REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE, LIVESTOCK, FISHERIES AND IRRIGATION

NATIONAL AGRICULTURAL AND RURAL INCLUSIVE GROWTH PROJECT (NARIGP)

INTEGRATED PEST MANAGEMENT PLAN

(IPMP)

FOR

NATIONAL AGRICULTURAL AND RURAL INCLUSIVE GROWTH PROJECT (NARIGP)

October 2018.

EXECUTIVE SUMMARY

1. The purpose of this document on Integrated Pest Management (IPM) is to provide a strategic framework for the integration of environmental and pest management considerations in the planning and implementation of the activities within the NARIGP by the MoALF&I. IPMP has been prepared as a guide for initial screening of the micro-projects for any negative impacts which would require attention and mitigation prior to their implementation. This IPMP initially disclosed by the Ministry of Devolution and Planning (MoDP) in February, 2016 has been reviewed, updated and aligned to the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALF&I) to serve as a guide for initial screening of the micro-projects which would require attention and mitigation.

2. The objectives of IPMP are:
   i. Establish clear procedures and methodologies for IPM planning, design and implementation of micro-projects to be financed under the Project
   ii. Develop monitoring and evaluation systems for the various pest management practices for subprojects under the Project;
   iii. To assess the potential economic, environmental and social impacts of the pest management activities within the micro-projects
   iv. To mitigate against negative impacts of crop protection measures
   v. To identify capacity needs and technical assistance for successful implementation of the IPMP
   vi. To identify IPM research areas in the Project
   vii. To propose a budget required to implement the IPMP

3. It will also improve beneficiaries' attention towards smart agriculture, SLM practices and technologies and climate change mitigation measures.

Brief Description of Project

4. The NARIG project will contribute to the Government's high level objective, which aims at transforming smallholder subsistence agriculture into an innovative, commercially oriented, and modern sector by: (i) increasing the productivity, commercialization, and competitiveness of selected agricultural commodities; and (ii) developing and managing key factors of production, particularly land, water and rural finance. The PDO of NARIGP is "*to increase agricultural productivity and profitability*

leading to reduced vulnerabilities of targeted rural communities in selected counties".

Project Components

5. NARIGP has 4 components. Component 1 entails strengthening community level institutions' ability to identify and implement investments that improve their agricultural productivity, food security and nutritional status and, linkages to selected value chains (VCs) and Producer organizations (PO). Component 2 aims at strengthening POs and improves market access for smallholder producers in targeted rural communities. Through a VC approach, CIGs, and VMGs formed under component 1 will be supported to federate into strong business-oriented POs. Component 3 is intended to strengthen the capacity of county governments to support community-led development initiatives identified under Components 1 and 2. Component 4 is concerned with financing activities related to the national and county-level project coordination, including planning, fiduciary, human resource management, safeguards compliance and monitoring,

Project Beneficiaries

6. The primary beneficiaries of the project will be targeted rural small and marginal farmers, including women and youth and Vulnerable and Marginalized Groups (VMGs) and other stakeholders, organized in Common Interest Groups (CIGs) and federated into Producer Organizations (POs) along the Value Chains (VC), and selected County Governments. NARIGP will be implemented in 21 selected counties with a total of 140 sub-counties. The updated and earlier disclosed PMF was prepared in accordance with the World Bank's safeguard policy on environmental assessment, World Bank Operational Policy on Pest Management, OP 4.09(1998).. The Bank uses various means to assess pest management in the country and to support integrated pest management (IPM) practices.

Potential Project Impacts

7. The potential impacts include reduction in crop and livestock production, food insecurity, human health and environmental degradation. Impact of pests on crop production can vary from insignificant to total (100%) loss depending on geographical area and season. Weed can lead to substantial crop losses. Losses in staple foods such as maize can lead to food insecurity. This applies mainly to maize which is a major food crop in Kenya. Losses of cassava, a major food item in ASALs can lead to food shortage.

Pests and animal diseases arising from pest infestation can also lead to serious losses in livestock production. This would lead to loss of meat, milk and income to the farmers. Some animal diseases also affect humans such as the Rift Valley fever.

Institutions/Departments Responsible

8. The proposed mitigation and monitoring measures require a clear and adequate institutional framework that will be used for each micro-project investments where pesticides will be used. Mitigation and monitoring measures will occur at different levels and undertaken by different institutions. The Ministry of Agriculture, Livestock, Fisheries and Irrigation (MOALF&I) will be the principal agency responsible for overall mitigation and monitoring of the adverse impacts of the pesticides including ensuring that the IPMP is followed under the NARIGP. NARIGP will recruit consultants (in the absence of specialist) agronomists, crop specialists who will prepare the IPMPs for sub projects in line with the requirements of this IPMP.

9. MOALF&I through NPCU will undertake screening of all micro-projects to determine if they intend to use pesticides and hence trigger the need to prepare an IPMP. If a project is screened and found that it will use pesticides, the NPCU will prepare Terms of Reference for the preparation of an IPMP. The NPCU will also provide overall technical support in monitoring of proposed mitigation measures and indicators on a period basis including the review of the monitoring reports.

10. The micro-projects will use farmer groups and associations who are the project beneficiaries to undertake monitoring for instance in observing the pests in the farms, identifying weeds, and reporting as part of the surveillance to inform what sort of control measure to adopt. The farmer groups and associations will be trained on surveillance and best management practices in pesticide application and use.

11. Members of the Agrochemical Association of Kenya (AAK) and distributors or wholesalers of pesticides will also be used to mitigate and monitor the adverse impacts. For instance, the agro-vet distributors will be trained to provide education and awareness to farmers on judicious pesticide use and application for the benefit of the environment and human health since they have constant contact with the farmers.

