number of nodes on which coffee will be produced next year. Since next year's production of coffee occurs on wood produced this season, the tip and shoot dieback caused by the rust can seriously reduce the following season's crop. On average, losses are believed to be about 15% annually.

Resistance varies with leaf age, particularly for susceptible varieties, young leaves being more susceptible than older leaves on the same plant. Plants with incomplete resistance, however, usually display the opposite response, with high resistance in young and low resistance in older leaves. Cultivars derived from Timor hybrid and the Icatu cultivar display this pattern (Eskes and da Costa, 1983; Eskes and Toma-Braghini, 1982). The important factors influencing leaf rust are planting density, host susceptibility, and predisposition of host due to high prior year yields. Disease severity is correlated with planting density and with berry yield. Generally, the lower the host density; the slower the rate of disease development. Rain plays the most important role in disease development. It provides moisture for spore germination and aids in dispersal. Seasonal variation in disease incidence is largely due to variation in rainfall patterns. Temperature also influences rust development. The lower limit for germination is 15 C.

Light intensity influences cultivar reactions. Leaves exposed to high light intensity are generally more susceptible to rust, varying up to 10 fold depending upon pre- and post-inoculation light intensity. Overbearing coffee may exacerbate rust intensity; leaves supporting rapidly growing coffee berries are more susceptible to infection than leaves that only support vegetative growth. High yielding coffee varieties are more susceptible than low yielding varieties.

Coffee berry disease (*Colletotrichum coffeanum*). The disease was first discovered in Kenya in 1920 and is caused by the virulent strain of *Colletotrichum coffeanum*. The fungus lives in the bark of the coffee tree and produces spores which attack the coffee cherries. Spraying has been determined to be the best way to avoid the coffee berry disease. Captafol and copper-based fungicides have been effective. The Kenyan coffee hybrid Ruiru 11 is resistant to both coffee berry disease and coffee leaf rust.

Where the virulent strains of CBD occur, serious losses have been reported. The loss of up to 80% has been reported. More conservative estimates of losses are 20%. Successful fungicide control programs frequently double or triple yields. Hedgerow planting and improved pruning practices to open the canopy improves fungicide penetration and coverage. The more open canopy is also less conducive to prolonged wetting and spore exudation and spread, resulting in lower CBD incidence.

Antestia Bug (*Antestiopsis spp.)*. The antestia bug is a major pest of coffee and there are different species of this bug throughout Africa. It attacks flowers buds, green berries, and growing tips of coffee. As they feed, they inject saliva containing the spores of the fungus *Ashbya*. This fungus is thought to cause the taste defect, i.e. marked “potato” (very similar to a freshly cut raw potato) or “green, pea/peasy” taste defect.

4.9. Important weed species

3.9.1 Striga (Striga hermonthica and Striga asiatica).

This weed is a parasitic weed that affects a range of cereal crops in semi arid tropics areas and can cause yield loss of 29% to 100%, impacting heavily on food security and income. The *Striga weed* is a major pest of agricultural intensification, associated with increased cropping intensity and declining soil fertility. It is common in Eastern province and was given a local name as “kurisuka” meaning 100% yield loss or zero yield.

The most affected crops include maize, sorghum, rice and sugarcane. The weed attaches itself into the host plant, penetrating its roots and starts to draw and divert nutrients, causing the host plant to stunt. Each Striga plant can produce up to 50,000 seeds, which lie dormant in the soil until stimulated to germinate when a suitable host plant starts developing roots. This dormancy can last for over 15 years.

4.9.2 Couchgrass (Digitaria scalarum):

This is one of noxious weed of the world, widely distributed in Rwanda. It is widely distributed in the larger part of the country. *D.scalarum* is a creeping, perennial grass with long, slender, branching rhizomes which form a dense mat beneath the soil surface. Culms decumbent near base, becoming erect, about 50 cm, occasionally up to 1 m high. Basal sheath usually glabrous. It is the most troublesome weed in the crops of Rwanda. It is reported as the most important weed of many crops (coffee, bananas, beans, tea, etc). The growth and yield of crops is greatly reduced in the presence of *D.scalarum*. Heavy infestations can kill crops (e.g. coffee bushes). Serious mechanical damage can occur when trying to remove rhizomes entwined in crop roots using hoe.

4.9.3 Water hyacinth

Water hyacinth as a weed is capable of multiplying very fast and infests the river or lake in a short period. One of the biggest threats this weed has is the incredible ability to spread, having the capacity to double in size every seven days under favourable conditions. The weed infested the river Nyabarongo and surrounding valleys. The plant prefers flat or gently sloping shores (rarely deeper than 5 m) with soft muddy bottom, rich in organic matter. It is distributed throughout the drainage system in the lake basin but especially along the intersection between Nyabarongo & Akanyaru rivers where water flow forces increase causing massive movements into the Lake Victoria through the River Kagera.

4.10 Quarantine pests (economic pests not found in Rwanda)

4.10.1 Larger grain borer (Prostephanus trancatus) (Horn)

The larger grain borer (LGB) *Prostephanus truncatus* (Horn) is the most important pest of stored maize and other cereals and cassava. It can cause weight losses as high as 70% after four months of storage. Currently, *LGB* is the most serious pest of dried cassava and maize in storage. In Rwanda, however, LGB has not been observed and reported. It is a serious pest and if there is no quarantine measure, it will enter the country because of unchecked movement of maize grain in the region.

Recommendations: (a) **Start research on LGB control**: Use of resistant varieties is the best option for economic control. The resistant varieties are available in Ugandan and Tanzania, (b) **Training:** Train farmers in storage of cereals

4.10.2 Grey leaf spot (Cercospora zeae-maydis)

The disease is not yet in Rwanda; however, it is in Tanzania and is spreading northward from South Africa where much research has been done. It is one of the most destructive leaf diseases of maize. It is becoming a major threat for maize production in Africa. The pathogen survives only on maize, and source of infestation originates from maize debris, from where the pathogen (conidia) is windborne and provide primary **inocula** for newly planted maize crop. The disease develops faster later in the season. It is highly dependent on weather, and requires high humidity and cool cloudy conditions with mists that extends dew period for infection and disease development. The optimal temperature is about 22 – 30 ^{O}C, and disease development is slow when mean daily temperature is below 20^{o}C. The disease also occurs at relatively lower elevation where it is usually associated with mists belts, and the disease can also tolerate adverse conditions. The incidence and severity is associated with the amount and distribution of rainfall, where it is severe in high and well distributed rainfall. The following are the suggestions for prevention of this serious disease.

a) **Start research on resistant varieties**: Use of resistant varieties is the best option for economic control. The resistant varieties are available in Ugandan and Tanzania**.**
b) **Crop rotation**: The pathogen survives only on maize, so crop rotation for at least two years with non-host crop and stubble crop management are major factors in disease management, but should be done on wider scale to be effective.
c) **Improve maize husbandry:** The maize standard husbandry like right soil fertility improvement, spacing (plant density), and chemical control also help to improve management.
d) **Residue management**: The destruction of crop residues should be done at community level to reduce external source of inoculums.
e) **Chemical control**: This is not practical for small scale farmers; however, it is useful in seed production plots. Both preventive fungicides (e.g. Mancozeb) and systemic broad spectrum fungicides are effective.

4.11. Major livestock pests and diseases in the basin in Rwanda

Livestock disease is one of the major constraints to animal production in Rwanda. This is in addition to inadequate nutrition, poor management practices and socio-economic constraints. Vector-borne diseases, particularly trypanosomiasis transmitted by the tsetse flies and tick-borne diseases (TBDs) seriously limit livestock production and improvement in the country. In addition the tsetse flies also transmit the fatal human sleeping sickness. Trypanosomiasis in livestock production (and sleeping sickness or nagana in human beings) is rampant. The Eastern Province is the major transmission and holding area for trypanosomiasis since most wildlife from Akagera National Park and across the Kagera river in Tanzania are carriers of disease.

For animals, the most common disease is the East Coast Fever which is a tick-borne disease. The pest is endemic to the whole East Africa. The problem is worsened as most of the role of tick management was left to livestock keepers as individual responsibility. Another reason is that the ticks may have now gained resistance to the organophosphates originally used for their control and the farmers now have to use pyrethroids which are relatively more costly and therefore unaffordable to most farmers. The situation may lead to an increase in other tick-borne diseases such as Babeiosis, heart water and anaplasmosis.

Foot-and-mouth disease is highly contagious and can spread extremely rapidly in cloven-hoofed livestock populations through movement of infected animals and animal products, contaminated objects (for example livestock trucks) and even wind currents. Vaccination is complicated by a multiplicity of antigenic types and subtypes. Substantial progress has been made towards the control and eradication of foot-and-mouth disease mainly in the Eastern Province. Foot and mouth disease is not widespread in Rwanda because Government through MINAGRI agency-RARDA puts quarantine measures whenever the disease occurs. This is has helped to contain the disease and is relatively easily contained through the use of vaccines and strict quarantine measures. However, the many variances of the disease slow down the control process.

Contagious bovine pleuropneumonia (CBPP) is often regarded as an insidious, low-mortality disease of cattle, but this assessment is based on experiences in endemic areas. In susceptible cattle populations, the disease can spread surprisingly rapidly and cause high mortality rates. The disease is spread with the movement of infected animals, including acute cases and chronic carriers. Major CBPP epidemics have been experienced in eastern province.

Another disease of importance within the region is mastitis. The disease is related to hygiene and is common where hygiene in the livestock pens is not maintained. The disease is very expensive to control. Rabies is endemic in the entire basin and affects all livestock.

The bulk of goats in Rwanda are local breeds. However, dairy goats are quickly gaining importance through Send cow grant to HIV positive patients. The most important disease occurring in goats is Helminthiasis. The disease is caused by helminthes (worms) and the farmers spend a considerable amount of money on buying dewormers.

The major disease for poultry in the region is Newcastle. The Newcastle disease is a virus spread primarily through bird-to-bird contact among chickens, but it can also spread through contaminated feed, water or clothing. Outbreaks can occur anywhere. It is a major constraint to the development of village chicken industries, particularly in Africa. A large number of wild bird species can harbour Newcastle disease virus and, occasionally, the disease affects large-scale commercial poultry units in developed countries. Others diseases include Coccidiosis and fowl pox.

5.0 Impact of pests and diseases on food security, socioeconomic and poverty reduction

The impact of pests and diseases implies the yield loss resulting from the damage caused on the crop. The damage may be in quantity or in quality or both. Globally, the loss of food and fiber produce caused by pests (insects, pathogens, nematodes, weeds, and vertebrates) in the field and storage is approximately 50% (Pimentel, 1997). The yield loss in Rwanda is yet to be quantified and documented. However, during recent years, the impact of pests and diseases on different crops was nationally felt and impact may be estimated and quantified. The following is reported: (i) Banana Bacterial Wilt (*Xanthamonas spp*.) on bananas, (ii) Cassava Mosaic Disease (CMD-UGV), (iii) antestia bug on specialty coffee quality grade, (iv) Striga weed (Striga Spp.) in Eastern Province, (v) couch grass (*Digitaria Scalarum*); (vi) Late blight (*Phytophthoras infestans*) on tomatoes, and (vii) Foot and Mouth Disease (FMD) on cattle in Eastern province.

5.1 Impact of Banana Bacterial Wilt (Xanthomonas spp.)

The banana bacterial wilt (BBW) infested fields in Rubavu District, in the Western Province, and was identified in 2005. The severity was localized, but very high. The banana field infested with BBW were uprooted and infested plant parts buried. This was 100% crop loss and farmers had to plant alternative crops. The GOR had to support them to get seeds and inputs. This was double loss, first loss of crop itself, and loss of GOR fund to supply those inputs. Although such impact is not clearly and systematically documented, it can be easily studied and quantified. The BBW is now spreading and it is already reported in seven Districts because of inefficient extension system.

5.2 Impact of Cassava Mosaic Disease (CMD-UGV)

The CMD was first reported in the border with Uganda in the year 2000 by monitoring system of IITA-ESARC in Uganda. During the year 2004, the disease had reached Nyamagabe (former Gikongoro Prefecture). Because cassava is an important food security crop, and CMD-UGV was attacking and damaging all local varieties, the GOR had to invest in multiplication and distribution of four resistant varieties. The impact from CMD is also very large, and may be studied and quantified in term of loss of revenue from cassava, combined with cost of production and distribution. The disease is reported to cause between 20 and 90% crop losses based on the cultivar, viral strain and environmental factors. Current estimates put losses due to CMD in Uganda at US dollar 60 million annually, and on a more practical level, food shortages resulting from this problem led to localized famine in 1993 and 1997.

5.3 Impact of antestia bug (*Antestia spp*.) on coffee:

The antestia bug is a major pest of coffee and there are different species of this bug throughout Africa. It attacks flowers buds, green berries, and growing tips of coffee. As they feed, they inject saliva containing the spores of the fungus *Ashbya*. This fungus is thought to cause the taste defect, i.e. a marked “potato” (very similar to a freshly cut raw potato) or “green pea” taste defect.

Therefore the impact of antestia bug is both quantity and quality. First, the damaged coffee cherries are rejected during sorting of cherries of good cherries at the farm and at washing station, a part of yield loss. The second loss is effect of potato taste which leads to rejection and not accepted as specialty coffee, and poor coffee grade which does not get higher price, thus loss in income.

5.4 Impact of striga weeds (*Striga Spp*.)

Striga weeds are among noxious weeds of the world**.** The witch weed (*Striga spp.*) has vascular plant root parasites on cereals, sugarcane and cow peas in Asia, Africa and USA. Generally, *Striga* has been reported to cause heavy significant crop losses ranging from 70-100% if there is no control instituted (Ransom 1996). In Rwanda, it is reported in Eastern Province and is given local “kurisuka” indicating high yield loss. The yield loss and impact of this disease is not yet quantified and reported.

5.5 Impact of couch grass (Digitaria Scalarum)

The couch grass is reported among the noxious weeds of the world with distribution limited to highland areas between the Great lakes of Eastern Africa: Lake Victoria, Kivu, and Tanganyika). These soils are largely acidic. It is serious weed which has infested large proportion of fields and take a long period to dig it out. The impact of this weeds is very high, first it takes time to dig out because farmers one day is spend on small piece of land, second, the farmers cannot cultivate and incorporate its fresh green stems into the soil to serve as organic matters, they dry them and hip or burn thus impacting on nutrient recycling.

5.6 Impact of water hyacinth

The impacts of water hyacinth are not well appreciated by the local communities in Rwanda owing to the location of the river through extensive flood plain wetlands. The downstream riparian communities in Tanzania and Uganda suffer serious environmental and socio-economic impacts generated by the proliferation of water hyacinth upstream in the Kagera. inadequate control measures such as failure of natural enemies (weevils) to establish in the river-line environment, lack of consistent monitoring & control mechanisms, inadequate scientific information on the hyacinth proliferation in different parts of the basin (several methods have been used such as weevils, mechanicals etc- literatures are available at LVBC); and insufficient resources to invest in mechanical removal limit the observable impact on this weed in the basin in Rwanda.

5.7 Impact of Foot and Mouth Disease (FMD)

The disease is very serious and spread very fast in Rwanda. The disease is common in the eastern province because of cross border link with Uganda and Tanzania, and because of neighbourhood with the Akagera National park in Rwanda and National reserve in Tanzania side. Moreover the disease is not properly controlled in Uganda and Tanzania.

The impact of this disease is very high. Whenever, there is an outbreak, MINAGRI imposes quarantine for animal product from the quarantine area. Cattle keepers cannot sell milk or animal or other products. This causes a huge loss to the producers and traders. Likewise to the national economy as it is usually reflected in National GDP.

6.0 Impact of current pest management relevant in the basin in Rwanda

Background: The pest and diseases control is essential in crop and livestock production. The insects and pests are part of biodiversity of any ecosystem. They become pests only when they multiply and exceed a certainly population level as a result of supply of good and high nutritive food from crops. When the damage causes economic loss, then they become major pest worth of investing in cost for control and stop further yield loss.

In the lake basin of Rwanda, there are pests and diseases of economic importance that require cost effective control for improved productivity. The effective control can only be obtained only when social, economic and environmental factors are taken in account. This is because farmers are independent managers of their own they make independent decisions. Therefore, they have to make choices of the appropriate control measures suitable for them. The importance of control option selected will determine future application and adoption of the method. This is important for increased adoption and effective use of the selected method.

6.1 Use of pesticides in pests and disease management

Under this report pesticides means insecticides, herbicides, fungicides, rodenticides and other chemicals used to control, prevent, destroy, repel, or regulate pests. As toxicants (poisons), they detrimentally affect living organisms and usually have adverse effects on other forms of life. Because of their poisonous nature, pesticides can injure or kill people, pets, and livestock; damage beneficial insects, birds, fish, and other wildlife; and can harm desirable plants. It is mandatory that all such materials be very carefully managed and handled during storage, transport, mixing and loading, application, and disposal. It is critical to stress the importance of safe pesticide use and need for IPM program.

The impact of pesticides use is very high especially in the fungal diseases control such as late blight (*P. infestans*) in potato and tomato, coffee leaf rust (*Hemilea vastatrix*), coffee berry disease (*Colletotrichum coffeanum*), rice blast (*P. oryzae*). These diseases are mainly managed using pesticides, and their impact can be tremendous. For example, the late blight can cause up to 100% yield loss in heavy rainfall areas of Rwanda.

Currently, common pest control practices in Rwanda include pesticides use in cash crops, resistant varieties in food crops and informal cultural practices for diverse many crops. However, pesticides use in Rwanda is very low and limited only to high income crops like coffee, potatoes and vegetables (e.g. tomatoes etc). Pesticides are either not affordable or not accessible in many parts of the country. According to the Ministry of Agriculture and Animal Resource report, the national averages of pesticides use is below 1kg/ha and it is mainly fungicides which are unlikely to cause major dangers when properly handled.

In general, pesticide use in Rwanda targets mainly plant diseases management and nearly 75% are fungicides while the remaining 25% is composed of different insecticides and a few herbicides. Among the fungicides imported, more than 90% of the products are Mancozeb and Ridomil which are applied to coffee, potato and tomato against the late blight (*Phytophtora Infestans*), coffee leaf rust and coffee berry disease.