12. The Pest Control and Product Board (PCPB) will remain significant in conducting

annual reviews and inspection of all pesticide storage where the NARIGP micro-projects are under implementation; ensure that only registered pesticides are used in the NARIGP micro-projects and enforce the guidelines for transportation and disposal of pesticide wastes including containers as required by law.

13. National Environment Management Authority (NEMA) will ensure that there is enforcement including monitoring of the guidelines and regulations for waste disposal including pesticide wastes and will undertake this jointly with the PCPB. NEMA has County offices and will be best placed to ensure the monitoring of pesticide use as well as their disposal.

Capacity building, Training and Technical Assistance

14. Positive impacts from the IPMP training will be expected to be realized by the target communities. Key among these include: (i) increased conformity to thee safeguard through various capacity building levels, (ii) increased income especially from sale of healthy and quality crop and livestock-products as a result of mainstreaming IPF safeguard in both individual smallholder farmer and community-based investments.

Stakeholder Consultation, participation and Disclosure of IPMP

15. Once the draft IPMP is approved by the NCPU, it will be circulated to the relevant institutions for comments. This is in accordance with the requirements provided for under EMCA (1999) and the WB policy on Pest Management (OP 4.09).

16. The Consultants carried out appropriate consultations with stakeholders during the preparation of the earlier disclosed IPMP. Stakeholders consulted included relevant Government agencies, county government officials, non-governmental organizations, non-state actors and civil society groups identified during the consultative period. Comments by stakeholders' public workshops were incorporated in the earlier disclosed IPMP and relevant comments including the ones by the WB team were also communicated to the Consultant for incorporation into the final IPMP. Further consultations between consultants and the government implementing agency (MOALF&I) were also held. Useful comments were made which have since been included in the disclosed IPMP. The IPMP has been reviewed so as to be aligned to the new implementing agency. Consequently, the IPMP will be disclosed both in-country

and in the World Bank Website.

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ACRONYMS AND ABBREVIATIONS

ASAL	Arid and Semi-Arid Lands
ASDS	Agricultural Sector Development Strategy
ATIRI	Agricultural Technology and Information Response Initiative
AGOA	African Growth Opportunity Act
BMP	Best Management Practices
BP	Bank Procedure
CAC	Catchment Area Coordinator
CAP	Community Action Plan
CAS	Country Assistance Strategy
CCC	Climate Change Coordinator
CBS	Central Bureau of Statistics
CBO	Community Based Organization
CBPP	Contagious Bovine Pleuropneumonia
CIG	Common Interest Group
CWG	Community Working Group
CGIAR	Consultative Group on International Agricultural Research CMS Convention on Migratory Species of Wild Animals
CDO	County Development Officer
CEO	County Environment Officer
CSC	County Steering Committee
CSDO	County Social Development Officer
DRSRS	Department of Resource Survey and Remote Sensing
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Co-ordination Act
ERS	Economic Recovery Strategy for Wealth and Employment Creation
EMP	Environmental Management Plan
ESA	Environmental and Social Assessment
ESMF	Environmental and Social Management Framework FFS Farmer Field Schools
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHGs	Greenhouse Gases
GMP	Good Management Practices
GMT	Good Management Technologies
GOK	Government of Kenya
IBA	Important Bird Area
ICC	Inter-Ministerial Coordinating Committee
ICM	Integrated Crop Management
ICRAF	International Centre for Research on Agro forestry (currently World Agro forestry Centre, WAC
IDA	International Development Association
ISC	Inter-Ministerial Steering Committee
IMCE	Inter-Ministerial Committee on Environment
IPM	Integrated Pest Management
IPMP	Integrated Pest Management Framework
KWS	Kenya Wildlife Service
M&E	Monitoring and Evaluation

MG& SS	Ministry of Gender and Social Services
MoALF&I	Ministry of Agriculture, Livestock, Fisheries and Irrigation
MoH	Ministry of Health
NFNSP	National Food and Nutritional Security Policy
NALEP	National Agricultural and Livestock Extension Project
NLP	National Livestock Policy
NARIGP	National Agricultural and Rural Inclusive Growth Project
NARS	National Agricultural Research Systems
NPP	National Productivity Policy
NASEP	National Agricultural Sector Extension Policy
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
OAC	Operation Area Coordinator
PEO	Provincial Environment Officer
PMP	Pest Management Plan
PRSP	Poverty Reduction Strategy Paper
PRA	Participatory Rural Appraisal
RSU	Regional Service Unit
RAP	Resettlement Action Plan
SC	Steering Committee
SLM	Sustainable Land Management
SRA	Strategy for Revitalizing Agriculture
TOR	Terms of Reference
TN	Total Nitrogen
TP	Total Phosphorus
UNFCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
VFF	Village Farmers Forum
VMG	Vulnerable and Marginalized Groups
WHO	World Health Organization

1.0 INTRODUCTION

1.1 Background

17. The rapid expansion of the agricultural sector in Kenya has resulted in increased demand for agrochemicals. The use of agrochemicals has many benefits such as increased crop and animal yields and reduced post harvest losses. However, agrochemicals are highly toxic and can cause serious human health and environmental damage if not properly handled. Integrated pest management (IPM) is an ecological approach to pest management as it discourages the use of pest control methods that have negative effects to the non-target organisms. Many crops grown in Kenya like elsewhere in the world, depend on insect pollinators. The vast majority of these pollinators are insects such as bees, moths, flies, wasps and beetles. Inappropriate use of agrochemicals could cause harm to non-target organisms including these pollinators.

18. The purpose of this document on Integrated Pest Management (IPM) is to provide a strategic framework for the integration of climate change mitigation measures, smart agriculture, SLM practices and technologies, environmental and pest management considerations in the planning and implementation of the activities to be implemented within the National Agricultural and Rural Growth Project (NARIGP). This IPMP initially disclosed by the Ministry of Devolution and Planning (MoDP) has been reviewed, updated and aligned to the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MOALF&I) to serve as a guide for initial screening of the micro-projects for negative impacts which would require attention and mitigation prior to their implementation. In Kenya, Integrated Pest Management is not prioritized, particularly through government policies. Though many solutions to pest problems exist, farmers tend to rely on pesticides as the first choice of pest control measure, particularly in high input agriculture experienced in horticultural sector. Knowledge on IPM and its utilization in Kenya is limited probably due to lack of IPM policy.

19. The major classes of pesticides used in Kenya are organo-chlorines, Organophosphates and carbonates. The organo-chlorines have significant toxicity to plants or animals, including humans. The major source of environmental contamination by pesticides is the deposits resulting from application of these chemicals to control agricultural pests. They affect the environment by point-source pollution and nonpoint-source pollution.

20. The former is the contamination that comes from a specific and identifiable place; including pesticide spills, wash water from cleanup sites, leaks from storage sites, and improper disposal of pesticides and their containers. The latter is the contamination that comes from a wide area, including the drift of pesticides through the air, pesticide run off into waterways, pesticide movement into ground water

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21. Environmentally-sensitive areas to pesticides include areas where water table is high, near the habitats of endangered species and other wildlife; near honeybees and near food crops and ornamental plants. Sensitive plants and animals as well as the water quality of water bodies in field margins can be affected either directly or indirectly. The degradation of pesticides is influenced by many factors such as the application factors, pesticide properties weather conditions and microorganisms. Some pesticides also escape into the atmosphere through volatilization process and some can travel long distances before they wash back down to earth in rainfall or settle out through dry deposition.

22. Agrochemical residues can enter streams through run-off and pose dangers to fish, birds, wild animals and plants in the aquatic habitat. Excessive use of fertilizers, for example, can lead to the contamination of groundwater with nitrate, rendering it unfit for consumption by humans or livestock. In addition, the run-off of agricultural fertilizer into streams, lakes, and other surface waters can cause an increased productivity of those aquatic ecosystems causing eutrophication. The ecological effects of eutrophication can include an extensive mortality of fish and other aquatic animals, along with excessive growth of nuisance algae, and an off-taste of drinking water.

1.2 Objectives of IPMP

23. The objectives of IPMP are:

i. Establish clear procedures and methodologies for IPM planning, design, implementation of micro-projects to be financed under the Project
ii. Develop, monitoring and evaluation systems for the various pest management practices for subprojects under the Project;
iii. To assess the potential economic, environmental and social impacts of the pest management activities within the micro-projects
iv. To mitigate against negative impacts of crop protection measures

v. To identify capacity needs and technical assistance for successful implementation of the IPMP
vi. To identify IPM research areas in the Project
vii. To propose a budget required to implement the IPMP

1.3 Project Description

24. The NARIG project will contribute to the Government's high level objective, which aims at transforming smallholder subsistence agriculture into an innovative, commercially oriented, and modern sector by: (i) increasing the productivity, commercialization, and competitiveness of selected agricultural commodities; and (ii) developing and managing key factors of production, particularly land, water and rural finance. The PDO of NARIGP is *"to increase agricultural productivity and profitability leading to reduced vulnerabilities of targeted rural communities in selected counties"*. An Integrated Pest Management Framework (IPMP) would be critical in achieving this objective.

1.4 Description of Project Components

Component 1: Supporting Community-Driven Development

25. The overall objective of this component is to strengthen community level institutions' ability to identify and implement investments that improve their agricultural productivity, food security and nutritional status; and linkages to selected VCs and POs.

Subcomponent 1.1: Strengthening Community Level Institutions

26. The project will finance activities aimed at building the capacity of community-level institutions, such as community-driven development committees (CDDCs), CIGs, and VMGs, to plan, implement, manage and monitor agricultural and rural livelihoods development interventions. Specifically, activities to be financed under this subcomponent will include: (i) facilitation of community institutions, including community mobilization, awareness creation of the PICD process through which priority interventions will be identified; (ii) development of, and training on, standardized training modules for PICD, VC development, fiduciary management (i.e., community financial and procurement management, and social audits) and

environmental and social safeguards monitoring (i.e., use of checklists in micro-project identification and implementation); (iii) payments to competitively selected advisory service provider (SP) consortia (i.e., to provide technical and extension advisory services, micro- projects planning and implementation support, local value addition, and link CIGs/VMGs to POs; and (iv) facilitation of County Technical Departments (CTDs) to provide oversight and

quality assurance at the sectoral level (e.g. agriculture, livestock, fisheries, environment and natural resources, cooperatives, youth and women affairs, among others).

Subcomponent 1.2: Supporting Community Investments

27. This subcomponent will finance physical investments in the form of community micro- projects identified in the PICD process that increase agricultural productivity, include a strong nutrition focus, improve livelihoods and reduce vulnerability. Micro-project investments will fall under four windows: (i) sustainable land and water management (SLM) and VCs development; (ii) market-oriented livelihood interventions; (iii) targeted support to VMGs; and (iv) nutrition mainstreaming through three pathways: consumption (e.g. nutrient-dense crops and livestock products), income (e.g. home-based value addition, storage and preservation), and women empowerment (e.g. on-and off-farm activities, labour-saving technologies, and savings and credit schemes). Priority will be placed on micro-projects that have the potential to increase agricultural productivity and incomes, value addition, and links to markets via POs; and sustain natural resources base and returns to targeted communities rather than simply providing inputs.

28. The County Project Steering Committee (CPSC) will be responsible for approving the investment proposals submitted by CIGs and VMGs through a competitive process, based on the recommendations of the County Coordination Unit (CCU). The mechanism for implementing micro-projects, including matching grants will be detailed in the Project Implementation Manual (PIM).