During a three years period (1997 – 2000) the proportion of different pesticides was as follows: fungicides (75%), insecticides (23%) and herbicides (2%). Although, the amount used is very small, pesticides use is associated with both positive impact through pest control and negative impact through risks on humans (producers and consumers) and the environment.

Based on the national pesticide survey in 2005 for the whole country, it was realised that there was a need for the following actions: (i) legislation of the pesticides to regulate importation, storage, handling and marketing; (ii) initiating the formation of associations of the distributors and the importers of pesticides; (iii) organizing sessions of training for all distributors of the pesticides; and (iv) importers and the distributors must have not only trade licence but also pesticide dealing licence indicating their competence in pesticide handling delivered by the competent Ministry. Currently there is no policy or regulation as regards to safe pesticide handling and use as required by international code of conduct.

In Rwanda, there are two major sources of importation of the pesticides: (i). importers having trade licences of importation and (ii) gifts coming from the European Union (Stabex), FAO, or NGO (e.g., World vision). The pesticide marketing is liberalized and supply is done by private sector, and directly sold to retailers, while the capability and competence of end-users to handle products within acceptable risk margins is questionable In general farmers and extension staff have very little capability to handle and use pesticides at low risk.

It is important that pesticides are used safely and in a way which is not hazardous to human (producer and consumers), animal/livestock, and to the environment. The farmers should be aware and observe the safe use of pesticides as specified in a user's guide. All pesticides should be treated with care whether they are known to be particularly poisonous or not.

Due to the nature of Rwanda land terrain, the pesticide use should be limited or used judiciously to minimise side effects to human, animals and environment downstream of watershed and in riparian countries. The alternative pest control means non-chemical methods (cultural, physical and biological) should be explored first before embarking on chemical pesticides application. The use of IPM accepts pesticides as last resort, i.e. if they cannot be avoided. The list of pesticides (insecticides, fungicides, herbicides, rodenticides and nematicides) allowed in Rwanda is provided in annex C. Together with prohibited pesticides the following sections will give guideline on best methods to benefit from pesticides use with minimal risk to human, environment and other organisms.

Recommendation: It is urgent to do capacity building at all levels including: farmers, extension staffs, pesticides traders, and local leaders. A brief description of current pesticides use in few selected crops is indicated in the following sections. The base line data for pesticides for each crop is not available because some cooperatives can buy and supply fungicides to farmers as loan deductible after harvest, while individuals buy insecticides using their own cash. This makes it difficult to establish reliable data on pesticides quantities used in each crop.

6.2 Pesticides use in different crops and livestock

6.2.1 Current pesticides use in potato

In the potato crop, the commonly used pesticide is the fungicide, and the most commonly used fungicides is Dithane M45/Mancozeb (contact preventive), and Ridomil/Metalaxyl (systemic). Both of them are unlikely to cause hazard because they are categorized as U and III under WHO respectively. Farmers apply Dithane M45 (protective fungicide) when rainfall is not continuous, and use Ridomil (systemic fungicide) when rainfall is continuous and can wash out protective fungicides. This experience is good and is an important tool in IPM development, since it is farmers' knowledge of their local condition. Even when using resistant varieties, the crop protected using fungicides gives higher yield. Therefore the impact of fungicides use on potato against late blight is expected to be a good and reliable component of IPM for the foreseeable future. It is recommended to continuously do research on testing various fungicides and monitor efficacy of those already used, and ensure right dose is used and properly, timely and safely applied in different agro-ecological zones, together in combination with developing alternatives or complementary options under IPM.

6.2.2 Current pesticides use in rice

Farmers producing rice apply in rare occasions fungicides (such Kitazine/IBP) against blast disease. The most commonly used fungicides are not uniform for all marshland and depend on seasons. Similarly they apply insecticides whenever required only, after observing large number of insects in the field, although the actual threshold is not established in Rwanda. Field observation as a guide to apply insecticides is a good practice which will be improved further through rice IPM development.

6.2.3 Current pesticides use in maize

The pesticides use in controlling insect pests in maize is not common except for a few farmers where the problem is severe and there is external support from some projects or NGOs to control maize stalk borers. The diseases are managed using resistant varieties.

6.2.4 Current pesticides use in tomatoes

The tomatoes crop suffers a large number of diseases. However, the pesticides are used only into controlling late blight (*Phytophthora infestans*). The latter is major constraint especially during the rainy season. The disease is controlled using the fungicides such Mancozeb/Dithane M45 or Ridomil/Metalaxyl (category U and III respectively. Similar to potato, the use of fungicides is expected to be a good means of control

6.2.5 Current pesticides use in cassava

The pests and diseases of cassava are managed using resistant varieties and cultural practices. The use of pesticides is not economical.

6.2.6 Current pesticides use in coffee

Coffee crop is the largest user of pesticides in Rwanda. It was reported during the 2005 study to use 90% of imported fungicides (75% of all pesticides) in the country. This amount is used against mainly coffee leaf rust (*Hemileia vastatrix*) and coffee berry disease (*Colletotrichum caffeanum*) as preventive measure. The insecticides sprayed against antestia bug (*Antestiopsis spp*.).

6.2.7 Current pesticides use in bananas.

The use of pesticides on banana is very little. Currently, the major threat of bananas in the basin in Rwanda is the banana bacterial wilt, which is spreading in all banana growing areas and its management does not require the use pesticides. The second most important disease in the country is the Fusarium wilt (*Fusarium oxysporum fs musae*) on exotic banana cultivars, which is soil borne disease and does not depend on pesticides for control or management.

The others pests of banana are not important but needs close monitoring due to climate change which may adjust to local climate. These include banana weevils (*Cosmopolites sordidus*), nematodes (like *Pratylenchus goodeyi*, *Helicotylinchus multicinctus,* and *Radopholus similis* and *Meloidogyne spp*.) and leaf spots (yellow sigatoka, black sigatoka and cladosporium leaf spot) are not a threat because of altitude effect. These pests are threat below 1400 m above sea level, while major banana growing areas in Rwanda are above this altitude. Even if they occur, the use of pesticides is not economical.

6.2.8 Current pesticides use in beans

The use of pesticides in pest management in the bean crop is very low under field condition. The use of systemic fungicides like benomyl is effective, however, not applied because the cost of control is very high while the value of beans is very low. The pesticides are applied against the storage pests, bean bruchids, using dust insecticides e.g. supper actellic.

6.2.9 Pesticides use in Livestock

Current Pesticides use in livestock: The pesticides used in livestock are mainly acaricides against tick control. The livestock in Rwanda, especially in the eastern province, move a long distance to the water drinking points at the dams or streams or rivers. In the process they are infested by ticks. The ticks are known to transmit diseases to livestock and cause major problems (e.g. ECF). In order to minimize the tick attack and disease transmission, the cattle keepers spray the acaricides on their cattle at their kraal at homestead. In the past and during colonial period, Government used to build dips for communal, however, the tick control was left to cattle keepers themselves. In the eastern province, they have access on acaricides from both Rwanda and Uganda, and since pesticides marketing are liberalized, cattle keepers are free to buy where prices are reasonable. Since farmers and cattle keepers have little knowledge on pesticides safety, use, and handling; they may misuse or buy poor quality acaricides which in turn will cause ticks to develop resistance. There is no grantee that such pesticides have required efficacy and that they are effective. The other pesticides used are the antibiotics, vaccines etc. The cattle keepers also buy their antibiotics and treat their own cattle. However, the vaccines are administered by RARDA and for a known period. In general the vaccines are very useful their impact is very high. There is vaccine against east coast fever (ECF), CBP etc. These are important pesticides which are administered regularly sometimes on annual basis.

Recommendation: There is a need to do continuous research on tick control and monitoring population, species profile, tick susceptibility to different acaricides in market, their persistency, application rate, in order to detect resistance when occurs. Meanwhile, it is important to develop alternative IPM options on how to apply alternate pesticides and delay pesticide resistance etc

6.2.10 Pesticide Concerns, measures required to reduce specific associated risks

6.2.10.1 Environmental and Public health risks/impacts

The pesticide transport, storage, handling, and use under local conditions need much improvement. Similarly stocks of obsolete pesticides have also become a serious health and environmental problem. Since pest outbreaks are erratic and difficult to predict, there is a danger that more pesticides than needed will be ordered or that pests will migrate out of the area before the pesticides arrive. As a consequence, stockpiles of pesticides can be found in many of the countries affected by migratory pests. Often they are not stored correctly, which has resulted in corroded containers, lost labels and release of the chemicals into the environment. The disposal of containers and obsolete stocks require much more effort especially in teaching people involved in pesticide marketing and use since there is little understanding on risks involved at all levels. Moreover, there is no report on water contamination, food safety or pest resistance because insecticides are used in small quantities and on few crops. However, with agricultural intensification, and rice double crop per year in marshlands, there is a fear that misuse of pesticides may cause risks on environment and human health explaining the need for extensive sensitization.

6.2.10.2 Legal framework and enforcement

There are two draft bills in process, one for agrochemicals (pesticides and inorganic fertilizers) and another plant health which addresses issues of plant protection. The later (plant health bill) is at advanced stage, while the former (agrochemical bill) is at early stage. However, there are other laws and texts making it possible to reduce the risks of pesticides such environment law etc. Nevertheless, the plant health focuses more on phytosanitary (inspection of imports and exports) and safe trade than on plant protection while growing in the field. The section of protecting growing crops in the field is not well elaborated; as a result there is very little mention of different pests' management strategies such as integrated pest management and other methods.

6.2.10.3 Capacity building in pesticide use

The capacity building in pesticides at all levels (farmers, traders, extension staff, local leaders and decision makers etc) is an urgent issue to be addressed. Rwanda is landlocked country, and has small pesticide market, and farmers with small purchasing power. As a result the distribution and marketing of various pesticides is done in small packets without original label, and instructions associated with labels. Moreover many farmers do not use pesticides so often, as they depend on cultural practices and resistant varieties for pest management. Nevertheless, the training of farmers, extension staff and retailers of pesticides is needed as an urgent and important activity required in Rwanda. Most extension staffs employed by farmer's cooperatives are not aware of hazardous nature of pesticides. They have knowledge from school which is not enough skill needed in the field. They need regular updating and more guidance on safe pesticide handling.

There is a minimum knowledge for safe use of pesticides which should be taught to all stakeholders in agriculture and livestock, including consumers' sensitization in issues like: (i) poisonous effect of pesticides thus safe handling, (ii) storage, (iii) disposal of containers, (iv) sprayer maintenance, (v) calibration, and (vi) use of protective clothes etc. Under agricultural intensification, and a need for more food for an ever increasing population, farmers will need to protect their crops continuously (e.g. potatoes, tomatoes or rice etc) using pesticides for greater part of their life. Therefore, the knowledge of safe use of pesticide is an important tool for their safety; other people's safety and environment health in general. Therefore, the capacity building will be the most important pre-requisite for safe use of pesticide at all levels, including local leaders, traders and policy makers.

6.3 Use of resistant varieties in pests and disease management

Currently the use of resistant varieties is the most reliable, affordable and sustainable pest management method in the country, in particular for diseases control. Among the most recently released crop varieties, the majority of them are resistant against particular disease; and both farmers and Government are much interested in such varieties as they provide affordable and sustainable solution to the disease problem. For example, during the last three years, the Government has been involved in assisting farmers to get resistant cassava varieties against cassava mosaic disease.

6.4 Use of cultural practices in pests and disease management

The use of cultural practice is the most common practices. Although not formally developed into IPM package, it is still the only method which keeps the pest below damage threshold while preparing their own fields. The cultural practices applied in Rwanda have some important elements useful in pest management. In most crops apart from irrigated rice and potatoes, other crops are planted in rotation or under mixed cropping system. The crop residues are normally destroyed by burying, burning or hipping or feed to livestock. All these methods do not allow population increase of the insect or diseases. The burning of crop residues is no longer allowed, because the Government has banned it. In general crop rotation is generally practiced by the majority of farmers.

6.5 Use of natural enemies in pests and disease management

The use of natural enemies is an important tool and method in biological control. In Rwanda, the biological control is not one of formal crop protection practices. However, due to very low pesticides use, the effect of pesticides on natural enemies is very low, and conservation of natural enemies is of course effective. In absence of side effect of pesticides, some pests are kept down by a combination of conserved natural enemies with good cultural practices. A field visit in different parts of Rwanda will indicate the importance of this combination. The field observation will indicate that there is much more disease problem at farm level than insect pests. Since, protective fungicides have little effects on natural enemies as compared to insecticides, it is obvious that the natural enemies of some insect pests are not much affected. However, research on natural enemies distribution and population dynamics for major and minor pests need to be established and the distribution mapped using GIS tools.

7.0 Proposed IPM for major crops in basin in Rwanda

The pest management during LVEMP-2 will focus on major pests and diseases of major crops namely potatoes, rice, maize, cassava and tomatoes, beans, bananas and coffee. The major crops are among the national priority crops in the country and the execution of IPM will involve different partners. Moreover IPM is normally executed at community level rather than at individual plot level; the execution of IPM plan will therefore involve Ministry of Agriculture and Animal Resources, District authorities, NGO's, farmers' organizations and farmers.

It is recommended to establish IPM at community level, not at individual farm level only. The plots in the same locality should apply the same principles to avoid source of infestation from the neighbourhood. Therefore, the IPM options should be taught to the farmer groups and not to individual farmers. The farmers should be organized into groups to work together, make regular field observations, discussions and agree on the best IPM approach to apply at the various growth stages of their crop.

Training of farmers in IPM is an important activity, because they should know and distinguish pests from non pests, recognize and appreciate damage caused and associate it with particular insect pests, diseases or weeds. Finally they should be able to make decision on pest management action to be taken in the controlling of the insect pests, diseases and weeds and the reasons underlying the decision to be taken. The following section will outline a range of IPM practices for major pests and diseases of each target crop which will form a part of the training package for farmers.

7.1 Management of major insect pests and diseases of potato

The pest management in potatoes is complicated and difficult, as the potato is a vegetatively propagated crop using tubers for seed, which transmit easily bacteria, viruses, fungi and insects, and some are rapidly disseminated by cutting knives. Therefore, the source of relatively pest-free seed is essential for healthy potatoes production. This is complicated by the quantities needed as seed rate per unit area. The experience from the field visit underLVEMP1 is that the major pests and diseases problems include: 1). Late blight (*Phytophthora infestans)*, 2) Bacterial wilt *Pseudomonas solanacearum*, 3). Potato tuber moths and 4) aphids (serious when rain is low). The pest management tools include cultural practices, resistant varieties and fungicide application.

The increase in potato yield is a result of good cultural methods such as right fertilizer practices, weeding, insect and disease management. There is a wide variety of cultural practices and agro-ecosystem manipulations used to control potato pests. Some of them may be integrated into pest management programs in Rwanda.

The best IPM tool is the use of healthy clean planting materials, and is of primary importance since most of the major diseases of potato can be carried by 'seed tubers'. The production of healthy seed tubers requires the use of specially prepared virus-free mother parts. These are often produced by micro-propagation techniques; and are grown under disease-free condition, and must include the absence of aphid virus vectors. The virus-free mother plants produce virus-free seed tubers. The basic prerequisite for improved agricultural production is the availability of a reliable source of relatively disease free seed. The potato seed producers should obtain their seed from "foundation" seed produced in isolated areas either at ISAR or certified fields, where they are maintained extremely in high standards for freedom from disease.

The general phytosanitary techniques such as crop rotation are also essential. Potato rotations with other crops are a component of both traditional and modern agriculture. Crop rotation is recommended as a means of disease control, and is especially important for the long-term control of diseases such as verticillium wilt, and fusarium wilt *(Fusarium* spp.) etc. It is important that the crop rotation does not include plants that are also hosts of the potato pathogens, like tomatoes since that may make the problem more serious.

The cultural manipulations and sanitation procedures such as use of clean seed, destruction of source of inoculums, hilling up and killing of infected vine near harvesting are used to reduce losses due to disease organisms such late blight disease (*Phytophthora infestans),* as it is important to delay initial infection.

The potato farmers in the North Province are very conversant with both protective and curative fungicide against late blight. They apply Dithane M45 (protective fungicide) when rainfall is not continuous, and Ridomil (systemic fungicide) when there is continuous rainfall which can wash out protective fungicide. This knowledge is good and their experience is an important tool in IPM because it is based on their observation.

It is recommended to apply fungicide (e.g. Mancozeb/Dithane M45), when growing both susceptible and resistant varieties as cash crop, especially when weather condition is favourable for spread of disease; because a combination of fungicides and resistant variety gives a relatively higher yield. There is sufficient resistant variety available to-date which does not need protective measures. The only risk with potato farmers is that they mix the insecticide with fungicide whenever they apply on weekly basis without basing on any basis on recommendation.

7.1.1 Management of potato late blight (Phytophthora infestans, Oomycete)

The late blight disease is caused by the fungus (*Phytophthora infestans, Oomycete)* and it is the most important limiting factor for high potato yields in the country. The epidemics are more severe in the North province of Rwanda. The first reason for the severity of blight epidemics is the absence of a prolonged dry period to check the disease; where it thrives throughout the year not only on potato crops, which are planted in many months of the year, but also on volunteer potato, tomato and alternative species. The second reason is that the climatic requirements of both the fungus and the crop are identical and are met in most months of the year. The management options include:

Resistant varieties*:* Although resistant cultivars are important tools in disease management, because of the highly variable pathogenicity of the fungus, there is no total resistant cultivars, and complementary fungicides have to be applied in order to get high yield. There are a number of resistant varieties in the country under national seed service including Kigega, Gikungu, Mizero, Ngunda and Nderera etc. The production and distribution of clean tubers is important in disease management. Farmers will learn on how to get clean tubers on time in their own community.

Cultural control*:* The cultural manipulations and sanitation procedures are used to reduce losses due to late blight disease (P. *infestans)*, as it is important to delay initial infection as long as possible by using of whole clean tuber clean seed, destruction of source of inoculums, hilling up and killing of infected vine near harvesting. The details of these practices are found in the potato IPM tool kit.