Component 2: Strengthening Producer Organizations and Value-Chain Development

29. The objective of this component is to strengthen POs and improve market access for smallholder producers in targeted rural communities. Through a VC approach, CIGs and VMGs formed under Component1 will be supported to federate into strong business-oriented POs; and integrated into input/output and service markets to improve production; and to take advantage of market opportunities available along the selected VCs. Targeted POs will include cooperatives, farmer associations and companies constituted by CIGs and VMGs.

Subcomponent 2.1: Capacity-Building of Producer Organizations

30. The objective of this subcomponent is to federate targeted CIGs and VMGs into profitable business-oriented POs through which they can have a stronger say in the VCs they participate in; negotiate for improved access to farming inputs, technologies and agricultural services (including extension and finance); and markets for their produce. The project support to POs will finance activities organized around two pillars: (a) organization and capacity building; and (b) financing for enterprise development tailored to the needs of the PO and its members. At the start of the project, each selected PO will be supported to prepare a 5 year Business Plan, which will become the main instrument for guiding project investments to the PO.

Subcomponent 2.2: Value Chain Development

31 The objective of this subcomponent is to identify and up-grade competitive VCs for integration and economic empowerment of targeted POs. Project support will be used to finance activities related to the: (i) selection, mapping and organization of competitive nutrition-sensitive VCs for smallholder development; and (ii) VC upgrading through a matching grants mechanism targeted at addressing key investment gaps, including: strengthening of inputs supply system (e.g. foundation seed by research institutions, commercial seed production by private sector, and community-based seed multiplication); development of farm mechanization technologies for climate smart-agricultural practices; value addition and processing; and post-harvest management technologies and facilities (e.g. drying, storage and warehousing receipt system).

32. Similar to subcomponent 1.2, the CPSC will be responsible for approving the investment proposals submitted by POs through a competitive process, based on the recommendations of the CCU. Details on implementing VC activities, including how the matching grants process, will be detailed in the PIM.

Component 3: Supporting County Community-Led Development

33. The objective of this component is to strengthen the capacity of county governments to support community-led development initiatives identified under Components 1 and 2. This includes the provision of technical advisory services (e.g. public extension services); enabling environment for the private sector and public-private partnership (PPP) to operate; and inter- community (e.g. catchment or landscape-wide and larger rural infrastructure) investments based on priorities identified under Components 1 and 2. This component will enable the county governments to have effective citizen engagement through consultations, sensitizations, capacity building and partnerships.

Subcomponent 3.1: Capacity Building of Counties

34. This subcomponent will finance the capacity building of participating counties in the area of community-led development of agricultural and related livelihoods. The objective is to enable them to support activities under Components 1 and 2. The project will ensure that capacity building under this subcomponent is coordinated and harmonized with ongoing county capacity building under the NCBF and other donors' ongoing initiatives. The subcomponent will finance activities related to: (a) stakeholder engagement through sensitization and awareness creation to become familiar with project objectives and "philosophy"; (b) the preparation of a Capacity Needs Assessment (CNA) and Capacity-Building Plan (CBP) for each participating county; (c) capacity-building through: (i) different forms of training (including the development of relevant standard training manuals, and Information, Education and Communication (IEC) materials) and technical assistance; and (ii) limited but necessary facilitation of relevant county staff (e.g. logistics, tools and basic equipment).

Subcomponent 3.2: County Investment and Employment Programs (US$55 million IDA)

35. This subcomponent will finance investments in key agricultural and rural development infrastructure, as well as natural resource management investments that span across multiple targeted communities. It will also finance short-term employment during off-season, particularly for VMGs and unemployed/out-of-school youth. Employment opportunities will largely be created under public works using cash-for-work approach and facilitated by concerned county governments. The employment programs will also provide life and technical skills development training in order to have long-lasting impacts beyond temporary works. Typical investments would include the construction of rural road construction, small multipurpose dams, earth pans, small scale irrigation systems, market and storage facilities (under PPP arrangement); restoration of degraded catchments and water courses; and rehabilitation of similar existing infrastructure. Co-financing and the availability of an operation and maintenance (O&M) plan, including cost recovery or sharing mechanisms and other sources of funding will be key criteria for the counties to access project funds.

36. The county investment proposals will be approved by the National Technical Advisory Committee (NTAC) through a competitive process, based on the recommendations of the National Project Coordination Unit (NPCU).

Component 4: Project Coordination, Monitoring and Evaluation

37. This component will finance activities related to the national and county-level project coordination, including planning, fiduciary, human resource management, safeguards compliance and monitoring, MIS and Information, Communication and Technology (ICT) development, M&E, impact evaluation, communication and citizen engagement. In addition, in the event of a national disaster affecting the agriculture sector, the project through this component would respond through a contingency emergency response provision.

Subcomponent 4.1: Project Management

38. .This subcomponent will finance the costs of the national and county level project coordination units (PCU and CCUs), including salaries of the contract staff, and O&M costs, such as office space rental, fuel and spare parts of vehicles, office equipment,

furniture and tools, among others. It will also finance the costs of project supervision and oversight provided by the NPSC and CPSC; and any other project administration.

Subcomponent 4.2: Monitoring & Evaluation and Impact Evaluation (US$5 million IDA)

39. This subcomponent will finance activities related to routine M&E functions (e.g., data collection, analysis and reporting); development of ICT-based Agricultural Information Platform for sharing information (e.g., technical or extension advisory services, business and market-oriented, agro-weather information and others); and facilitate networking across all components. It will also finance the baseline, mid-point and end of project impact evaluation of the project. The Agricultural Information Platform is intended to provide the project and other stakeholders the ability to: (i) capture data from ongoing programs and projects using electronic devices connected to mobile networks; and (ii) upload information from manually collected data and geospatially aggregate the data from community, county, and national levels including agricultural statistics. See Annex 11 for further details.

Subcomponent 4.3: Contingency Emergency Response (US$0 million IDA)

40. This zero budget subcomponent will support a disaster recovery contingency fund that could be triggered in the event of a natural disaster affecting the agricultural sector through: (a) a formal declaration of a national emergency by the authorized agency of GoK; and (b) upon a formal request from the National Treasury (NT). In such cases, funds from the unallocated expenditure category or from other project components would be re-allocated to finance emergency response expenditures to meet agricultural crises and emergency needs.

1.5 Institutional and Implementation Arrangements

41. Implementation of NARIGP IPMP will involve a 3 tier institutional arrangement (national, county and community). The 1st tier which is at national level will represent the MOALF&I (the main implementing agency) and other national GoK stakeholders (Agriculture, livestock, Fisheries, Industrialization, etc.) need to be sensitized on the environmental and social safeguards. In the MOALF&I. The 2nd and 3rd tiers are the county and community levels respectively. The county governments are

the executing agencies of the project while at the community level is the target beneficiaries who will directly implement community-led-interventions. The last two levels need to be trained and capacity build on safeguards and implementation of the frameworks in order to ensure the relevant safeguard policies are integrated in a sustainable manner into all project activities. The three tier institutional arrangement aims at achieving efficient decision-making process and implementation as well as using the constitutionally mandated governance procedures at all levels for a sustained application and adoption.

1.6 Approach and Methodology of Revising and Updating IPMP

42. The methodology used to review, revise and update this IPMP was based on literature review, interviews and public consultation. Literature review of existing policies and legislation of the Government of Kenya and of World Bank Safeguard Policies was carried out in areas of crop and livestock production and protection. A review of policies relevant to this updated IPMP and which were left out in the earlier disclosed document were examined.

43. Interviews with key stakeholders from relevant NEMA and Pest Control Products Board (PCPB) were conducted in order to understand the impacts of the pesticides on public health and environment.

44. Public Consultation process: Public consultation meetings took place during preparation of earlier disclosed IPMP. There was no need for another public consultative forum. However, the consultant will submit a draft Final report to the NPCU of the implementing agency for review, input and approval of the draft IPMP.

45. Preparation of the IPMP included the following stages:

- Collation of baseline data on agriculture, livestock and pesticide use in Kenya. Identification of positive and negative economic and environmental and social impacts of pesticide use under NARIGP by analyzing responses from questionnaires (Annex1).
- Identification of environmental and social mitigation measures.

3.0 ECONOMIC IMPACTS OF PESTS

3.1 Crop Pests

3.1.1 Impact on Production

46. Estimates of potential crop damage from pests in the absence of control have been made by measuring damage as a proportion of total feasible output. Generally, estimates of damage during outbreaks and plagues range from insignificant losses of the planted crop to 100 percent, depending on the year, region and pest species.

47. Weeds are reported to generally cause up to 70% of yield losses on susceptible crops. However, in some areas such as the Lake Victoria Basin, *Striga* is the number one ranked weed causing severe damage to crops like maize, sugarcane and sorghum. Documented literature indicates that it causes between 42-100% yield losses. Other notorious weeds are grasses and broad-leaved weeds that cause 30- 70% yield loss.

48. A major weed that may require noting although it does not affect crops is the water hyacinth, which causes fish catch reduction ranging from 30-100% depending on the levels of infestation. A serious production impediment in many developing countries is the spread of introduced weed species such as the water hyacinth, which results in severe disruption of the socioeconomic activities of the local communities.

49. Some studies may over-estimate the potential crop losses caused by pests. They rarely account for farmers' response to mitigate the effects of pests and are often based on calculations of optimal production conditions. In both ways, they may overstate the losses caused by the pests. Studies of pests have been carried out by focusing on estimated damage in the absence of control and comparing them with direct costs of control operations. Thus, these studies have the same drawbacks. In all likelihood, they give an incomplete picture of the true net benefits of pest control.

50. There are numerous diseases of crops reported in Kenya that are causing havoc to crop production. Among the leading diseases are those caused by viruses and bacteria.Although the impacts are not clear, the major diseases identified include**:**

(a) Mosaic virus causing up to 19% loss on maize and sugarcane.
(b) Cassava mosaic virus seriously affected the crop causing significant losses in production. Experiments carried out by KALRO estimates losses of crop at 36%,

although the impact seems to be declining after introduction of resistant cassava varieties.

(c) Sugarcane ratoon stunting disease which cause up to 19% yield loss in the basin.

(d) Coffee berry disease is a major disease which causes heavy crop losses which reach 90% with heavy infestation.

(e) Other diseases causing heavy losses include sugarcane smut and rice blast.

3.1.2 Impacts on food security

51. The effect of pest damage on the food security has not been analysed in the past. However, where there are major damages there is significant losses in production and hence the food supply such as in maize. A case in point is that of the Cassava mosaic virus which razed the whole of the lake basin in Kenya extending to the Uganda side, thereby causing serious reduction in the crop supply.

52. During severe attacks of these diseases the supply of the affected crops is inhibited hence causing shortages in the availability and hence high prices in the market Thus the consumers are exposed to high prices making the crop unaffordable.

3.2 Livestock Pests

3.2.1 Impacts on production

53. All animal diseases have the potential to kill affected animals, but the severity of the disease will vary depending on factors such as the species and breed of animal, its age and nutrition and the disease agent. Many animal diseases have mortality rates of between 50% and 90% in susceptible animals. Rift Valley Fever normally produces only a mild infection in local African breeds of cattle, sheep and goats, while exotic breeds of the same species may experience severe spates of abortion. Under experimental conditions, some "mild" strains of classical swine fever virus kill less than half of the infected pigs while other “virulent” strains may kill up to 100%. Productivity losses can persist even in animals that survive disease. Abortions caused by Rift Valley fever do not only entail the loss of offspring but also the loss of one lactation and thus reduced milk supply for human consumption in the year following an outbreak. Foot-and-mouth disease leads to considerable loss in milk production in dairy cattle. In Kenya, losses caused by foot-and-mouth disease in the early 1980s amounted to KShs.