Fungicides management*:* It is recommended to apply fungicide (e.g. Mancozeb), whether a farmer is growing a susceptible or resistant variety, especially when weather condition is favourable for the spread of the disease. Potato farmers in the Northern Province are very much aware that the fungicide spraying is necessary when growing susceptible varieties.

There is an increasing use of fungicide in Rwanda to control late blight, which at the same time controls the other fungal diseases like early blight *(Alternaria solani)*, because fungicides used are broad spectrum. In general, fungicides used are essentially protectant, and for effective control, a continuous film over the entire surface of the plant is necessary. Many of the protective fungicides control late blight effectively and economically and are applied at regular short intervals of 5, 7, or 10 days depending on weather conditions and the proximity of source of infestation where an alternative host crop is growing. The mode of action of the protective fungicide is generally non specific in interfering with many vital functions of fungi.

In contrast, systemic fungicides (e.g., Ridomil) penetrate the cuticle and are translocated throughout the plant, so that their action is much more efficient. However, some systemic fungicides such as Rridomil/m Metalaxyl are highly specific in their mode of action. Thus, their fungicidal action seems to depend on the interference with only one or a very few vital organs, and a single gene mutation in the pest organism can result in a modified system, which may be no longer sensitive to an attack of fungicide. Such change would result in an immune individual and provide the basis for a resistant population. As a result, a fungus population with resistance may probably arise, and resistance to fungicides may probably become a problem in control of late blight. This message should clearly be understood by farmers.

7.1.2 Management of bacterial wilt (Ralstonia solanacearum, Bacterium)

Bacterial wilt disease is caused by the bacteria *Ralstonia solanacearum (formerly known as Pseudomonas solanacearum).* The external symptom is a wilting of the vegetative parts in spite of a moist soil. A white bacterial mass oozes from the vascular tissue when the base of the stem or a tuber is cut. The main method of spread is by diseased seed tubers. Once the bacterium is in the soil, it remains there almost indefinitely both because it can survive saprophytically and also because it parasitizes a number of very common weeds. The disease management plan includes the following:

Resistant varieties: Planting of resistant varieties is the only reliable means of combating bacterial wilt. There are a number of tolerant varieties including Mabondo, Kirundo, Mugogo, Mizero, Ngunda, Nderera. Currently, there is only one resistant variety in the list of RADA namely cruza which is not appreciated favoured by farmers.

Use of clean seed: Bacterial wilt is often transmitted in tubers. It is important to use clean seeds when growing susceptible variety on clean site. The use of bare fallowing during the dry season reduces the amount of inoculum by desiccation but it cannot eliminate it entirely. Infected tubers often show vascular discolouration. Typical wilting with bacterial exudation from the vascular tissue is clear symptom. Other cultural practices have very little impact.

7.1.3 Management of potato tuber moth (Phythorimaea operculella, Gelechiidae)

The tuber moth is one of the main important pests of potato. Infestations arise initially in the field and continue during storage of the tubers. Potato is the main hosts, while tomato, eggplant, tobacco and other Solanaceae members and *Beta vulgaris are al*ternative hosts. The potato tuber moth was in the past reported in the former Mutura district and was serious, but currently it is under control.

***Cultural control**:* The cultural manipulations and sanitation procedures are used to reduce losses due to potato tuber moth (*Phthorimaea operculella),* as it is important to delay initial infestation as long as possible by hilling up to cover the tuber properly and delay infestation in the field, closed season to avoid continuous availability of hosts in the field before the following season crop, encourage crop rotation with none host crops to ensure complete rotting of potatoes residues and rejected tubers, destroy crop residue to eliminate pupa remaining in the litter, use of selective insecticide such as systemic ones which does not kill some insects visiting the crop, test the use repellents in store like botanicals (e.g. Nneem, lLantana and eEucalyptus), and if the situation continues use non persistent pesticide such as Ppyrethrin. More details of these practices are found in the potato IPM tool kit.

7.2 Management of major insect pests of Maize

Maize crop is an important staple crop and source of income in many parts of the country. However, many farmers lack the basic knowledge in good crop husbandry which gives high productivity, and pest and disease management techniques. Therefore, the Rwandan farmer interested in to investing in maize production should be learning improved maize production technologies and their role in pests and diseases management.

Maize crop is produced on hill side and in marshlands. In the Southern province, the maize crop is mainly produced usually during the dry season in the marshlands along Akanyaru river and its own tributaries (a network of tributaries of Nyabarongo river), upper stream of Akagera river. The maize crop is followed by a rotational crop or flooding during the rainy season, (for example the farmers association in Ngenda Sector produce maize crop in rotation with bean or soya in the marshland of Umurago, a tributary of Akanyaru river, and then followed by a flood from the river. This cropping system has an implication on the stem borer and other pests' management. In the Northern and Eastern provinces, maize is produced on the upland as rain feed crop and in rotation with potatoes. Maize stalks are also used to feed livestock in the Northern Province. This is a good practice which is useful in the management of stem borer and other maize pests. The actual management of each individual major maize pest or disease is indicated in the following section.

Major insect pests and diseases of maize: The maize crop has a list of pests which are generally considered to be major pests, however, their economic importance varies according to environmental conditions and cultural practices applied by farmers. Nevertheless, maize stalk borers, striga weeds, maize streak virus, leaf blight and storage pests are among the major pests. Diseases like maize streak and leaf blight are reliably controlled using resistant varieties.

Currently, some of these pests are not a threat because the current maize production system which include crop rotation with other crops such as beans, soya beans or potatoes, and in some places flooding as seen in along Akanyaru river marshlands and tributaries. Similarly, in the Virunga area, the maize crop produced in rotation with potato which is not an alternative host. All these practices and their implications on IPM approach will be further elaborated in the sections below.

7.2.1 Management of maize stalk borers

Stem borers are the most destructive pests of maize crops. Its immature stage (larvae) causes damage either by 'Windowing' of the unfolding leaves as an early symptom or death of the central shoot of maize called "dead heart". Sometimes the early stage larvae mine into leaves causing yellow streaks in addition to the 'windowing. The yield loss from stalk-borers varies from 23 to 53% of the crop.

Control of stem borers by insecticides is not economically justifiable and feasible because it is expensive for resource -poor farmers, moreover, it needs timing of application before boring into stem; otherwise pesticides do not reach the stem borers once inside the stem.

There are three species of stem borers: *Chilo partelus*, *Sesamia calamistis* and *Busseola fusca*. These differ in ecological condition preference. In Rwanda, there is a possibility that *Busseola fusca* is more abundant and may be causing more damage to maize crop The *Busseola fusca* is indigenous to Africa and present in high- and mid-altitude (areas above 1077 masl). It is therefore expected to most common in Rwanda. The following crop management practices can reduce the damage of stem borers to a low and uneconomic level. However, there is a need for nationwide testing and promotion.

Cultural practices: The management of stem borer is more effective when life cycle is well understood in a particular area. The following cultural practices controls borers and reduce the population below economical damage level. These include manipulation to reduce population below the damage threshold such as (1) Simultaneous early planted maize over a large area at the onset of rain completes its vulnerable stages before the population of borers has time to build up, (2) destruction of thick-stemmed grass weeds which would act as an alternative hosts, (3) Uproot young plants which have been killed, (4). crop residues burning, deep burying or feeding to cattle to kill pupae left in old stems and tall stubble, (5) destroy damaged cobs and stems which might harbour diapausing larvae, since they will increase infestation in the next crop, (6) watch out for young plants with signs of 'windowing', and apply control early in the season for two reasons: (i) if the first generation is allowed to go unchecked, there will be greater damage to the cobs by the second generation; (ii) the caterpillars are most vulnerable to insecticides when they are in the funnel of the plant, and before they begin boring in the stem; and (7) closed season of at least for two months to prevent population continuity, the objective here being to have as long a period as possible when there are few hosts for it to feed on. If maize were planted only in the long rains, when it grows best, it would mean an eight month period from harvesting one crop to the young plants of the next, during which the maize stalk borer would find it difficult to survive. Most of them are commonly applied in Rwanda, especially in the marshlands and Virunga areas.

Push pull strategy: This is a technology developed by ICIPE and her partners as an effective, low-cost and environmentally friendly technology for the control of stem borers and suppression of striga weeds. It is a simple cropping strategy, whereby farmers use Napier grass and Desmodium legume (Silverleaf and Greenleaf Desmodium) as intercrops. Desmodium planted between the rows of maize produces a smell or odour that stem borer moths do not like. The odour of Desmodium 'pushes' away the stem borer moths away from the maize crop, while Napier grass *(Pennisetum purpureum)* which is planted around the maize plot attracts the adult moth and pulls to lay their eggs on it. Since the Napier grass does not allow stem borer larvae to complete development on it; the eggs hatch and the small larvae bore into Napier grass stems, the plant produces a sticky substance like glue which traps them, and the majority of them die, and very few survive. As a result the maize crop is saved from damage. In addition, Desmodium fixes nitrogen in the soil and enriches the soil. Details are provided in the maize IPM tool kit.

7.2.2 Management of major diseases of Maize

The maize diseases are important and serious threat, causing heavy losses up to 100% if not well managed. The major diseases of maize include: (1) maize streak virus disease, (2) southern and northern leaf blight, (3) leaf rust and (4) grey leaf spot (not yet in Rwanda). However, during the visits, disease incidence and severity were very low in many fields. This may vary from season to season, for example season "A" may have low incidence because of the long dry season preceding it, but in season "B" the incidence and severity might be higher because of continuous availability of host plants in the field in the absence of closed season, and then in season C, it might be much higher. The researchers may have to monitor this problem.

7.2.2.1 Management of maize streak disease

Maize streak virus disease is transmitted by leafhopper of the genus" Cicadulina". The diseased plants show a marked streaky chlorosis of the leaves. The chlorotic streaks are individually narrow, often discontinuous, but evenly arranged in parallel across the leaf. The streaks occur uniformly over the infected parts of the plant that has grown after infection. The leaves produced before infections are free from streaks. The severity varies according to resistance of the host and virulence of the virus strain. The yield loss is proportional to the time of infection. The seedling infection results in 100% yield loss.

Disease management include the following practices: (1) Use of resistant varieties is the best management option, (2) maize crop planted early escapes build up of vector population and gets low infection, (3) close season by destroying source of infection from crop grown during dry season and also avoid to plant near the crop that was produced during the dry season using irrigation, and (4) Rogue out all diseased plant as soon observed in the field.

7.2.2.2 Management of southern leaf blight (Helminthosporum maydis)

This disease is common in areas with warm damp climate. The dry weather is unfavourable for disease development. The primary source of inoculums is frequently plant debris from previous season. The disease develops very fast and can appear on young crops from infection of neighbouring fields. The fungus is also seed born and can be spread by untreated seed, and seed should be dressed using fungicide & insecticide mixture.

The disease management includes the following practices: (1) Use of resistant varieties is the best management option and the most important measure, (2) destruction of crop residue prevents early diseases development, (3) use of seed dressed with fungicide & insecticide mixture to delay early infection.

7.2.2.3 Management of maize leaf rust (Puccinia polysora, P. sorghi)

This is a host specific and, it does not have an alternative host. The spores are air-borne and are carried long distances by wind. The infected plant can spread diseases over long distance. *P. polysora* is favoured by high temperature and high humidity so common in low altitudes, while *P. sorghi* is common in cooler high elevations in the tropics. Maize leaf rust management include the following practices: (1) Use of resistant varieties which is the best management option and the most important measure, (2) Use of resistant varieties screened against rust, and (3) Destruction of source of infection at community level to delay early disease development.

7.3 Management of major pests of rice in Rwanda

The pests and diseases attacking the rice crop are many; however, only few of them are of economical importance in Rwanda due to high altitude. Among the diseases, only the blast (P. *oryzae*) is a serious diseases that calls for attention. The other diseases are minor and can be managed with various strategies and monitored closely without significant effect on yield. Similarly, the insect pests attacking rice in Rwanda are minor pests which do need much attention. Nevertheless, the major pests and diseases problems observed in the field and reported by farmers are: a) Rice blast *(Pyricularia oryzae*, b) Stalk-eyed borer **(***Diopsis thoracica*, Diopsidae), c) birds, and d) rats

7.3.1 Management of Rice blast (Pyricularia oryzae)

The rice blast is the most important and serious disease of rice. It attacks all aerial parts such as, leaves, culms, branches of panicles and floral structures. Its main host is the rice plant **(***Oryzae* spp). And a wide range of other graminaceous hosts. It is widely distributed in all rice growing areas. Alternative grass hosts, crop debris, volunteers and seed borne inoculums are major sources of the disease. High levels of nitrogenous fertilisers also increase susceptibility whereas high silica content in the leaf decreases it. The rice blast affects more severely the upland rice than paddy rice because drier conditions predispose plants to infection, and it is distributed in all major rice growing areas.

Because of the nature of the disease, phytosanitary practices have little effect but it is the only option applicable and affordable by the majority of our farmers. Use of resistant varieties (e.g., Kigori) is the best option, however, there are very few varieties adapted in the highlands. Therefore a combination of cultural methods and chemical options are necessary.

Cultural practices: The cultural methods include the synchronized early planting, fertilizer management to avoid over dosing which favour pests and diseases, crop rotation and destruction of residues by burning or burying them to ensure they have rotten.

Chemical control There is a wide range of fungicides with specific actions available such as Isoprothiolane which is a systemic fungicide active against rice blast, and is available as granules, dust, and emulsifiable concentrates (rated slightly hazardous by WHO).and IBP/Kitazin which is also systemic fungicide and controls rice blast and has also insecticide action (it is rated III under WHO).

7.3.2 Management of stalk-eyed borer (Diopsis thoracica West, Diopsidae).

The stalked-eye borer's main hosts are rice and sorghum. It attacks rice plants and the maggot feeds on the central shoot of the young rice plant causing a typical 'dead-heart'. The larva on emergence moves down inside the leaf sheath and feeds on the central shoot above the meristem. Later generations of larvae feed on the flower head before emerging. Although, it is a serious pest of rice, however, its pest of economical importance is not well established because of compensation nature of rice. The yield loss occurs only when the damage exceeds 50%. There is no justification as to why farmers should spend money on insecticides on this pest.

7.4 Management of major pests of Cassava

Management of cassava mosaic disease (CMD): Among the biotic factors, the cassava mosaic disease (CMD) is the most important. Epidemics are particularly ravaging causing yield losses as high as 100%. The CMD can be managed and its damage and effects can be reduced, however; a lot of effort should be deployed and coordinated. The major strategies to be adopted in order to reduce CMD damage include: (i) phytosanitary, (ii) use of resistant varieties, (iii) improved crop husbandry, (iv) training of farmers and extension workers, (v) monitoring and diagnosis and creation of public awareness, and (vi) coordination and linkages. The phytosanitation strategies include:
a) **Using Clean Planting Materials**: Selection of plants without symptoms for field planting.

b) **Roguing of infected plants**: The rouging of diseased plants of age 1-3 MAP (months after planting) will reduce yield loss by 40%. However, care should be taken to identify the CMD infection. The infection of plant older than three months may produce low yield but at least some roots may be obtained.

c) **Disposal & burning of crop debris:** Proper disposal & burning of crop debris removes alternative sources of infection. The uprooting of infected plants should be accompanied by destroying them; otherwise they may sprout and spread further the infection.

d) **Multiplication of Resistant Varieties**: The application of community based approach in the multiplication and the distribution of cassava planting materials is the only reliable means of timely distributing widely the available recommended resistant varieties. The LVEMP provided to support Ingabo and Imbaraga and they have multiplied and distributed a large number of cuttings.

e) Training of trainers (TOT): Train the farmers on the effects of CMD and its management is the priority strategy in the fight against CMD. However, to make sure that it is sustainable, the field staff working with farmers should be trained as TOT to enable them to train farmers and coordinate their activities. The staffs to be trained as TOT include the GOV extension staff at District and Sector level, the staff of NGOs working on agriculture in rural areas, and community based organizations (CBOs). The training should also cover pests and disease identification, symptoms, causes, transmission and vectors.

The coordination of stakeholders is important for success of CMD management. TheLVEMP2 needs to establish strong stakeholder coordination down to Sector level, determine the roles and linkages between them, and organize regular stakeholder meetings to discuss CMD status, management and new varieties on pipeline and other cassava production technologies, markets and opportunities. This will depend whetherLVEMP2 will support cassava in the Sector.

To ensure that coordination of activities is sustainable, there will be a need in each District to assign some members of staff as responsible of pest management task force which includes CMD and other pest problem in the district and inputs availability and marketing The LVEMPII in partnership with RADA needs to support districts to empower such a task force in pest management technologies. The main strategy of IPM is the production of healthy plants which can tolerate small pest damage without significant loss. The CMD can be managed successfully by community empowerment and participation in phytosanitary, multiplication of available varieties, participation in continuous research and bulking of newly released varieties. The involvement of local leaders is essential in IPM technologies dissemination.

7.5 Management of major pests of Tomato

Tomato is one of the most important vegetables, relatively easy to grow, important source of nutrition (vitamin A and C) and good source of income for smallholder farmers. In general tomatoes production is constrained by diseases and insect pests and all are economically important.

7.5.1 African Bollworm (Helicoverpa armigera)

Bollworms are large caterpillars often seen feeding in tomato fruit. Adults are large brown moths (figure 1a) which fly at night. The larvae (caterpillars) feed on leaves, flowers and fruit. The leaf damage can reduce leaf area which slows plant growth and the flower feeding can prevent fruit formation. When they burrow in the fruit they are difficult to reach and control with insecticide. The damage may cause the fruit to drop or make it more susceptible to secondary fungal and bacterial diseases. Management options include:

(1) Scouting is important to detect infestations early, preferably for the presence of eggs, since the larvae are well-protected once they move into the flowers and fruits. When larvae have entered the fruit, the damage caused is severe, (2) crop rotation can only help to prevent build up of populations, if it is done over large areas, since adult moths can move quite long distances and infest fields which were under rotation. This is likely practical for smallholders in the farmers associations, (3) hand picking of eggs and larvae can be an effective method if infestations are not too severe. Chickens can also help by eating larvae and pupae at certain times of crop development, although they should not be allowed in seedlings or plants with fruit since their scratching and pecking will cause damage, (4) infested fruit should be destroyed, and after harvesting infested plants should be composted or burnt, (5) infested crop residues are carefully destroyed to prevent pest switching backwards and forwards between different hosts. Pesticide may be used as last resort when other options have failed. A number of pesticides are effective and commonly available in Rwanda e.g., Dimethoate

7.5.2 Cutworm (Agrotis spp.)

Cutworms cause serious damage by cutting young plant stems at the base. Young larvae may feed on leaves and cause tiny holes, but they drop to the ground after a few days. Mature larvae are about 4 cm long, but because they hide in the soil during the day, and only emerge at night to feed on the crop, they are not often seen unless the farmer digs them up. The caterpillars are easy to recognize by their smooth skin, greasy grey/black colour and C-shaped posture when disturbed.

Cutworm infestations can appear suddenly (as a result of moths flying into the area) and are often associated with fields that are weedy, having high amounts of organic residue or very wet due to poor drainage or heavy irrigation. The following are management options: (1) prepare fields and eliminate weeds at two weeks before planting to reduce cutworm number. Ploughing can help to expose larvae to predators and bury others so that they cannot reach the surface, (2) early detection of cutworm infestations helps to initiate control before serious damage occurs. Cutworms are usually present when seedlings are found cut off at the base of the stem. However, small infestations can be controlled by digging near damaged seedling to find and kill the individual larva, (3) delayed transplanting slightly ensures bigger size seedlings that can be more tolerant to damage, (4) widespread outbreaks may require use of a pesticide application around the plant as drench or granules. Granules are best option when spread in a circle around the plant, (5) in the marshlands areas like Nyabarongo valley, flooding of the field for a few days before transplanting helps to kill larvae present in the soil.

7.5.3 Leaf miner (Liriomyza spp.)

The main damage is caused by larvae mining inside the leaves and reducing the photosynthetic leaf area. Some species mine over 2cm per day. If the infestation level is high, when the weather warms up, the leaves may be killed and drop off, leading to yield loss, fruit sun scald or in serious cases, death of the plant. The management options are indicated in tomato IPM tool kit.

7.5.4 Spider mites (Tetranychus spp.)

Infestations start first on the lower surface of leaves, particularly around the main vein. The leaves may become spotted, yellow, brown or silvery as a result of the spider mites' feeding activity. Yield can be greatly reduced as the plants are weakened or even killed as a result of feeding by large numbers of spider mites. Fruit can also be attacked, causing white speckling and loss of market value. The pest management options are indicated in the tomato IPM tool kit.

7.5.5 Aphids (Myzus persicae & Aphis gossypii)

Aphids damage tomato plants in two ways. (1) They suck plant sap which can reduce plant growth; and (2) they also excrete sticky liquid called honeydew, which coats the leaves, causing sooty moulds and develop slow plant growth. Aphids infest upper and lower leaf surfaces and are often seen on tomato plant stems. Infested plants may show signs of curling, wrinkling, or cupping of leaves. This is a minor pest during rainy season. Pest management options are indicated in tomato IPM tool kit.

7.5.6 Whitefly (Bemisia tabaci)

Whiteflies damage plants in three ways. Firstly, by sap-feeding of adults and nymphal stages which distort and cause yellowing of the leaves and weakens the plant; Secondly, mould develops on the excreted honeydew deposits which reduce plant growth and fruit quality. Thirdly, whiteflies can carry some virus diseases like tomato yellow leaf curl virus. Plants with heavy whitefly infestations will not yield well, however, a small number of whitefly can be tolerated, and pesticide sprays may not be necessary. When the tomato yellow leaf curl virus is known to be common in the area, even small numbers of whiteflies should be controlled. The white fly can be managed using the following options.

(1) Spraying the plant with soap and water solution controls whitefly. However, the mixture should be no more than 1 part soap to 20 parts water (1:20). If it is too concentrated, it can burn the plant, (2) the use of neem seed extracts in control of whitefly is effective, as it inhibits young nymphs to grow and develop into older nymphs, and reduce egg-laying by adults, (3) growing African marigolds has been reported to discourage whitefly; however, it is bad weed which is difficult to control when it is established, (4) in case the population of whitefly increases to high levels, application of pesticide by spraying may be necessary using effective and commonly available pesticides. The application of a systemic pesticide will be more effective than contact one. *The addition of soap to the spray solution will help the spray droplets spread on the waxy wings of the whiteflies.* A single pesticide application may not be effective against eggs or nymphs, so a second application may be necessary to control the adults which have emerged from the immature stages. Whiteflies develop resistance to pesticides very quickly so pesticides should be rotated to prevent it.

7.5.7 Damping off (Pythium spp. & Rhizoctonia solani)

Damping off disease can occur in two ways, first as pre-emergence damping off when seedlings die before they have pushed through the soils, resulting in patches which appear to have germinated poorly. The second type is post emergence damping-off which occur after seedlings have emerged, thus falling over and dying while still small, and usually within two weeks after emergence. The fungus infects the roots and base of the stem, and the infected plants show water soaked and shrivelled stem at ground level. The damping off disease of seedlings in the seedbed is caused by fungi. Development and spread of fungi is influenced by wet soils, crowded seedbeds and high temperatures. Damping off usually occurs in small patches at various places in the seedbeds, and disease spots increase in size from day to day until the seedlings hardened after two weeks from emergence.

The fungi are common in moist soils and may survive for several seasons without crop. The infection of plants is through the roots or via leaves which are touching the soil or have been splashed by rain or irrigation water. The fungi can also be transmitted on seed which has not been treated. The management of damping off includes the following options:

Use disease-free seed, and sow thinly to avoid crowding of seedlings in the seedbed and do not apply too much irrigation water or nitrate fertilizer. When buying seedlings, examine them in the seedbed to be sure they have been grown well. If there is doubt about the seed, for example, with farmer-saved seed, it can be given hot water treatment (for 10 minutes at 50-52°C) or else seeds can be treated with systemic fungicide. Use wax stick to bind a piece of metal and a floater tied on thread and stick which lay across the pot to monitor temperature. When temperature reaches 52^{O}C the wax will melt and the metal drops in water, the floater comes on surface. Destroy diseased seedlings by burning them; do not throw them in the field where tomato is to be planted. Make the seedbeds on land which is several metres from land which has previously produced crops of tomato or related crops such as potato, pepper or egg plant, and if there is a tomato field, make sure the seedbed is preferably located up-wind or upstream. Seedbed soil can be partly sterilized by fire, solarisation, or by drenching with a fungicide. If damping off occurs in the seedbed, spraying may be effective using effective and commonly available fungicides. Make sure the seedlings are thinned to enable good air circulation.

7.5.8 Early blight (Alternaria solani)

Early blight affects all aerial parts of the plant. Disease incidence increases in warm moist conditions (high temperature and humidity). The disease may defoliate the crop in the seedbed; plants may develop dark, wet patches all around the stem *(girdling)* near the soil surface. This is sometimes called collar rot, and will damage or kill small plants. When older seedlings are infected, it causes stem lesions that are usually restricted on one side, and to become elongated and sunken.

The affected leaves have brown circular spots with concentric rings (rings inside each other) and yellow halos, the pattern of which distinguishes this disease from other leaf spots on tomato. The leaf spots first appear early in the season on the older leaves and progress upward on the plant.

The greatest injury occurs as the fruit begins to mature. When this coincides with favourable conditions for disease development, it causes a great loss of foliage, weakens the plant and exposes fruits to sunscald. When plants are larger, patches of disease *(lesion)* sink into the tissue of the stem forming dark hollows. Black sunken spots can also develop around the stalk of the fruit causing it to fall.

Early blight can be seed-borne, resulting in damping off. Infected plant residues in the soil can carry early blight pathogen to the following season, particularly if the soil is dry. The spores are formed on the surface of infected tissue and can spread by the wind and splashes of water.

Control options are as follows: Avoid planting tomatoes next to related crops such as potato, pepper and egg plant, and remove Solanaceous weeds such as *Solanum nigrum.*, if there is doubt about the seed, for example, with farmer-saved seeds, it can be given the hot water treatment (sink in hot water at $50\text{-}52^{0}$C for 10 minutes with seeds lapped in cloth; use thermometer to monitor temperature). An alternative is to use a fungicide (See details above). When the crop is harvested, remove plant residues and use them for compost making or destroy them and do not plant tomato during consecutive years on the same land. If the problem of blight is serious, spray the crop using effective and commonly available fungicides such as mancozeb., and avoid windbreak and shade areas as they encourage dew and disease development, and keep the field free from weeds.

7.5.9 Late blight (Phytophthora infestans)

Late blight is one of the most serious diseases in cooler moist conditions, and may completely and rapidly destroy the crop (contrary to early blight which prefers warmer condition see above) causing 100% yield loss in absence of any intervention. The disease causes leaves to develop irregular greenish-black, water soaked patches, usually at the edge of the leaves. The leaves turn brown and wither but often stay attached to the plant. Under humid conditions, a white dusty layer which contains spores can be seen on the underside of the leaves.

When conditions are good for the development and spread of the disease, the whole crop can be lost in a very short time. Grey green watery spots can develop on the upper half of the fruit, which later spread and turn greasy brown and bumpy. Stems can also develop long watery brown patches. However, it is usually a very minor or non- existent problem in the dry season

Cultural techniques can help to reduce the risk of blight outbreaks. Stake plants to keep them off the soil, mulch to reduce splashes, and remove or deeply bury in old crops after harvest. Pruning will increase air movement and allow good spray penetration if pesticides are to be used. Irrigating in the heat of the day should allow the crop to dry before nightfall and reduce transmission and development. If there is wet weather, apply fungicide as soon as the disease is seen or as soon as local experience suggests that the weather conditions are favourable for disease development. Use of effective and commonly available fungicides such as Mancozeb or Ridomil as they can provide adequate control.

7.5.10 Fusarium wilt (Fusarium oxysporum f. sp.lycopersici)

Fusarium wilt disease affects the tubes which carry sap (water and nutrients) and blocks the supply to the leaves. The leaves turn yellow and die, usually the lower ones are the first to die The wilt is typically one-sided - at first only one side of a leaf is affected, then leaves on only one side of a branch, then leaves on only one side of the whole plant. If a stem is cut lengthways, the tubes appear brown/reddish. Light sandy soil and high temperatures both cause water stress which makes the disease worse. Fusarium wilt can be accidentally introduced to the field on infected seeds and seedlings. It can also arrive in the soil through farm tools, staking materials and shoes. Once it has been introduced, it can survive in the plant residues and weed hosts and can re-infect new crops. The fungus also produces special spores which can survive for many years even when no tomatoes are grown. Acidic soil and nitrogenous fertilizer favour the disease, and there is evidence that presence of root knot nematodes encourages Fusarium wilt.

Disease management includes the following options: Do not locate seedbeds on land where Fusarium wilt is known to have occurred. Where soil is acidic, raise soil pH to 7 by liming or use farmyard manure; avoid excessive nitrogen fertilisation and control root-knot nematodes.

7.5.11 Verticillium wilt (Verticillium dahliae)

Verticillium wilt is a disease which affects the tubes carrying sap (water and nutrients) around the plant. The symptoms are similar to those of Fusarium wilt. The older affected leaves turn yellow and gradually wither and/or fall off, but the damage is not one-sided as with Fusarium wilt. Plants with early infections often wilt during the day and then recover at night, but eventually the wilt becomes permanent. When cut lengthways, the plant often shows symptoms of brown colouration of the tissues. The plant may develop a lot of extra roots at the base of stem. This disease can have a devastating effect on the individual plants, but nearby plants may not be affected

Verticillium wilt can be both seed-borne and soil-transmitted. Unfortunately it can remain in the soil for many years in a dormant form or as soil inhabitant. When a plant is infected the spores can also be blown by the wind to infect other plants. The disease is serious if there is any slight root damage when transplanting or cultivation which can allow the disease to establish, or due to root-knot nematode damage.

The control options include the following: avoid alkaline soil which is good for the disease development; control root-knot nematodes if present in the field; do not locate seedbeds on land with a history of the disease; destroy crop debris after harvest; rogue out and burn any diseased plants and fruit; if plants are grown in the valley, temporary flooding will help to reduce the Verticillium pathogen in the soil.

7.5.12 Anthracnose (Colletotrichum spp.)

The anthracnose is indicated by small, slightly sunken circular spots developing on the ripe fruits. Even if green fruits are infected, they will not show any symptom until they begin to ripen. As the disease progresses, the spots spread and fruits cracks open. Leaves and stems of infected plants do not show any clear symptoms. The fungus can be seed-borne or can infect new crops from infected plant residue in the soil. Spores from the soil splash onto lower leaves of the new crop and infect them. Spores produced on these newly infested leaves can be carried by rain splash to the young fruit and spread around the farm by people moving through the crops.

Disease management include the following options: (1) Appropriate cultural techniques to reduce the risk of infection (by staking plants to keep them off the soil and remove lower leaves); application of mulch to reduce soil splashes; removal or digging out of old crops after harvest; removal of severely infected plants and harvesting fruit before the fully ripen. If the conditions favour development of anthracnose, a preventative spray program may be required to give adequate control using mancozeb or Ridomil fungicides.

7.5.13 Bacterial wilt (Pseudomonas solanacearum also known as Ralstonia solanacearum)

Bacterial wilt disease causes rapid wilting of the whole plant and the plant usually collapses and dies without any yellowing or spotting of leaves. All branches wilt at about the same time. If the stem of a wilted plant is cut, the centre appears brown, water-soaked and hollow. Squeezing the cut stem may cause white or yellowish bacterial slime to appear and if the stem is held in a glass of water for a few minutes, the milky bacterial slime starts streaming down from the cut end. Roots turn brown and may become soft and slimy in wet conditions.

The bacterium is soil-born and can survive in the soil for long periods. It has a very wide host range and infects all members of the Solanaceae family, including egg plant, peppers and Irish potato and some common weeds like lantana, black nightshade etc. It infects plants through their roots and when diseased plants are removed, the pieces of infected root which remain can infect new crops.

It is often introduced to fields via diseased seedlings which have been raised in infected seedbeds, in drainage and irrigation water. The disease develops best under warm (above 24^0C), wet conditions, and in slightly acidic soil, not favoured by alkaline soil (high pH). Root-knot nematodes can increase the severity of the disease. When the roots of diseased plants decay, the bacteria are released back in the soil.

Disease management include the following practices: growing varieties which have some tolerance; Avoiding to grow tomatoes in soil where bacterial wilt has occurred before; removal of wilted plants to reduce the spread of the disease from plant to plant; controlling root-knot nematodes since they may help the disease to establish and spread; liming the soil to raise soil PH; maintaining high nitrogen level. If possible, prolonged flooding of the field can reduce disease levels in the soil. Spraying pesticides will not help to control this disease.

7.5.14 Tomato yellow leaf curl virus (TYLCV)

Infection of young plants causes severe stunting of leaves and shoots which results in the plant looking very small and bushy. The small leaves roll up at the edges and yellow between the veins. Fruit set is severely affected with less than one in ten flowers on infected plants producing fruit. There are no signs of infection on fruit. TYLCV is neither seed-borne nor mechanically transmitted - it is spread by the whitefly *Bemisia tabaci* and can be accidentally introduced on infected seedlings NOT CLEAR. High temperatures and very dry conditions favour whitefly populations and therefore help the spread of leaf curl virus. The earlier plants are infected, the more serious the impact on them. Tobacco can also be infected and, although there are no symptoms, it becomes a carrier which can be the source for re-infection of tomato crops.

Disease Management options include**:** Rogue out diseased plants (in the seedbed and the field) and destroy them. Replace them with healthy plants; protect seedbeds from whitefly, because when plants are infected when old/large enough, they are less affected. Spraying with oil is said to be effective against the disease, probably because they reduce the infestation of whiteflies. Use different methods to reduce the ability of whiteflies to find the crop, for example, planting in a new area away from previous tomato cultivation, or planting maize around tomato fields; apply mulches (straw, sawdust etc) to control the whitefly as vector. However, whitefly control may not be sufficiently effective to control the TYLCV in areas where the disease incidence is high, because very small numbers of whiteflies can transmit the disease between plants. Cultivars such as Roma and Marglobe are highly susceptible and should not be used in areas where the disease is common

7.5.15 Tomato mosaic virus (TMV) management

Affected plants show light and dark green mottling and some distortion of the youngest leaves which may be stunted or elongated, a condition called “fern leaf”. This refers to the resemblance of these leaves to leaves of many kinds of ferns. Under high temperature and high light intensity, the mottling can be severe. Under low temperature and low light intensity, stunting and leaf distortion are severe. If fruit is infected when nearly mature, they can develop discoloration and brown streaks inside the flesh. The disease can be seed-borne, but can also survive on plant debris in the soil and so re-infect newly planted crops. The virus is easily mechanically transmissible by contact between plants, or through human activities, for example, transplanting seedlings or pruning.

General tomato disease management options **are as follows:** Remove crop debris and roots from the field, and do not overlap tomato crops; remove any crop or weeds in the Solanaceous family from within and around the field; workers should not smoke or take snuff when working in tomato fields as it is believed that ToMV can be transmitted from the tobacco;. When working with plants, it is claimed that dipping the hands in milk or skimmed milk prevents spread from plant to plant; and field tools should be washed thoroughly.

7.5.16 Blossom end rot

Blossom end rot usually begins as a small water-soaked area at the blossom end of the fruit. This enlarges, becomes sunken and turns black and leathery sometimes turning the core of the fruit brown. In severe cases, it may completely cover the lower half of the fruit, becoming flat or concave. Secondary pathogens can invade the fruit and destroy it. The problem is caused by calcium deficiency brought about by rapid changes in soil moisture and poor root development. Other factors that reduce calcium uptake, such as use of ammonium nitrate and high humidity, can make the problem worse. Rapidly growing plants are more susceptible to the disease.