230 million (1980 value) annually, approximately 30 % of which were due to reduced milk production.

54. The first outbreak of Rinderpest in Eastern Africa in 1887 was estimated to have killed about 90% of Ethiopia's cattle and more than 10 million cattle on the continent as a whole resulting in a widespread famine. Rinderpest losses in production has been estimated with and without the control campaign and found benefits exceeded costs. The benefit/cost ratio ranged from 1.35:1 to 2.55:1. As mentioned earlier in cost-benefit studies, there are many variables that are not considered in a simple evaluation of costs and losses that might lead to an underestimation of the costs and/or an overestimation of the benefits of a control campaign.

55. Reductions in mortality and improvements in animal productivity are the traditional goals of disease eradication programmes. Access to export markets is now becoming an equally important reason. Improved response to outbreaks and increased access to vaccine have reduced the likelihood of many disease epidemics, but this experience is countered by increased trade, smuggling and susceptibility of small poultry and ruminant populations raised in intensive conditions.

56. Most analyses of animal diseases do not include the cost of treatment, perhaps because it is regarded as minor. The effects of diseases on animal productivity depend on the actual disease incidence, which may be reduced by a control campaign.

57. Animal diseases directly affect the size and composition of animal populations and thus indirectly have repercussions on the environment. In conjunction with other environmental factors, major livestock diseases determine which production system, species and breeds of animals are adopted by livestock owners.

58. The majority of animal diseases do not cause epidemics in humans, although occasionally humans can become infected. The viruses causing Rinderpest, *peste des petits* ruminants, classical swine fever and Asian swine flu, as well as the causative agent of Contagous Bovine Pleuro Pneumonia (CBPP), are not infective for humans but foot-and-mouth disease virus has been isolated from around 40 people worldwide following a mild cause of disease.

3.2.2 Impacts on human health and the environment

59. Some animal pests and diseases can affect humans directly and may use animals as vectors that aid in their transmission. Areas with conflict or poor health controls pose a greater risk of human infection from animal disease. Larger production units and increased contact among animals also increases the impact of outbreaks.

60. Rift Valley fever virus can infect humans, where it causes a febrile illness, which is sometimes complicated by hemorrhage, encephalitis and blindness. The virus is transmitted among animals and from animals to humans by certain mosquito species, which gives rise to the distinct association of Rift Valley fever epidemics with periods of high rainfall. Humans also appear to contract the infection through direct contact with infected tissues and fluids of animal sat slaughter.

3.3 Economic impact of forest pests

3.3.1 Impact on Production

61 The story of the *Cyprus* aphid exemplifies one of the problems affecting African trees today, the accidental introduction of exotic insect pests and associated diseases, which can affect both exotic and indigenous tree species. Native African pest species rarely produce such noticeable results, but like alien pests have a capacity to reduce tree growth and fitness considerably through feeding and, consequently, a loss in annual growth increment. Finally, besides pests that directly affect tree health, invasive weed species can damage forests by competing with existing stands and preventing forest regeneration.

4.0 INTEGRATED PESTMANAGEMENT

4.1 Existing and anticipated pest problems

62. Climate change, trade liberalization, and agricultural intensification (introduction of irrigation farming, increased fertilizer use, introduction of new crops and varieties, changes in land use etc.) could trigger the occurrence of new pest problems. This requires frequent pest risk surveillance and continuous updating of the existing pest list, an issue already being addressed by the MOALF&I. There is also need to strengthening National Disaster Preparedness and Response Capacity

4.2 Definition of Integrated Pest Management

63. Integrated Pest Management (IPM) is an approach designed to manage pests and diseases with as little damage as possible to people, the environment and beneficial macro- and micro-organisms. Sophisticated, well-considered strategies in which all components to prevent pests and diseases fit together are the cornerstone of IPM. Different techniques and products are used within IPM, including scouting, monitoring, crop sanitation, cultural and mechanical control, and the introduction of beneficial insects and mites. Corrective chemical control measures are used as a last resort. Increased environmental awareness has led to the need for sustainable agricultural production systems. Good Agricultural Practices (GAP) and IPM have become essential components of sustainable agriculture. The integration of the various control measures supports consumer safety and enhances international market access. IPM utilizes all suitable pest management techniques and methods to keep pest populations below economically injurious levels. Each pest management technique must be environmentally sound and compatible with producer objectives.

4.3 History of Integrated Pest Management

64. In the early years of the last century, different crop protection practices were integral parts of any cropping system. However, with increased world human population, the demand for more food was eminent. This also coincided with increased pest problem and advent of pesticides. From the 1940’s to the 1970’s, a spectacular increase in yield was obtained with the aid of an intensive development of technology, including the development of a variety of agro-pesticides. In many countries this advancement was coupled with the development of education of farmers and efficient extension services. However, in many developing countries, pesticides were used

without adequate support systems. Agro-pesticides were often used injudiciously. Misuse and over-use was stimulated by heavy subsidies on agro- chemicals. Crop protection measures were often reduced to easy-to-use pesticide application recipes, aimed at immediate elimination of the causal organism. In places where the use of improved varieties was propagated, packages of high-yielding varieties with high inputs of agro-pesticides and fertilizers made farmers dependent on high external inputs. Since then, it has been realized that this conventional approach has the following drawbacks:

a) Toxicity; poisoning and residue problems

b) Destruction of natural enemies and other non-target organisms

c) Development of resistance in target organisms

d) Environmental pollution and degradation

e) High costs of pesticides;

f) Good management of pesticides use requires skills and knowledge

65. Because of the drawbacks of reliance on pesticides, a crop protection approach is needed that is centered on local farmer needs that are sustainable, appropriate, environmentally safe and economic to use. Such approach is called Integrated Pest Management (IPM).

66. There are many different definitions that have been developed over the years to describe IPM. In 1967, FAO defined IPM as "a pest management system that in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible manner as possible, and maintains the pest population at levels below those causing economic injury". The requirement for adoption of IPM in farming systems is also emphasized in the World Bank OP 4.09 on Pest Management, which supports safe, effective, and environmentally sound pest management aspects, such as the use of biological and environmental friendly control methods.

67. The following are key preconditions for an IPM approach:

a. Understanding of the ecological relationships within a farming system (crop, plant, pests organisms and factors influencing their development
b. Understanding of economic factors within a production system

(infestation: loss ratio, market potential and product prices)

c. Understanding of socio-cultural decision-making behaviour of the farmers
d. (traditional preferences, risk behaviour)
e. Involvement of the farmers in the analysis of the pest problems and their management
f. Successive creation of a legislative and agricultural policy framework conducive to a sustainable IPM strategy (plant quarantine legislation, pesticides legislation, pesticide registration, price policy).

68. The key elements of an IPM program are:

a. Use of available, suitable, and compatible methods which includes resistant varieties, cultural methods (planting time, intercropping and crop rotation), biological control, safe pesticides, etc. to maintain pests below levels that cause economic damage and loss
b. Conservation of the ecosystem to enhance and support natural enemies and pollinators
c. Integrating the pest management strategies in the farming system
d. Pests and crop loss assessments

69. The IPMP addresses the need for the projects to promote ecosystem approach in pest management. This approach has benefits in terms of enhancing good human and environmental health, and improving economic wellbeing of the farmer.

70. The IPMP provides:

a. An information basis for stakeholder groups to establish functional mechanisms enabling farmers to identify understand and manage pest and vector problems in the further development of agriculture.
b. Reduction of personal and environmental health risks associated with pesticide use.
c. Protection of beneficial biodiversity such as pest natural enemies and pollinators to enhance farmer' crop productivity.
d. The need for farmers to understand and respond to the external factors affecting farmers' livelihoods that contributes to pest management.

71. For example, quarantine pests, alien invasive species and stringent minimum pesticide residue levels limit the potential for farmers to benefit from international trade opportunities. Collaborative linkages between the project and international IPM groups will help to bring relevant expertise and supporting IPM resources developed elsewhere to strengthen national and local capacity to address pest problems. A mechanism to develop a national IPM policy to encourage national and local compliance with international conventions and guidelines on pesticides, and to further develop IPM.

5.0 POLICY, INSTITUTIONAL AND LEGAL FRAMEWORKS FOR IMPLEMENTING IPM

5.1 Introduction

72. The Government of Kenya has been emphasizing on the commercialization of agriculture. Farmers are expected to increase utilization of external inputs, including pesticides. This IPMP intends to ensure that there is safe and judicious use of pesticides in the country. Worldwide, there is also a common agreement that although agriculture is a main contributor to food security, the sector has contributed to environmental degradation and climate change. Therefore, both the government and international stakeholders have had impact on the implementation and utilization of IPM strategies in Kenya. This has resulted to formulation of policies, institutions and legal frameworks that in one way or another affects agricultural production and agro-enterprises.

5.2 Policies for IPM International policies

5.2.1 Convention on Biological Diversity (1992)

73. The Convention on Biological Diversity adopts a broad approach to conservation (Alistsi, 2002). It requires Parties to the Convention to adopt national strategies, plans and programs for the conservation of biological diversity, and to integrate the conservation and sustainable use of biological diversity into relevant sectoral and cross-sectoral plans, programs and policies. The proposed programme is expected to conserve biodiversity, especially the rare and endangered species in the project area and its environs.

5.2.2 World Bank Operational Policy on Pest Management, OP 4.09 (1998)

74. The Bank uses various means to assess pest management in the country and support integrated pest management (IPM) and the safe use of agricultural pesticides, economic and sector work, sectoral or project-specific environmental assessments, participatory IPM assessments, and adjustment or investment projects and components aimed specifically at supporting the adoption and use of IPM. In the Bank-financed agriculture operations, it advocates pest populations reduction through IPM approaches such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The World Bank does not finance any pesticides, which

fall under WHO class Ia and Ib.

5.2.3 International plant Protection Convention of FAO (1952)

75. The IPPC is an international treaty to secure action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control. It is governed by the Commission on Phytosanitary Measures (CPM) which adopts International Standards for Phytosanitary Measures (ISPMs).

5.2.4 United Nations Framework convention on Climate Change (1992)

76. The convention seeks to regulate levels of greenhouse gases (GHGs) concentration in the atmosphere, to avoid the occurrence of climate change at levels that would harm economic development, or that would impede food production activities.

5.2.5 World Food Security and the Plan of Action of November1996

77. This declaration seeks to secure effective prevention and progressive control of plant and animal pests and diseases, including especially those which are of trans-boundary nature, such as Rinderpest, cattle tick, foot-and-mouth disease and desert locust, where outbreaks can cause major food shortages, destabilize markets and trigger trade measures; and promote concurrently, regional collaboration in plant pests and animal disease control and the widespread development and use of integrated pest management practices.