If blossom end rot is a known problem on the farm, avoid growing varieties which are known to be susceptible such as the processing cultivars Roma. Get the soil tested and if necessary, calcium deficient soils should be limed with high calcium limestone before planting. Soil moisture should be kept constant if possible especially during the flowering and fruiting period. Foliar application of calcium chloride or soil applications of gypsum at transplanting time may help.

7.6 Management of major pests of Bananas

7.6.1 Management banana insect pests

Highland bananas (*Musa AAA-EA*) are traditional food and cash crop in the East and Central Africa highlands, where they are largely produced and unique in the world. Highland cultivars (*Musa AAA-EA*) are endemic in the region and account for 75% of production in Africa and 20% in the World. These bananas are resistant to Fusarium wilt race 1 and 2, though not resistant to BBW. Since these two diseases are the major banana constraints in Rwanda, coupled with poor crop management. The pest management strategies will be effective in their management. These strategies will also manage the minor pests which may become major under poor cultural practices. These strategies include:

a) **Use of clean planting material and clean site:** Planting new site with cleaning planting materials which are either corm pared and treated with hot water or obtained from tissue culture reduces infestation to new plantations and delays pest population build up.

b) **Improved agronomic practices:** Practices such as weeding, mulching and application of manure encourage vigorous crop growth thus reducing pest attack. The use of mulches and manure has been shown to result into better bunch weight as a result of improved plant vigour. Good weeding reduces weed competition such as *Commelina bengalensis* (which is alternate hosts of the banana nematodes) and couch grass (*Digitaria scalarum*).
c) **Management of crop residues:** Destruction of crop residues of the harvested plants reduces breeding sites for the weevils. The use of pseudostem traps continuously to low or monitor weevil population and reduced damage to the bananas,
d) **Host resistance to weevil and nematodes**: Improved banana cultivars with high levels of resistance/tolerance offers one of the solutions to weevil and nematode damage.
e) **Use of neem in banana pest management**: Treatment of pseudostem traps with neem oil (1-5%) has been found to inhibit the growth of weevil larvae up to 14 days. Neem repels the insects and treatment corms show less weevil damage.
f) **Use of insecticides**: Insecticides may be used sparingly when the methods have been found to be ineffective.

7.6.2 Management of Banana diseases

6.6.2.1 Fusarium wilt (Fusarium Oxysporium fs musae):

The main foliar diseases of banana can be easily controlled in Rwanda mainly through culturally-based practices. The Panama disease caused by Fusarium oxysporum, is the only threat found in all banana growing areas in the country together with BBW which is expanding. The Fusarium pathogen is spread between areas mainly through affected planting materials or equipments. The disease can be prevented through adoption of: (i) clean planting material, (ii) improved crop hygiene and (iii) good soil fertility. Moreover, the highland cultivars (*Musa AAA-EA*) which are endemic in the region and account for 90% are not susceptible. Farmers with problem of Fusarium wilt can plant local cultivars (*Musa AAA-EA*) and keep them for up to 30 years, because the fusarium spore can remain in the infested soil without host for about 30 years.

7.6.2.2 Management of banana bacterial wilt (.Xanthomonas campestris pv musacearum)

The banana bacterial wilt (BBW) is a serious disease attacking all cultivars of bananas. The incidence is very high and yield loss can go up to 90 – 100%. The management is still under development by research. So far the following options are in use:

(a) Cut the male bud after flowering and sterilize the equipment after every cut
(b) Disinfect equipments and tools after work and make sure they are sterilized before using another field
(c) Destroy and uproot infected plants and bury them to rot in the soil
(d) Destroy any regrowth from destroyed stools
(e) Restrict movement of bananas from infected areas (quarantine) to none infected zones
(f) Mobilize the threatened communities and involve them to enforce the restriction of banana movement to their area
(g) Monitor any new infestation and involve the community to give report on time

7.7 Proposed Management of major pests of beans

7.7.1 Management of field pests (insects and pathogens)

The successful management of pests and diseases of beans depends on the crop husbandry applied. The important beans diseases are seed borne and are transmitted by using infected seeds. Field insect pests have little effects on a health and vigorous plant. Therefore by applying recommended agronomic practices, the pests and diseases management can be easily achieved. The following are the general management options for producing health bean crop without significant pest damage effects.

a) **Clean seed**: Use treated clean seeds, and plant on clean soil which was not planted with beans for at least 2 years.
b) **Resistant variety**: Plant your crop using resistant varieties against major diseases where they are available, accessible and affordable.
c) **Crop rotation**: Rotation of beans with none legume crop such as tuber crops. This practice will reduce bean stem maggot (BSM) and root rot.
d) **Fertility management**: Make sure the soil is fertile, and if not, apply manure and inorganic fertilizers as recommended. A vigorous crop tolerates small infection without significant effect on yield.
e) **Weeding**: Timely weeding is important for producing healthy crop. While weeding, it is recommended to do hilling up soil around the stem of the seedlings to encourage development of adventitious roots and enhance recovery of plants from BSM damage.
f) **Crop residue management**: After harvesting, bury the crop residues, and do not use manure from livestock which were fed residues from legume crop.
g) **Fungicide**: In case the above methods fail, you can apply systemic fungicides like benomyl at recommended rates in your area.

7.7.2 Management of beans storage pests

The harvested beans are attacked by storage pests. There are two main species which cause severe damage, *Zabrotes subfasciatus* (Boheman) and *Acanthoscelides obtectus* (Say). The most common in Africa is the bean bruchid (*Acanthoscelides obtectus* (Say). The losses have been estimated to reach 35% in central and South America. The infestation starts in the field in the cracks of cracked dry pods. However, the main source of infestation is unclean store. The attacks of fungus and bacteria are avoided by storing dry beans below 14% relative humidity.

Management of bruchids. The control method depends on quantity of beans. At farm level with small amount you can use simple technology including: (i) Early harvesting to reduce early infestation, (ii) Mixing with ash at a rate of 20% of bean weight, (iii) Mixing beans with vegetable oil at a rate of 5mls oil/kg of beans, (iv) Use chemical by mixing with super actellic. For large commercial amount use chemicals: (i) use of super actellic, (ii) fumigation.

7.8 Proposed Management of major pests of coffee

Coffee is an import cash crop for Rwanda. It is attacked by many pests (about 850); however, only few of them are major pests which need control. These include coffee leaf rust (*Hemilea vastatrix*), coffee berry disease.

Antestia Bug (*Antestiopsis spp.)* management: The antestia bug is a major pest of coffee and there are different species of this bug throughout Africa. It attacks flowers buds, green berries, and growing tips of coffee. As they feed, they inject saliva containing the spores of the fungus *Ashbya*. This fungus is thought to cause the taste defect, i.e. marked “potato” (very similar to a freshly cut raw potato) or “green peas” taste defect. The antestia bug management includes the following actions**:**

a) Pruning to remove the dense foliage that the insect prefers.
b) Hand collection can be practical for small plots of coffee. The farmer burns plant materials and pass them around the coffee plant allowing drift of smoke through the leaves and fruit, driving the bugs to the center of the tree, where they can be more easily collected and put into container with kerosene or other substance to kill bugs. This practice can tested with with farmers with small plots or few scattered plants.

c) The antestia bug lay eggs in masses on leaves. The leaves with egg masses must be removed. However, the collected leaves with eggs should be left in adjacent area to the field where possible for the wind to blow back the egg parasites back to the coffee plants. The antestia bug has got natural enemy (egg parasite) which may reduce level of infestation by killing eggs.
d) Pesticides are recommended when the average number of bugs per tree exceeds two (2500/ha).
e) Natural enemies of the antestia include hymenopterous parasites and parasitic flies that feed on the eggs and mantids and assassin bugs that feed on adults.

Coffee leaf rust (*Hemilea vastatrix*): Management of *H. vastatrix* is not easy task. The coffee leaf rust cause damage on leaf as a result it reduces photosynthetic capacity of infected leaves and causes premature defoliation or leaf drop associated with high infection levels. Vegetative growth and berry growth and size are reduced depending on the amount of rust in the current year. The impact of rust, however, can have a longer term impact. Leaf rust associated defoliation and the strong carbohydrate sink of the berries cause shoots and roots to starve and consequently to dieback, thereby reducing the number of nodes on which coffee will be produced next year. Since next year's production of coffee occurs on wood produced this season, the tip and shoot dieback caused by the rust can seriously reduce the following season's crop. On average, losses are believed to be about 15% annually.

(a) Non-chemical management: the non-chemical control consists of: (a) pruning infected leaves, (b) Use of resistant cultivars, (c) Early intervention to prevent the spread of disease, (d).Shade culture may be useful in avoiding epidemics because monocultures of all crops tend to promote outbreaks, (e) better understanding of the life cycle may lead to further advances in the control of *Hemileia vastatrix*, (f) good cultural management to produce healthy plant

(b) Chemical control: Fungicides have been used successfully to control rust for a quite a number of years. The metallic copper fungicides have been the least expensive and most effective, with copper oxychloride formulations being the best. The dithiocarbamate protectant fungicides have been useful, but their short residual life and instability at higher temperatures and humidity have limited their widespread adoption. Their performance is better when mixed with copper fungicides. The systemic triazole sterol biosynthesis inhibitors have been effective, but high cost and occasional problems with severe defoliation (phytotoxicity) have been observed.

Fungicide efficacy depends both on timing of application and complete placement or coverage of the toxicant. This latter factor is important, since redistribution by rain is very limited. Important factors are spray volume, droplet size, and coverage. In timing the application of fungicides, rainfall was generally the most important factor to consider. Sprays during the rainy season were recommended, and sometimes recommended before the onset of the rainy season. Only 2-3 fungicide applications were required during low yield years and 4-6 applications during high yield years.

Coffee berry disease (*Colletotrichum coffeanum*) management. CBD Management includes both none chemical and chemical methods. The disease was first discovered in Kenya in 1920 and is caused by the virulent strain of *Colletotrichum coffeanum*). The fungus lives in the bark of the coffee tree and produces spores which attack the coffee cherries. Spraying has been determined to be the best way to avoid the coffee berry disease. Captafol and copper-based fungicides have been effective. The Kenyan coffee hybrid Ruiru 11 is resistant to both coffee berry disease and coffee leaf rust. Where the virulent strains of CBD occur, serious losses have been reported. The losses of up to 80% have been reported. More conservative estimates of losses are 20%.

(a) None-chemical. The none chemical method includes: (a) Hedgerow planting to reduce wind carrying innoculum, (b) improved pruning practices. The more open canopy is less conducive to prolonged wetting and spore exudation and spread, resulting in lower CBD incidence. Also the open canopy improves fungicide penetration and coverage

(b) Use of resistant variety: Differences in susceptibility to CBD are known. Kenyan variety, Ruiru-II is resistant to both CBD and coffee rust.

(c) Chemical control: Successful fungicide control programs frequently double or triple yields. Several different and effective fungicides for control of CBD are known, however, their use in the field is inconsistent. Numerous studies suggest that fungicide applications early in the season are effective only in those seasons when both flowering was early and the rainy season finished early. In the years when flowering is normal or late, and the rainy period extends longer into the season, early season fungicide applications is ineffective and CBD become worse during the season. The key issue is to protect the immature crop throughout the rainy season. Numerous fungicides have been evaluated for CBD control, and most are effective such as 50% copper formulation, which is also affordable to farmers. The systemic fungicides are also quite effective (e.g. benomyl) but more expensive. A mixture or rotation with non-systemic protectant fungicides is recommended.

7.9 Management for the water hyacinth

Efforts to control water hyacinth in the Lake Victoria basin and Kagera River system have been based on the use of biological control weevils (*Neochetina eichhorniae* and *Neochetina bruchi*. which predate on the water hyacinth plants, in combination with mechanical removal. The biological control involved the rearing and release of two types of weevils *(Neochetina eichorniae and Neochetina bruchi*) into the lake, while physical extraction involves a combination of manual and mechanical methods to reduce and maintain the weed biomass to minimal levels. However, the biological control on Kagera river has been unsuccessful mainly because the weevils do not develop effective populations in the riverine environment. Mechanical control is undertaken in

Rwanda and involves chopping and destroying the weed. Presently, it seems that there are no effective sustainable interventions being implemented to control this weed.

Recommendation: (a) To conduct research and identify appropriate and effective mechanisms for controlling the weed in the river line environments (b) continue with *intensive physical extraction* to reduce and stop weed biomass flowing into Lake Victoria via the Akagera River. (c) monitor regularly and systematically on infestation level and impact of intervention.

7.10 Management of striga weeds (witch weed) (*Striga hermonthica, Striga. asiatica*)

The Striga is an obligate parasitic weed 'witchweed' and is an important pest of cereals, especially in semi drier areas like the Eastern Province of Rwanda. There are two species of Striga which are common ***(****Striga hermonthica, and Striga. Asiatica****)***, The *Striga hermontheca* has large attractive pink flowers, while the *Striga Asiatica* is smaller species with purple flowers. A distinctive feature of both species is that each striga plant can produce up to 20,000-50,000 seeds, which lie dormant in the soil until a cereal crop is planted again. This dormancy can last for over 15 years. As striga germinates, its roots grow towards the host crop because the host plant releases chemicals which break dormancy and stimulates striga seed germination. The roots of seedlings of striga penetrate the host crop's roots and start to draw nutrients from the host.

The young striga plants tap the roots of the maize plant and draw water and nutrients in the underground part, reducing production from 30% to 100%, or complete loss of the crop. If maize plants are attacked by both stem borers and striga weed, the yield loss is often 100%. When a farm is infested with striga, the affected plants seldom grow more than one foot (30 cm) tall. The weed does not put roots into the soil so as to grow on its own, but grows by attaching itself onto the host (e.g. maize) plant.

Recommended management measures: Taking into account the peculiar nature of striga seeds, farmers are advised to control it before the weed emerges above the soil.

- **(a)** Hand-pulling or Manual removal of the striga before flowering reduces re-infestation, but it is uneconomical since most damage is done even before the weed emerges. Any control strategy has to begin within the soil.

- **(b)** Currently striga management is possible using "push-pull" technology. A ground cover of Desmodium (*Desmodium uncinatum*, or silverleaf), interplanted among the maize, reduces striga weed. Research at ICIPE has shown that chemicals produced by the roots of Desmodium are responsible for suppressing the striga weed. Therefore, striga does not grow where Desmodium is growing. Being a legume, Desmodium also fixes nitrogen in the soil and thus acts to enrich the soil. Therefore, "push-pull" technology used on maize stalk borers manages also both stem borers and striga. The details of the approach can be tested with farmer groups from different association. This can be done during one season, and study tour can be organized to visit western Kenya where the technology is adopted by many farmers, in areas where *Striga hermontheca* is predominant. In Rwanda, striga is becoming a problem in the Eastern province of Rwanda, but not yet quantified.

7.11 Management of couch grass (*Digitaria.scalarum*) in Rwanda.

D. scalarum is a creeping, perennial grass with long, slender, branching rhizomes which form a dense mat beneath the soil surface. Culms decumbent near base, becoming erect, about 50 cm, occasionally up to 1 m high. Basal sheath is usually glabrous. It is the most troublesome weed in the crops of Rwanda. It is reported as the most important weed of many crops (coffee, bananas, beans, tea, etc). The growth and yield of crops is greatly reduced in the presence of *D. scalarum*. Heavy infestations can kill crops (e.g. coffee bushes serious mechanical damage can occur when trying to remove rhizomes entwined in crop roots.

Mechanical Control: A forked hoe will remove many rhizomes; however, this method is very labour intensive and total eradication of all viable fragments left in the soil is virtually impossible. Where high densities of *D. scalarum* are present, ploughing with draught animals is impeded. The increased traction can cause injury to the shoulders of draught animals. Mechanical tillage with tractors can expose rhizomes to desiccation on the soil surface, but can also spread the fragmented rhizomes.

Chemical Control: Use of systemic herbicides such as glyphosate is effective against couch grass. The systemic herbicides are the only to kill the underground rhizomes and enable cultivation by incorporating the weeds into the soil thus improve organic matters. However, fields treated with glyphosate will not be certified for organic farming for about 20 years or more.

7.12 Livestock pests and Diseases management

The control of tick infestations and the transmission of tick-borne diseases remain a challenge for the cattle industry in tropical and subtropical areas. Traditional control methods have been only partially successful and the parasites continue to result in significant losses for the cattle industry. Throughout most of the twentieth century, tick infestations on cattle have been controlled with chemical (acaricides), typically administered by dipping or spraying. This approach can cause environmental and residue problems and has created a high incidence of acaricide resistance within tick populations in the field in many parts of the world. The evolution of tick resistance to acaricides has been a major problem. Cattle keepers need to know and follow proper application procedures of acaricides application in order to get maximum benefits. Most cattle owners depend completely on acaricides to control ticks.

The livestock in Rwanda, especially in the eastern province, move a long distance to the water drinking points at the dams or streams or rivers. In the process they are infested by ticks. The ticks are known to transmit diseases to livestock and cause major problems (e.g. ECF). In order to minimize the tick attack and disease transmission, the cattle keepers spray the acaricides on their cattle at their kraal at homestead. In the past and during colonial period, Government used to build dips for communal, however, the tick control was left to cattle keepers themselves. In the eastern province, they have access on acaricides from both Rwanda and Uganda, and since pesticides marketing are liberalized, cattle keepers are free to buy where prices are reasonable. Since farmers and cattle keepers have little knowledge on pesticides safety, use, and handling; they may misuse or buy poor quality acaricides which in turn will cause ticks to develop resistance. There is no guarantee that such pesticides have required efficacy and that they are effective. The other pesticides used are the antibiotics, vaccines etc. The cattle keepers also buy their antibiotics and treat their own cattle. However, the vaccines are administered by RARDA and for a known period. In general the vaccines are very useful their impact is very high. There is vaccine against east coast fever (ECF), CBP etc. These are important pesticides which are administered regularly sometimes on annual basis.

Recommendations include: (i) there is a need to establish a focused research on tick control and monitoring population, specie profile, tick susceptibility to different acaricides in market, their persistency, application rate, in order to detect resistance when it occurs, (ii) meanwhile, it is important to develop alternative IPM options on how to alternate pesticides and delay pesticide resistance etc, (iii) There is a great need to strengthen and improve research on tick and develop guidelines on how to make a profit from tick control or how to detect and resolve problems with resistance to acaricides.

8.0 Capacity to design and implement IPM system

The development of sound IPM goes through various stages including: (i) insect or disease identification, (ii) Life cycle and mechanism of spreading, (iii) symptoms of damage, (iv) damage levels and effect on yield, (v) damage threshold, (vi) Scouting mechanism, (vii) pest management options. These are mainly activities done by research institutes, Universities and their partners, such as International Agricultural Research Institutes (e.g. CIAT, IITA, ICIPE, ICRISAT, CIP, IRRI, CYMMIT, ILRI CABI etc) and members of Regional Agricultural Research Networks (e.g. ASARECA).

Since most crops grown in Rwanda, are also produced in many countries, the designing IPM in Rwanda would most likely be through adaptive research of technologies which are working in other countries. This could be done in collaboration with competent Research Institute or University through ASARECA. Currently, the capacity to develop IPM in Rwanda is still weak, due to lack of experience in some areas like insect or disease identification. The number of subject matter specialists is still small and systematic are lacking in all Rwanda knowledge institutes.

However, the capacity to execute IPM through participatory approach exists in the country. Due to weakness in the plant protection at any one Agricultural Institution (Research, University or agencies of MINAGRI) in Rwanda, the National Plant Protection Organization (NPPO) is formed by shared responsibility between institutions to maximize national human resource available.

9.0 Institutional or partnerships mandates in the implementation of IPM

9.1 Institutions for IPM execution

The implementation of IPM activities will be undertaken through decentralized system. The Districts and Sector will execute IPM activities with farmers organization under guidance of MINAGRI agencies (RADA, RARDA, RHODA and ISAR), together with Universities (NUR and ISAE) and Rwanda Bureau of Standards (RBS). They are organized under National Plant Protection Organization (NPPO) which is a Biosecurity system established to share responsibilities in phytosanitary and plant protection, as no single institution in Rwanda had sufficient capacity to carry phytosanitary role effectively..

9.1.1. Rwanda Agriculture Board (RAB)

Under public sector reform to enhance the efficiency and effectiveness of Public Sector Institutions and achieve higher levels of services delivery, which is on-going, the MINAGRI agencies which were responsible for research and extension (including IPM) namely ISAR, RADA, and RARDA will be merged together to form one agency namely, **Rwanda Agriculture Board (RAB).** Under RAB, the research activities under ISAR and extension activities performed by RARDA, RADA will be combined under one Zonal headed by Director General. Each Zone (North, South, East, West) will be responsible to develop site specific participatory IPM and disseminate it. The RAB institutes will avoid duplication of responsibilities and enable efficient use of human resources. It will also enable joint and proper planning of activities including IPM. Similarly, the OCIR-café, OCIR-thé and RHODA will form separate agency for export promotion and marketing.

RAB and Universities (NUR, ISAE, UP etc): These institutions are mandated to do research in Rwanda in agriculture related fields including livestock, environment etc. Currently, these institutions have capacity to develop IPM in Rwanda in collaborations with their partners (International Agricultural Research Centre – IARC, Regional Universities and Research Institutes Networks-ASARECA etc). The IPM development should include adaptive studies of already developed technologies and their improvement to suit local conditions.

Rwanda climate being semi temperate conditions, some insect pests and diseases important at low altitudes of tropics may not constitute serious problem. Therefore, it is important to conduct adaptive studies for IPM development in Rwanda. For example, two of three maize stalk borers which are serious at low altitude of eastern Africa, may not be serious in Rwanda because of altitude limit as most parts of Rwanda are above 1000 masl, making the environment unsuitable for their development. Likewise, the serious banana pests such as nematode (*Radopholus Similis)*, banana weevil (*Cosmopolites sordidus*) and leaf spots (black sigatoka-*Mycosphaerella musicola)* which are a major problem below 1400 masl may not cause problems in Rwanda,since most bananas in Rwanda are growing above the altitude of 1400 masl. However, monitoring is required because of climate change which may increase temperatures and making environment suitable.

Pest surveillance is needed to monitor pests which are not present and status of those present in the country. The monitoring will focus the pests and diseases not yet reported in Rwanda such as large grain borer (*Prostephanus truncatus*), Grey leaf spot (*Cercospora zeae-maydis*) etc. They will also map the disease incidence and severity distribution in the country. These activities will be done in participatory way, involving the extension staffs and farmers organizations. IPM development under RAB, will include dissemination mechanisms at early stage, because both research and extension are in one directorate.

9.1.2 Local Government (District and Sector

Following decentralization and administrative reform 2004-2006, extension function passed under direct responsibility of decentralized entities and performance and problem reporting system goes from Sector to District and from District to Province and to Ministry of Local Government. Therefore, the execution of IPM is in the mandates of local Government. However, they have a serious problem of h*uman resource and technical capacities, as they are under-staffed at both District and Sector level.* The District has only one agricultural extension staff responsible for both agriculture and livestock under Director for Economic Development. Similarly Sectors are also under-staffed and most likely under-funded. There is one staff for agriculture in each sector responsible for crops, livestock, cooperatives, infrastructures, forestry, and environment. With such overload, there is little hope of getting much time needed in training farmers in participatory approaches.

As a result, they are not in position to effectively undertake adequate planning and operational IPM activities in participatory manner, since it involves a lot of work e.g. training all season long, monitoring, reporting, sensitization and technical backstopping of farmers etc. In these situations, it’s even harder to engage other partners, with respect to subject matter specialists from Research Institutes or Universities. Inadequate staffing will make IPM training and monitoring more difficult; moreover, they have low technical capacity in IPM technologies.

Some of the weaknesses of Local Government identified by stakeholders workshop as reported in the draft extension strategy include: (a) local authorities which do not understand agricultural policy or do not consider agricultural sector as a priority; (b) lack of training for extension workers at District and sector level, (c) lack of means of work for extension workers (means of transport, GPS, Veterinary Kits, Computers.etc); (d) low organisational and technical capacity of existing farmers organizations; (e) absence of functional relationship between MINAGRI and extension workers at District and Sector level (no mechanism of feedback) (details are presented in annex B)

In the new context of decentralized extension, main functions of the MINAGRI are as follows: (i) coordination and planning of agricultural development programs, (ii) agricultural sector information function, (iii) monitoring and evaluation function, (iv) regulation and control function, (v) resources mobilisation function. Currently, as indicated in the weaknesses above, the absence of functional relationships between MINAGRI and decentralized entities (Districts and Sectors) makes it difficult to fulfil above mentioned functions, and hence it will be more difficult to execute IPM activities without more staffing at local authorities. It would be better to consider establishing agricultural unit at Sector level. This will enable IPM execution through training of farmers and provide good service to the community.

9.1.3 Farmer organizations (cooperative, Federations etc)

Farmer organisations are close to the farmers and provide proximity services needed by producers, such as problem identification, and supervise experimentations in farmer fields and solutions dissemination. It is expected that farmers organisations will play key role in IPM technologies development and dissemination under decentralised participatory extension system. However, their capacity in IPM needs to be reinforced during training and linked to MINAGRI agency (RAB) and Universities for easy access of information and directly reporting of the problem. The promotion of partnership between farmers' organisations and extension and research services will be essential at early stage.

9.1.4 NGOs, Civil Society and private sector

Local and international NGOs may be useful, but not much reliable in capacity building, but in input and marketing services. They can provide capacity building of farmers' organisations through contracts as service providers. The private sector is active in inputs supply, production, marketing, processing and commercialisation of the final product. This is also important in accessibility of inputs and generating income. The objectives of IPM may not be attained without accessible and affordable inputs and the market for the products.

10 Relevant researchable areas

There is very little pest management research work done in Rwanda in area of pest status and yield loss (pre and post harvest). This is an important research ground for major pests of all crops grown in Rwanda.

In addition, pesticides research does not exist and pesticides recommendation is not legal obligation; moreover, there is neither pesticide law/regulation nor pesticides registration. This is due to many reasons, such as lack of qualified staff, equipments, lack of law to re-enforce pest control measures etc. Research on pesticides and recommendation is an urgent issue. Moreover, agriculture is recognized by all national policies (vision 2020, NAP etc) and strategies (EDPRS, PSTA-I &II etc), and that agricultural intensification is a necessity; and pesticides used is expected to increase and reach 37%.

It is important to strengthen the research in pest management to reduce unnecessary loss in yield and income. The experience from cassava mosaic disease has demonstrated that there are multiple losses beyond the crop value.

Pesticide management: Rwanda being a mountainous hilly country, the pesticides applied are washed downstream and may have negative effects away from application area. The research should establish the pesticide use patterns, residue in soils, underground waters, and in food. The impact of pesticides repeated applications, their half lives, and leaching should be clearly reported and necessary recommendation made and action taken.

Therefore, Rwanda needs a focused research in developing research tools to generate site-specific data for crop, pests' dynamics and environmental safety. In addition, it should include monitoring mechanism of long term impact of recommended measures. The following researchable areas are proposed.

Develop strategies in the management of pests and diseases: The research would develop strategies in the management of pests and diseases which would have the following criteria: (i) economically feasible, (ii) socially acceptable, (iii) environmentally-friendly and safety, (iv) profitability, (v) affordability by large community. The researchable areas in IPM in order to achieve the above objectives include: (a) determining economic thresholds for major pests and diseases; (b) undertaking risk analysis to provide information that assists in making a decision on the choice of management options; (c) assessing impacts in terms of production (tonnage and monetary value), (d) conducting environmental impact assessment of specific pesticides for short and long term, (e) developing IPM dissemination strategies, and (f) further research on alternative pests management options.

(a) Action Threshold for the pests and diseases: The pest management in Rwanda is faced with serious problem of lacking locally proven pest management technologies, species profile, pest status, and action threshold in Rwanda. It is important to generate local information since it will guide the decision making on whether to invest in the control or not. There will be a need to undertake studies that will establish this threshold for diseases/pests of economic importance in the basin in Rwanda.

Action threshold. The principal objective of the IPM options is not to totally eradicate pests (normally impossible or very expensive) but rather to suppress or manage pest populations in ways that keep their numbers (or damage caused) below the established threshold level. The pest action thresholds are based on the findings of inspections or monitoring and on specific biological attributes of given pest. The applicable thresholds will be initially established by research findings (from either ISAR, Universities or partners etc) for all major pest species identified on major crops in Rwanda by descriptions of individual species.

The action threshold is refined as more information becomes available from monitoring programs and scientific research. Criteria used to establish thresholds will be based on estimations or observations of: (a) pest identification, (b) knowledge of pest biology (especially reproductive potential), (c) estimated population numbers and possible damage, (d) expected damage to crops and natural resources, and (e) possible control strategy and documented scientific information from other sources.

In case there is no capacity in Rwanda, it will be sought first from the basin knowledge institutions (Research Institutes and Universities or International Research Institutes such as ICIPE or CABI international in Kenya etc). The established threshold will be developed into simple technology useful by farmers for scouting. For sustainable agriculture and development, the pest control in the basin of Rwanda would be preferably based on established action thresholds, as criteria to justify the initiation of control methods.

(b) Pest Risk analysis: Risk analysis is carried out to identify and assess the risks and uncertainties associated with pests and to identify management options for mitigation. In the basin area of Rwanda, the pest risk is related to the environment suitable for their development which affects the occurrence of various pests and diseases. It is important to study and document the risk for pests.

(c) Economic Impact of the pests and diseases: Even though GOR puts much efforts in management of pests and diseases of both crops and livestock such as CMD in cassava and FMD in cattle; the assessment and quantification of actual losses is very rare and information is scanty. Research should focus more on the quantification of losses in terms of production (tonnage), and economically value (monetary from lost quantities, costs of control, opportunity cost etc), social value of missed crops etc The role and benefits of using *resistant varieties and strong breeding for resistance. The identification of site specific technologies for optimal site requirements for each major crop of Rwanda.*

(d) Efficacy of pesticides and environmental effects: The safe use of pesticides is one of the IPM tools. Although there are various pesticides used in Rwanda, yet there are no locally recommended application rates. The Ministry provided pesticides list which is used by RRA customs to allow importation, however, the list is not based on locally generated data and recommendation. The farmers use quantities without clear research-supported information. In most cases they use blanket recommendation. *The research on pesticides recommendation, safe use, and environment safety are an urgent issue.* This is coupled with pesticides hazardous awareness creation at levels including policy makers and local leaders.

11.0 Recommendation on Policy, legislative and Institutional Frameworks

11.1 Policy for IPM development and implementation framework

The agriculture sector in Rwanda is recognized by both vision 2020 and EDPRS as an engine of national economy and development. As a result, it is guided by many important policies which are related to IPM, in particular: Vision 2020, National Agricultural policy, National environment Policy, and biodiversity policy and strategies like EDPRS, PSTA etc. However, these policies do not cover the details needed for developing and implementing IPM in the country, although PSTA-II recognizes the need for IPM policy and participatory extension system. Therefore, Rwanda may ideally need the IPM policy to guide its development and participatory implementation to meet the need of diversified agro-ecosystem in the country.

11.2 Legislation framework

In general, it is observed that a policy and legislative framework for plant protection (IPM inclusive) and pesticides regulation do not exist in the country. The draft bill for plant health is in the process, and there is no assurance as to when it will be available for use. However, it is important to note that the draft bill for plant health concentrates on phytosanitary and inspections for safe trade without much attention on production processes which is generally complicated under subsistence system. It focuses more on meeting the conditions for WTO-SPS. There may be a need for developing plant protection sector policy, which would sets out direction on how to produce healthy food without compromising the environment. This would include role of IPM and its execution.

11.2 Pesticide law and Regulations.

The concepts of IPM was born out of concern on pesticides use and their negative impacts on humans, animals and the environment. The absence of pesticide regulations could be understood because of the small size of markets available in Rwanda. However, as the country is now promoting horticultural crops and focuses on diversification of export, the pesticides used in the production should be known and application guided by policies. The pesticides regulation should set out conditions and system of safe pesticides use in the country.

11.3 Awareness and sensitization

Many of the stakeholders in agriculture are not aware on the hazardous nature of pesticides and their effects on health of people, animals and the environment. The farmers are not informed on dangers of over use or sub-lethal dose on pests and environment, on how in long run the pests develop resistance and cause more crop losses. Similarly, the consumers are not sensitized on the dangers caused by pesticides treated food and impact on their health. Community sensitization on hazardous nature of pesticides and implication on their health in short term and in long period is urgently needed. The adoption of IPM depends on many factors including the community involvement in the process of IPM development in order to understand why it is needed, and that pesticides can be used safely and timely when necessary.

11.4 Legislative enforcement

The law and regulations on pesticides and IPM, once established, will need a proper and guided enforcement mechanism to ensure compliance. The law and regulations should be widely known and enforcement clearly spelt out. Rwandan community has been operating without quarantine procedure in agriculture. The farmers and consumers were not protected and investing in agriculture was at risk without Government protection from invasive pests and diseases. This weakness led to the spread of CMD in cassava because it took six years to act, since it was reported at the border in 2000. Similarly, BBW is spreading in banana growing areas because there is no quarantine law or bylaws to enable local leaders make local community apply the instructions.

11.5 Institutional Arrangements

The agricultural production is a part of wide community development and is linked to many institutions. At national level, agriculture has direct relation with REMA and MINELA in general. Similarly, the food production should ensure healthy food hence direct link and relationship with Ministry of Health (MOH). Therefore, the development of IPM policy should take into consideration the requirements and standards set out by these partners' institutions for the sustainable production process. At the international level Rwanda is signatory to many treaties such as IPPC, WTO-SPS and is obliged to abide to them. This calls for safe agricultural production and safe trade. This could be achieved through use of IPM because it meets the concern of many partners.

11.6 Local Governments structures

Rwanda Government adopted decentralized governance in 2001 and was executed in 2006. However, it is still young and evolving. There is no agricultural unit at District or Sector level, and also there is inadequate staffing, insufficient logistical supports (e.g. transport, fund etc). This has an implication in IPM execution. The execution of IPM will require involvement of local leaders under the defined role and the partnership between Institutions.

11.7 Farmer cooperatives and associations (grass-root based structures)

Under decentralized system, there are high potentials for community based organization to execute IPM activities. The problem, however, is that these structures lack the capacity, and as a result they need close support from the local administration at the Sector level. Therefore, the cooperatives are important in IPM execution, moreover, IPM is site specific and every cooperative should develop and take role in adaptive participatory studies with options tailored for their condition. Establishing policies and regulation guiding on roles and responsibilities of farmers in IPM and other technologies in agriculture would be important.

11.8 Participation of civil societies and Private Sector

The private sector is directly involved, because they are involved in marketing of agricultural inputs and products. The public-private partnerships in IPM execution are important, and IPM policy should be clear on their roles and responsibilities.

Similarly, civil society organizations (NGO) are involved in interventions for agricultural production and rural development. They are involved directly with farmers. In general, a combination of IPM policy, regulation formulation, institutional coordination, human and technical capacities development can make IPM execution successfull and enhance agricultural productivity without compromising environment for Rwanda and other riparian countries.

12.0 Proposed comprehensive monitoring and evaluation for IPM implementation

The execution of IPM under decentralized system will be done at grass root level with farmers organization taking lead, and extension staff and subject matter specialists (from research institutes and Universities) being facilitators of the process. The extension staffs are employees of local Government at District and Sector level. The role of MINAGRI and its agencies (RAB: RADA, RARDA, RHODA, Ocir-cafe, Ocir-the) remains to facilitate, monitor and evaluate the performance. The local Government is responsible for implementation of approved plans including IPM activities.

Major objectives of the pest management program would therefore be: (a) to maintain economically sound practices in agricultural and livestock management; to reduce yield loss and increase productivity, (b) to maintain a safe and sustainable environment and to reduce environmental pollution, degradation, and risks to human and animal health. Under IPM implementation, the term monitoring (M), evaluation (E) and participatory monitoring and evaluation (PM&E) would have the following meaning:

- **(a) Monitoring** in this report is a routine and continuous process of observing and recording data and information done regularly during the period of the IPM activities in the area.

- **(b) Evaluation** in this report means a collection of activities designed to determine the value or worth of a specific IPM intervention. It entails judging, appraising, determining the worth, merit, value or quality of IPM option at different stages (proposed, on-going, or completed) in terms of their performance, effectiveness, efficiency, relevance, quality and impacts. It indicates on how IPM objectives are being achieved.

12.1 Participatory Monitoring and Evaluation (PM&E)

PM&E means that the stakeholders in the process of monitoring and evaluation demonstrate evidence of participatory culture. The process includes: (a) participants are actively involved in generation, understanding and analysis of information, (b) all the stakeholders jointly participate in sharing, learning and decision making at the various stages of IPM execution. A reflection process will enable sharing and learning from participants' views and strengthening their inclusion in decision making. This would require developing a process for systematically sharing and documenting the IPM execution activities in the framework of PM&E as follows:

a) Monitoring and Evaluation process that involves stakeholders in goal setting, establishing priorities, focussing questions, interpreting data and connecting process to outcomes
b) Participants in the process own monitoring and evaluation. They make the major focus and design decisions,

c) Participants are committed to monitoring and evaluation process and outcomes,
d) All aspects of monitoring and evaluation including data, are understandable and meaningfull to participants,
e) Participants are accountable to themselves and their community first.
f) Monitoring and evaluation embrace involvement, negotiation, learning and flexibility.

Under IPM-PM&E the Local authorities are a part of activity planning process and should also include in their plans the IPM activities as a way to achieve local authority tergets (Imihigo).

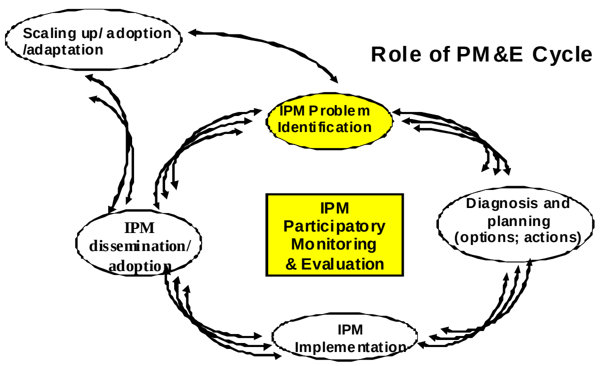

Figure 5. Participatory Monitoring and Evaluation (PM&E) for Integrated Pest Management (IPM) program in the Basin in Rwanda (Source: Modified from CIAT-PM&E, 2005).

Monitoring and evaluation in IPM is done at two levels as follows: (a) the first monitoring is the pest monitoring in the field to determine the timing of control or management of action; (b) the second monitoring is related to IPM execution and reporting to inform all stakeholders on progress and for making decision on improvement if needed. Therefore, in the first pest monitoring, it is a more technical focusing on pest population and/or damage and it involves field inspection, and identification of pest for guiding in decision to take action; while in the second monitoring it involves reporting system to make sure that IPM activities are being implemented as planned and whether they are producing desirable results, or need modification etc. The following section will present the two types of monitoring.

12.2. Pest Monitoring under PM&E

Inspection and monitoring are basic to the success of any IPM program. Correct and accurate identification of a suspected pest is essential to obtain additional information on the species. This often helps to find out the underlying causes for a pest problem. All major pests on priority crops posing potential problem in the basin in Rwanda will be identified. Often, the underlying reasons for a pest infestation become apparent during either the initial inspection or pre-treatment monitoring.

The pest *inspection* here means the *initial discovery* of pests or conditions that may support pests. While *monitoring* refers to *measuring changing conditions over time* so as to be able to determine if pest populations are static, increasing, or decreasing and to use those findings to support pest management decisions and set injury action levels. Monitoring is also used to determine the time and place treatments will be most effective, least disruptive to natural controls, and least hazardous to human health or the environment. *Monitoring is required throughout a pest management program; It allows to regularly evaluate pest populations and their natural enemies, sanitation practices, availability of food, water, and harbourage to pests, weather conditions, and management decisions and practices affecting pest populations.*

All pest management measures taken at the basin of Rwanda would require first to begin with an initial inspection to identify the sources, kinds, and extent of infestations. The inspection will be followed by a monitoring program that regularly evaluates changes in the pest infestation or habitat. A combination of staff from different institutions of Rwanda would join and carry out the inspection and monitoring efforts. Timely action is important in IPM in order to assure disruption of pest biology.

12.3 Monitoring of IPM implementation

The monitoring of IPM execution will involve farmers, local leaders and key stakeholders depending on location and crop. The involvement of farmers and local leaders under PM&E process would make them familiar with IPM methods and objectives and will enable them to identify potential pest problems in their area, participate in remedial actions, and inform others about the beneficial aspects of the IPM program.

12.3.4 Records and Reporting.

Monthly evaluation and reporting of pest monitoring data and other aspects of the IPM Program is a key to the success of IPM Plans. Such evaluation allows getting timely information of progress of IPM option, efficacy of pesticides used and their environmental effects; it helps to identify possible modifications that would improve the program.

Farmer organizations will organize detailed and accurate record keeping for inspection and monitoring reports, control strategies, pesticides used as fundamental activity for the success of an IPM program. IPM records are used to evaluate control programs, justify future treatments, and help resolve any potential legal questions concerning pesticide applications. The extension staff at District and Sector levels will develop field data sheets, and ensure that they are available at farmer organization level and all field staff and used in the inspection and monitoring.

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14.0 Annexes

14.1 Annex-A. : Terms of reference

Lake Victoria Basin Commission: Terms Of Reference For The Prepara*tion Of Formulation Of The National Integrated Pest Management (IPM) For The Second Phase Of Lake* Victoria Environmental Management Programme

1.0 Introduction

Lake Victoria and its Basin are shared transboundary resources, which have received a lot of attention over the last decade. Lake Victoria Basin is a shared by Burundi, Rwanda, Kenya, Tanzania and Uganda and is part of the Nile River Basin system, which is shared by ten countries: Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Eritrea, Kenya, Rwanda, Sudan, Tanzania, and Uganda. Rwanda and Burundi are part of the upper watershed that drains into Lake Victoria through the Kagera river. In addition to its environmental values, including biodiversity and the hydrological cycle, Lake Victoria supports a large fishing industry for export and local consumption, hydropower production, drinking and irrigation water, lake transport, and tourism.

The Lake Victoria Basin benefits are threatened by environmental degradation manifest in reduced fish stocks, decline of biodiversity, variable water levels, increased sedimentation, eutrophication and proliferation of Water weed, especially the Water Hyacinth. Efforts to regulate and manage the activities threatening the Lake and its Basin clearly need upscaling, and widespread poverty in the basin exacerbates environmental stress. Even in its current parlous state the lake is a valuable asset supporting the livelihoods of approximately three million people directly, and indirectly the entire population of the basin of over 30 million.

The LVEMP-2 to be implemented within the entire Lake Victoria Basin will enhance environmentally friendly economic growth in the Basin through knowledge generation for development, socio-economic development, promotion of effective natural resources management framework, and enhancing public participation and communication. LVEMP-2 is to contribute towards the achievement of the regional Lake Victoria Development Vision of having “a posperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits to the riparian communities”.

The project will be implemented through a number of institutions and organisations in Kenya, Uganda, Tanzania, Burundi and Rwanda accountable to the relevant focal point Ministries and regionally coordinated by the East African Community/Lake Victoria Basin Commission.

2.0 Project *components and sub-components*

The LVEMP-2 is a broad programme and will have four components. The project is clustered into four components as follows:

Component 1: *Strengthening governance of water and fisheries resources*
Component 2: Investing in pollution and erosion control and preention measures
Component 3: Raising public awareness and participation
Component 4: *Project coordination and management*

2.1.Component 1: *Strengthening governance of water and fisheries resources*

This component has four sub-components: (i) Applied research; (ii) Ecosystem monitoring; (iii) Harmonization of policies, regulations, and standards and (iv) Institutional development and strengthening.

2.1.1. Sub-component: *Applied Research for the Lake Victoria Basin*
Scientific research areas will focus on: (i) Water resources; (ii) Fisheries resources; (iii) Land resources and (iv) Aquatic weeds. It should be research to inform: (i) inform management of Natural Resources; (ii) Social Development; (iii) Economic Development and (iv) Other Relevant Research

2.1.2. Sub-component: *Ecosystem monitoring*
This sub-component will finance the development of ecosystem monitoring tools for (i) Water information System (WIS); (ii) Decision Support System (DSS) for water resources; (iii) Atmospheric deposition monitoring network; (iv) GIS-based database for the land use, hydrology, and biodiversity, and Lake Victoria Dynamic Information Framework (LVDIF) and (v) Regional framework for fish stocks assessment.

2.1.3. Sub-component: *Harmonization of policies, regulations, and standards*
This sub-component will focus on Legal Frameworks for managing the Lake Victoria Basin at different levels: Community; District; National and Regional.

The interventions should include to: (i) review and harmonize national policies, laws, and regulations governing utilization of fisheries, and water resources; (ii) develop mechanisms for enforcement of regional environmental regulatory standards (water, and fish quality; and (iii)develop and apply regional standards for industrial and municipal effluent discharges into sewerage and river systems.

2.1.4. Sub-component*: Institutional development and strengthening*
Institutional Framework for managing the Lake Victoria Basin at different levels: Community; District; National and Regional.

This sub-component will support the: development of the Basin-wide watershed management strategy; adoption of Land suitability mapping and spatial planning in lake basin districts and implementation of community land use plans and sub-catchments management. In addition, it supports (i) development of the Regional Water Resource Management Plan (WRMP); (ii) update of the Lake Victoria Fisheries Management Plan.

2. 2 Component 2: *Investing in pollution and erosion control and preention measures*

The component has four sub-components: (i) Liquid and solid waste management; (ii) Watershed rehabilitation; (iii) Industrial pollution control; and (iv) Pollution risk prevention and navigation safety.

.2.2.1. Sub-component: *Liquid and solid waste management*

Interventions will include (i) Solid waste management; (ii) Rehabilitation of Sewerage treatment systems of major cities and connection to constructed wetlands;

2.2.2. Sub-component: *Watershed rehabilitation*
Interventions will be on: Soil and water conservation and livelihood improvements
Categorize and prioritized investments based on

i) investments indicating clearly the Private Sector, Civil Society and Community involvement;

ii) Small-scale investments/ micro-projects;
iii) Articulate funding Sources and Access and
iv) Creation of conducive environment for private and public sector involvement and Partnerships.

Sub-component component 2.3*: Industrial pollution control*
Interventions will include: (i) Cleaner production in-plant assessment; (ii) Environmentally sound technology assessment and transfer and (iii Training of industries on cost-effective measures of reducing wastes, hence increasing savings.

Subcomponent 2.4: *Pollution risk prevention and navigational safety*
State specific interventions unique to Rwanda

2.3. Component 3: Raising public awareness and participation

This component has three sub-components: Internal communication; Regional and national outreach program; and Community awareness and participation program.

2.3.1. Sub-component: *Internal communication*
The focus will be on development of an: (i) internal communications system linked to the M&E system to facilitate information sharing developed; and (ii) information sharing protocol among and within countries and agencies, (iii) integrated regional Lake Basin website and a feedback system for the GIS-based Management Information Systems.

2.3.2. Sub-component: *Regional and national outreach program*
The focus will be on implementation of: (i) national public awareness and education campaigns and (ii) Outreach activities to seek political buy-in of the parliamentarians to ensure success and sustainability.

2.3.3. Sub-component: *Community awareness and participation program*
Interventions will include: (i) development of training modules for teaching environmental and socio-economic impacts of Lake Victoria's watershed degradation; (ii) dissemination of guidelines for the Preparation and Implementation of Community Sub-projects; (iii) production community educational and promotion materials.

2.4 . Component 4: Project coordination and management

This component will provide resources necessary for the effective coordination, and monitoring and evaluation of the project activities.

2.4.1. Sub-component: Project coordination
This sub-component would finance: (i) incremental operating costs of the various project committees.

2.4.2. Sub-component: Monitoring and Evaluation

This sub-component would provide resources for the: (i) establishment of the national GIS-based M&E and Management Information System (MIS) and (ii) collection, analyses, storage and dissemination of the project's implementation performance, outcome and impact data and information.

2.0 Overall objective of consultancy
To enhance Integrated Pest Management within the Lake Victoria Basin.

2.1 Specific Objective

(i) To assess the pest and disease status in the Basin in Rwanda.
(ii) To propose appropriate Integrated Pest Management strategies so as to reduce risks of pest attacks and associated damage.
(iii) To develop an integrated pest management/control strategy/regime that uses appropriate arrays of complementary methods – natural predators and parasites, pest-resistant tree/crop varieties, cultural practices, biological controls and other physical techniques.
(iv) To assess the capacity to design and implement IPM regimes.
(v) To define clear profile of the institutional or partnerships mandates in the implementation of IPM within the basin.
(vi) To define/outline outstanding relevant researchable areas.
(vii) To provide clear policy recommendations on how to address any risks related to pests that the project may stimulate, and
(viii) To develop a comprehensive pests monitoring and evaluation regimes.

3.0 Specific Tasks/Activities

The consultancy will be expected to undertake the following tasks:

(i) Review LVEMP II documents as an input into this consultancy.
(ii) Review current pest and disease control strategies in the Basin (including institutional, policy and legal frameworks).
(iii) Review the impact of the current pest control measures.
(iv) Identify key pests and diseases of the major crops and livestock in the Basin
(v) Quantify the losses attributed to these pests and diseases.
(vi) Propose appropriate Integrated Pest Management strategies for the major pests and diseases in the Basin.
(vii) Define appropriate implementation strategy for the proposed measures.
(viii) Propose a monitoring and evaluation framework for the IPM.
(ix) Prepare a final National IPM Report.

4.0 Methodology

The Consultant shall undertake the above tasks in close collaboration with the client. The consultancy will be done in two stages: an inception phase and the main stage.

During the inception stage, the Consultant shall:

(i) Carry out a preliminary assessment of available data by doing desk reviews on existing empirical and situational literature and case studies.
(ii) Produce an inception report.
(iii) In collaboration with the client, hold a stakeholders, inception workshop

The purpose of the inception report will be threefold:

(i) To test the understanding of the terms of reference by the consultant.
(ii) To state clearly how the consultancy will be carried out, in terms of both the methodology and timelines, as well as the anticipated limitations/constraints; and
(iii) To state the progress which will have been made and problems/challenges if any.

During the main stage the consultant will:

(i) Consult with appropriate stakeholders, projects and programmes relevant to the assignment.
(ii) Use appropriate approaches for the study to review the study reports and identify the issues and propose in detail the needed interventions as specified.
(iii) Produce the *Mid-Term* and *Draft* Final Report.
(iv) In collaboration with the client, hold a Stakeholders Workshop for consideration of the *Draft* Final Report; and
(v) Incorporation of comments to produce and submit a Final Report.

5.0 Outputs from the consultant

The outputs shall be:

Inception report	- 1 week from the date of signing the Contract
Mid Term Report	- 3 weeks from the date of signing the Contract
Draft final report	- 5 weeks from the date of signing the Contract
Final report	- 6 weeks from the date of signing the Contract

All Reports will be submitted in both hard and soft copies (5 hard copies).

6.0 Duration of the Assignment

The duration of the consultancy will be executed within a period of one and half (1.5) months and the assignment a maximum time of 40-person days starting August,, 2008 to end of September, 2008.

7.0 Qualifications and Experience

The consultant must have at least M.Sc/M.A/MBA in any of the following areas:

a) Pathology/Pharmacology/Parasitological.
b) Entomology.
c) Integrated Pest Management.
d) Environmental economics.
e) Ecology
f) Environmental Chemistry/ Applied
g) Environmental science.
h) Law.
i) Sociology

The consultant must have at least 10 years of relevant experience.

LANGUAGE

The Final report to be submitted in both electronic and hard copy and should be in English.

8.0 Payment Schedule

The client will pay ten percent (10%) of the contract price upon the signing of the contract, 20% upon submission of an acceptable inception report, thirty percent, (40%) on presentation of draft final report and thirty percent (30%) upon submission and acceptance of the final report.

14.2 Annex-B: SWOT of current situation of extension services in Rwanda

(source: draft strategic plan for MINAGRI)

Strength	Weakness
i. **-**Existence of many Farmers organizations, NGOs and Projects as service providers**;** ii. **-**Qualified extension workers (A0 and A1) at District and Sector level - Existence of infrastructures to support extension services (training centres, storage infrastructures ….); - Many trained and innovative farmers in the country.	i. -Local authorities which do not understand agricultural policy or do not consider agricultural sector as a priority; **ii.** **-**Lack of extension training material for extension workers and farmers; iii. -Lack of training for extension workers at District and sector level) iv. -Lack of means of work for extension workers (means of transport, GPS, Veterinary Kits, Computers.....); v. -Low organisational and technical capacity of existing farmers organizations; vi. -Media which are not sufficiently used in extension messages delivery; vii. -Absence of functional relationship between MINAGRI and extension workers at District and Sector level (no mechanism of feedback…) viii. -Local authorities and extension workers don't do in their own farms what they are supposed to teach farmers; ix. -Good quality seeds are insufficient on input markets ; x. -Farmers don't know the utility of good quality seeds and continue to use seeds of bad quality, even when seeds of good quality are available; xi. -Farmers are not sufficiently sensitised on the utility of agricultural credit and fears to take credits; xii. -Farmers don't know where they can find service providers; xiii. -People trained by RSSP and UBPR (Union des Banques Populaires) to help farmers to prepare eligible projects in banks are insufficient; **xiv.** **-**Lack of agricultural competitions (concours agricole) to stimulate farmer competition.
Opportunities	**Threats**
i. Good governance and political will to develop agricultural sector; ii. -Existence of a national agricultural policy; iii. -The resettlement policy (Umudugudu) iv. policy network of micro finance institutions distributed in all Districts;	i. -Local authorities don't consider agriculture as a priority; ii. -Local authorities don't do in their own farms what they are supposed to teach to farmers; iii. -Lack of motivation for Extension workers; iv. -Lack of functional relationship between MINAGRI and decentralized extension services; - Public extension workers at District and Sector level are diverted of their main

v. -Experience of Ubudehe which is a good example on which can be built the participative extension approach in agricultural sector; vi. Agricultural Education Institutions (UNR, ISAE, etc) . vii. -Increasing small agro processing units; viii. -Communication facilities (Several radios, newspapers, ICT); ix. -Facilities given to local communities to take part in decision-making in the context of decentralization and good governance; x. -Existence of a good policy for Cooperatives promotion; xi. Organisation of agric shows; xii. Political stability in the country xiii. -Good climatic conditions favourable to agriculture, especially in the north and the west xiv. The use of one mother tongue understood by everyone xv. -Opportunities for expansion on regional and international markets**.**	task which is agricultural service delivery; v. -Resistance to change by the farmers ; vi. -Insufficiency of extension workers, in particular veterinary specialists; vii. -The research confined in experimental stations and not enough done in farmers fields; viii. -No certified seeds sold at the same price as certified seeds; ix. -Insufficiency of public financing granted to agricultural sector; x. -Agric inputs are expensive compared to the purchasing power of the farmers; xi. -Farmers fear to take credit and don't pay back properly when they get credit ; xii. -Climatic risks (especially in the East and the South); - High interest rate on bank credits; xiii. -Lack of insurance scheme in agricultural sector: xiv. -Farmers can not fill eligibility criteria to access to bank credit; xv. -Lack of consultation platforms between all stakeholders in agricultural sector; xvi. -Good quality seeds are not enough on agric input markets xvii. -High density of population; xviii. -Land locked country; xix. -Globalisation; xx. -Political instability in the sub region; xxi. -Macro-economic instability; xxii. -Gacaca courts take part of time that farmers should devote to agricultural works; xxiii. -AIDS pandemic cut down labour forces in rural zones.

14.3 Annex -C: Agricultural inputs and pesticides recommended in Rwanda

(source: MINAGRI-RADA).

14.3.1. List of agricultural inputs

14.3.1.1. Fertilizers

*Agricultural lime
*Ammonium sulphate
*CAN
*Compound fertilizers; DAP 18-46-0; NPK 17-17-17; NPK 20-10-10; NPK 20-5-5
*Micro-nutrients fertilizers
*Nitrogen fertilizers: urea 46%
*Others fertilizers
*Phosphates fertilizers

*Potash fertilizers: KCL

14.3.1.2. Seeds and plant material

14.3.1.3. Insecticides and acaricides

*Abameclin
*Acephate
*Acrinathrin
*Alphacypemethrin EC
*Alphamethrin EC
*Amitraz EC
*Azocyclotin WP
*Beta-cyfluthrin 2.5% EC
*Betacypermethrine EC
*Bifentrhin 0.05%PP,80g/l
*Bromopropylate EC
*Carbofuran 2.5%, 5% Granules
*Chlorpyriphos-ethyl 48%EC, 5% Granules
* Chlorpyriphos-methyl 50%EC
*Clofentezine
*Clofenzine EC
*Confidor super
*Cyfluthrin EC
*Cyhalothrin (15g)+Chlorpyriphos(300g)
*Cypermethrin 10%EC
*Deltamethrin (12g) +Chlorpyrifos(300g)
*Deltamethrin 2.5% EC,WP, Tablets
*Detamethrin
*Dichlorvos EC
*Dienochlor WP
*Dimethoate 40% EC
*Fenazaquin SC
*Fenbutatin oxide SC
*Fenitrothion EC
*Fenthion 50% EC
*Fenvalerate EC
*Fipronil 0.05 RB, 25g/IFS
*Flufenoxuron EC
*Flumethrin EC
*Hexythiazox WP
*Imidachlopride 200g/l SL, EC, 300g/l SL, EC
*Lambda-cyalothrin 50g/l EC
*Malathion, PP
*Methomyl 90 WP
*Methomy SL
*Nimbecidine
*Omethoate EC
*Permethrin 0.5%PP; 0.7%EC; 20%EC; 25%EC
*Phosphure d'aluminum(PH3):pillis, tablets and plates for fumigation
*Pyrimiphos-methyl 2%PP

*Tau-fluvalinate EC
*Tebufenpyrad WP
*Teflubenzuron SC
*Teradifon EC

14.3.1.4. Fungicides

*Azoxystrobin SC
*Benalaxyl
*Benomyl 50%WP
*Bitertanol EC
*Bupimate EC
*Captan
*Carbendazime+chlorothalonil EC
*Chlorothalonil
*Cuivre+chlorothalonil 250g/l WP
*Cuivre+propineb 37%+17%WP
*Cuivre de l'oxyde de cuivre cuivreux
*Cuivre hydroxyde WP
*Cymoxamil+propineb
*Dichlofluanid WP
*Difenaconazole EC
*Dimethomorphe+mancozeb 69%WP
*Dithianon SC
*Dodemorph
*Epoxiconazole+carbendazime EC
*Fenarimol
*Flutriafol+thiabendazole EC
*Flutriafol 125g/SL, EC
*Fluzilazole EC
*Folpet 50WP
Folyoxin-al
*Fosetyl-aluminium WG
*Hexaconazole SC
*Iprobenfos 480g/EC
*Iprodione SC
*Kresoxim-methyl WG
*Mancozeb+metalaxyl 62.5% WP
*Mancozeb 80% WP
*Metiram WP
*Micronised Sulphur WG
*Oxychlorure de cuivre WP
*Penconazole EC
*Propamocarb hydrochloride SL
*Propineb 70% WP
*Pyrimethanil SC
*Tebuconazole WP, EC
*Thiabendazole EC
*Thiophanate methyl SC
*Thirame 80% WP
*Tricyclazole 75% WP

*Triforine EC
*Vinchlozoline 50% SL

14.3.1.5. Herbicides

*2,4 D(acide dichloro-2.4 phenoxy acétique)
*Acide organique halogéné: dalapon 85% WP
*Alachlor+Atrazine
*Amerthrym 50SC
*Diuron
*Diuron 80 SC
*Gluphosate 360 LC
*Glyphosate 360g/l SL, Granulés
*Lasso-atrazine,EC
*Methribuzin
*Metolachlor 960g/l EC
*Paraquat 40g/L SL
*Propanil 360 g/l EC
*Trietazine : Atrazine 500g/l SC, Ametryne 500g/SC
*Trifluraline+linuron EC

14.3.1.6. Rondenticides

*Brodifacoum
*Bromadialone
*Bromadialone+Cumatetralyl+Sulfaquinox
*Coumatetryl
*Difenacoum

14.3.1.7. Nematicides

*Aldicarbe
*Dazomet 98% G
*Phenamiphos

14.3.1.8.Molluscicides

*Mercaptodimethu
*Methaldehyde 5 G

14.3.1.9. Growth Regulators

*Daminozide 85% SP
*Substances à composition complexe : rootone ; speedone ;etc

14.3.1.10. Oil additive

*Alkyl phenol/éthylène

14.3.1.11. Biological control

** Bacillus thurengiensis*

14.4 List of pesticides prohibited in Rwanda

.

Name	Category
1. Aldrin	Organochloré
2. DDT	Organochloré
3. Dieldrin	Organochloré
4. 1-2 Dibromoethane	Dérivé bromé
5. Fluoroacetamine	Dérivés fluorés
6. H.C.H Gamma(lindane)	Organochloré
7. Choldimeforme	Organochloré
8. 2 , 4 , 5-T	Acide phénoxyacetique
9. Captafol	Phtalimide
10. Chlordane	Organochloré
11. Dinoseb et sels de dinoseb	
12.H.C.H (melandes d'isomeres)	Organochloré
13. Heptachlore	Organochloré
14. Hexachlorobenzene	Organochloré
15. Composés de mercure	Dérivés de mercure
16. Chlorobenzilate	Organochloré
17. Penchlorophenol	Chloronitrophenol
18. Monocrotophos	Organochloré
19. Methamidophos	Organochloré
20. Phosphamidon	Organochloré
21. Methyle-parathion	Organochloré
22 Parathion	Organochloré
23. Toxaphène	Hydrocarbure chloré
24. Binapacryl	Dérivé benzenique
25. Endosulfan (Thiodan)	Organochloré

14.5 Annex -D: Summary tables of the IPM document

14.5.1 Summary table 1. Unique features that calls for Rwanda to implement IPM

Item	Implication in relation to IPM
Upper end of the basin	• Contamination by overuse of pesticides will have effect downstream, away from the treated area. Therefore, care should taken before it is too late.
Mountainous country	• Being mountainous means, heavy rainfall will cause runoff down the slopes into the valley. • Therefore, the contamination on the hill slopes will find its way down into the valley, rivers and inland lakes and finally into lake Victoria and Nile River. • Over use of pesticides should be monitored because it has transboundary effect.
High rainfall	• The high rainfall in Rwanda will cause runoff and carry pesticides, cchemical fertilizers and erosion downstream.
Streams and rivers all over the country	• The river networks in the whole country, means the contamination in one part will have negative effect in large area downstream and finally into lake Victoria and Nile River.
Over 90% of the population involved in farming	• The involvement of large population into farming without alternative source of income is a problem, because it will put pressure on land, resulting into over use of pesticides, chemical fertilizers and over exploitation of marginal land leading to severe erosion. The IPM is about growing health plants which depends on good soil and land management.
Vision 2020	• Vision 2020 is supportive policy on both agriculture and environment and any suggestion for good agricultural practices is supported.
Well structured administration	• Rwanda is a small country with 416 sectors. This well distribution of administration structures is usefull in extension and might be easy to apply IPM at lower level close to farmers. • The decentralisation, coupled with result based management “imihigo” is beneficial in technology dissemination including IPM training.
Future invested in intensification	• The agriculture intensification policy will promote the production of health crop and hence better use of IPM tools in pest war.
Etc (just to mention a few areas)	• Lack of IPM policy and pesticides regulation makes the IPM execution weak and pesticides misuse uncontrolled.

14.5.2 Summary table 2. Policy/institutional framework that affects implementation of IPM

Project/Item	Strength (positive ingredient)	Weakness
RSSP	• The project has fund to finance the recommended activities • It works with cooperatives and has direct measurable impact • The execution of IPM is easy and supported	• As a project has life span when it will stop • The sustainability of their activities beyond project period is not certain • The farmers request for pesticides is also possible, and if not well trained may lead to misuse.
EDPRS	• It is medium term macro policy which is supportive for agriculture as engine of economic growth • The execution of IPM is supported where it leads to economic growth	• The EDPRS does not have weakness as such, however, it encourages increase of pesticides use instead of decreasing, without linking with reduction on yield loss or increase in yield or income.
Vision 2020	• It is long term macro policy which is supportive for agriculture as engine of economic growth • The execution of IPM is supported where it leads to economic growth	• The vision 2020 does not have weakness as such, as it encourages agricultural modernisation. The application of the policy will determine the role of IPM under modernise. This leave room for linking with protection of environment
Land reform	• Land reform allows for ownership and willingness to invest in sustainability activities including IPM.	• It is good process, and does not have weakness. • The concern is that it should take care of landscape management for improved ecosystem services.
Imidugudu schemes	• The imidugu will improve easy access for information and improve technology transfer. • The informal communication will improve technology transfer	• It is good process, and does not have weakness •
Agricultural intensification	• Will improve plant health and application of IPM tools	• It may encourages overuse of pesticides when the focus is yield only. •
Etc …..		

14.5.3 Summary table 3. Major crops of Rwanda and their vulnerability to pests and diseases

Crop	Duration (annual, perennial, …)	Where grown	Recommended agro-ecological zone (Provinces)	Known major diseases/pests	Corrective/preventive measures
Maize	Annual	Eastern, Southern Northern Western	Eastern, Southern Northern Western	• Maize streak • Maize stalk borers • Striga weeds	• Resistant varieties • Cultural • Push-pull
Rice	Annual	Eastern, Southern, Western and Kigali city	Eastern, Southern, Western and Kigali city	• Rice blast *(P. Oryzae)* • Stalked eye borer	• Resistant varieities • Cultural practices • Fungicides use against *P.Oryzae* • Establish pest status 1st of stalk eyed borer
Potato	Annual	Eastern, Southern, Western and Kigali city	Eastern, Southern, Western and Kigali city	• Late blight • Bacterial wilt • Potato tuber moth, • Aphids during low rainfall period	• Resistant varieities • Fungicides • Cultural practices/rotation
Cassava	Biannual	Eastern, Southern Northern Western	Eastern, Southern Northern Western	• Cassava Mosaic diseases (CMD)	• Resistant varieties • Cultural practices • Rogue diseased plants
Banana	perennial	Eastern, Southern, Western and Kigali city	Eastern, Southern, Western and Kigali city	• Banana bacterial wilt • Fusarium wilt	• Good cultural practices as recommended • Crop rotation • Use clean suckers on clean site
Coffee	perennial	Eastern, Southern Northern Western	Eastern, Southern Northern Western	• Coffee leaf rust • Coffee berry disease • Antestia bug	• Good cultural practices • Fungicides (blue copper) • Insecticides •
Tomato	Annual	Eastern, Southern,	Eastern, Southern,	• Late blight • Early blight	• Fungicides (Dithane M45)

		Western, North and Kigali city	Western and Kigali city	• Fusarium wilt • Bacterial wilt • Bollworm	• Insecticides • Good cultural practices
Beans (climbing and bush types)	Annual	Eastern, Southern, Western, Northern, and Kigali city	Eastern, Southern, Western, Northern and Kigali city	• Angular leaf spot • Bean anthracnose • Halo blight • Beanfly • Bean bruchids	• Resistant varieties • Use clean seeds • Cultural practices • Seed dressing

14.5.4 Summary table 4: Commonly chemical pesticides among those allowed in Rwanda,
(range of diseases and pests controlled and hosts, effectiveness and affordability by local people)

Chemical	Range of diseases, pests and hosts	Effectiveness in the control	Affordability by a medium farmer (cannot, hardly, can afford)	Short remarks/ References
Insecticides				
• Dimethoate	Broad spectrum insecticide killing target and none target insects	• Effective against many insects	• Expensive • Sold in small volumes • Some retailers violate label condition	• No legal obligation as there is no pesticide regulation or law
• Chlorpyriphos (Dursban)	Broad spectrum insecticide killing target and none	• Effective against many insects	• Relatively cheap and commonly used • Retailers sell in small volumes without label	• Overuse my lead pesticide resistance • Farmers and extension staffs are not trained in pesticides safe use
• Cypermethrin, Deltermethrin etc	Broad spectrum insecticide killing target and none	• Effective against many insects	• Expensive and not affordable to many farmers • Some retailers sell in small volumes and violate label condition	• Farmers and extension staffs should know the alternation of pesticides basing on their actions to avoid pests developing resistance to pesticide for long period
• Mancozeb WP (Dithane M.45)	Broad spectrum fungicide	• Effective on late blight in potato and tomato	• Relatively cheaper than Ridomil and more used in tomatoes and potatoes	• The fungicide is unlikely to cause hazard
• Ridomil	Broad spectrum systemic fungicide	• Effective on late blight in potato and tomato • Used when rainfall is heavy	• Expensive and not affordable • Used only when the rainfall is very heavy	The fungicide is unlikely to cause hazard
• Copper Oxychloride	Preventive and contact Fungicide	• Effective against coffee leaf rust and coffee berry disease	• Affordable and supported by cooperatives • Use on calendar spraying	• Fungicide with slight hazardous

14.5.5. Summary table 5. Chemicals used for pests and diseases control: health aspects

Chemicals	**Nature of the chemical**	**Health aspects for people and animals**	**Care/precautions required (Include being forbidden in the options)**	**Way of disposal**	**References/Remarks**
Chlorpyrifos (Dursban)	Insecticide (I): Organophosphate (OP)	Moderate hazardous insecticide: Use with maximum care	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instruction on label	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained
Dimethoate	I- OP	Moderate hazardous insecticide	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instruction on label	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained
Cypermethrin	Insecticide(I):Pyrethroid (PY)	Moderate hazardous insecticide	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instruction on label	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained
Deltermethrin	I-PY	Moderate hazardous insecticide	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instruction on label	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained
Mancozeb (Dithane M45)	Fungicide (Preventive: contact)	Unlikely to cause hazard	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instructi	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained

				on on label	
Ridomil	Fungicide (systemic)	Unlikely to cause hazard	• To follow label instruction. • Train farmers and other users	• Depends on type of container • Follow instruction on label	• Farmers and extension staff should trained • Retailers of pesticides should registered and trained

14.5.6 Summary table 5. Proposed areas of intervention in IPM in Rwanda

Nature of intervention	**Who should intervene**	**Expected gain**	**Conducive issues**	**Obstacles**
• Research to establish pests status in different agro-ecological zones	Research and Universities	• Focus on major pests for control • Monitoring the control practices • Monitor pests situation on different crops • Develop appropriate technologies	• Availability of fund for carrying on research • Joint effort between Institutes	• Lack of funding • Lack of qualified staffs
• Training of Extension staffs and farmers on available IPM technologies	• MINAGRI • MINALOC • Research • Universities • NGOs	• Farmers knowledge on IPM increased • Yield increased due to reduced pests damage • Environment, human and animal health improved due to proper use of pesticides • Researchers and Academia experience increased	• Funding availability • Coordination effort to network all actors • Sharing responsibilities according to proximate • Development of technical manual for all pests and diseases used by any actor • Making researchers and academia responsive to farmers needs as a part of their workload	• Lack of funding • Lack of qualified staffs • Poor coordinatio n •
• Development of IPM materials	• MINAGRI • Research • Universities	• Technical IPM information available • Develop approval mechanism	• Funding for these materials development	• Lack of fund
• Conducting adaptive research with farmers in different agro-ecological zones	• Research, • Universities	• Working technologies approved and adopted by farmers • Dissemination of approved technologies	• Availability of fund • Willingness of Research and Universities	• Lack of approval mechanism • Lack of funding for adaptive research

NB: Condensed information in such or similar tables can be useful for rather busy policy makers/investors who otherwise might not read even 5/>100 pages of the document.