5.2.6 National policies

78. There are several policies that have been developed in the country that have impact on crop production and IPM implementation. Some of these policies are:

(i) Vision 2030

(ii) National Agricultural Research Systems

(iii) Agricultural Sector Development Strategy

(iv) National Agricultural Sector Extension Policy

(v) Environment policy

(vi) National food and nutrition policy

(vii) National seed industry policy

The Kenya Vision 2030

79. The Sessional Paper Number 10 of 2012 on the Kenya Vision 2030 under the economic pillar identifies specific interventions which in the agricultural sector include increasing productivity of crops and livestock, introducing land use polices for better utilization of high and medium potential lands, developing more irrigable areas in arid and semi-arid lands for both crops and livestock, and improving market access for smallholders through better post-harvest and supply chain management. It also prioritizes flagship projects in the sector, specifically: enactment of the consolidated agricultural reform bill, fertilizer cost-reduction investment, disease-free zones, land registry, land-use master plan and arid and semi-arid lands development project. The Policy makes reference to climatic change and directs responses.

80 The Policy under the social pillar, with respect to environmental management proposes to intensify conservation of natural resources, such as establishing voluntary carbon markets, intensify research on impact of and response to climatic change and pilot adaptation programmes.

(i) The Agricultural Sector Development Strategy (ASDS)

81. The Agricultural Sector Development Strategy (ASDS) 2010-2020 sets out to implement the Kenya Vision 2030 in the agricultural sector. It identifies two strategic thrusts for its vision of a food-secure and prosperous nation, i.e. increasing productivity, commercialization and competitiveness of agricultural commodities and enterprises and developing and managing the key factors of production. The ASDS makes reference to climatic change and directs the expansion of irrigation to mitigate adverse effects of climatic change in agricultural production. It commits government to implement "National Climate Change Response Strategy" which would include mainstreaming of tradition early warning and mitigation systems, identification of priorities for climate adaptation and mitigation with specific measures for vulnerable groups, awareness creation, conducting of periodic climate change threat and risk assessments and their mitigation as well as research and development in the area.

(ii) The National Agricultural Research Systems Policy (NARS)

82. This policy provides the foundation for research in the agricultural sector. It aims at achieving reforms in the Kenyan agricultural research systems to support the development of an innovative, commercially oriented, and modern agricultural sector. The Policy aims at achieving objectives that include problem-solving and impact driven research agenda, fast-tracking national adoption of available technologies and knowledge and enhancing capacity to access and adopt knowledge and appropriate technologies available world-wide. It directs re-focusing of research to solve problems, the harnessing of indigenous knowledge while upholding professional ethics and the adoption of innovative methods of knowledge transfer.

(iii)The National Agricultural Sector Extension Policy (NASEP)

83. This policy implements the ASDS on matters of agricultural extension services. It directs extension service providers to apply sustainable, dynamic, innovative and effective extension approaches and methods, especially those promoting demand-driven and beneficiary led approaches in the selection of technologies and extension messages. It promotes decentralization of extension by using clientele groups (e.g. common interest groups, smallholder associations and primary cooperatives) and general public outreach for cost-effectiveness, taking into consideration the importance of indigenous knowledge and technologies.

(iv)National Climatic Change Strategy (NCCS)

84. The Strategy sets out to reduce the vulnerability to impacts of climatic change and to catalyze transition to cleaner, lower emission and less carbon-intensive development in the country. Government commits in the Strategy to enhance climatic resilience and adaptive capacity and put in place mechanisms for sustainable utilization of natural resources. The Strategy directs integration of climate change risk and vulnerability assessment in the Environment Impact Assessment and the Strategic Environment Assessment. It lays the blame for emissions of green-house gases largely to agriculture, more so livestock, and in land-use change and suggests deterrent taxation and friendly regulatory environments for low carbon-pollutant activities.

(v) The National Productivity Policy (NPP)

85. The Sessional Paper Number 3 of 2013 on the National Productivity Policy responds to low productivity and directs corrective measures. The Policy aims to achieve accelerated economic growth through high investment and productivity growth, being the incremental growth of 5% per year up from current less than 1%. It also aims at increased productivity awareness and consciousness level in the country from the current level of about 1 percent to 60 percent of the population. It proposes training programmes outside the formal education system for skills transfer to the labour force. It will also support technological change and innovation.

(vi) The National Food and Nutritional Security Policy (NFNSP)

86. The Sessional Paper Number 1 of 2012 on the National Food and Nutritional Security Policy aims at achieving safe food in sufficient quantity and quality to satisfy the nutritional needs for optimal Agricultural Policies & Legislation: The Policy directs the promotion of sustainable food production systems with particular attention to increasing soil fertility, agro-biodiversity, organic methods and proper range and livestock management practices. The Policy also directs that different approaches to food production are adopted based on the agro-ecological diversity which should include promoting irrigation.

(vii) The National Livestock Policy (NLP)

87. The Sessional Paper Number 2 of 2008 on the National Livestock Policy aims at achieving sustainable development of the livestock industry while improving and conserving animal genetic resources. It guides effective control of animal diseases and vectors and directs the increase of the competitiveness of the livestock industry.

(viii) The National Wildlife Conservation and Management Policy (NWCMP)

88. The Wildlife Conservation and Management Policy, 2012 promotes the conservation of biodiversity by protecting wild fauna and flora and regulating their exploitation for human development. It has the objective of achieving the sustainable conservation and management of wildlife and their habitats in and outside the protected areas and the conservation and management of wildlife resources as a national endowment for sustainable development, wealth creation and employment. The Policy provides direction

for the management of problem wild animals and for minimization of damage to crops, livestock, property and loss of human life. It promotes land use zoning and barriers to minimize human/wildlife conflict as well as prompt payment of adequate compensation for human injury and loss of life, and damage to crops, livestock and property.

5.3 Institutional capacity and regulatory framework for the Control of distribution and use of pesticides in Kenya

89. The Pest Control Products Board (PCPB) has been established by the Government of Kenya (GoK) as the legal regulatory institution in the country. It is mandated to provide guidelines for commercialization and use of pest control products in the country. The institution monitors pest control products entry/exit on all the borders and ensures only products legally registered in the country are marketed. The board monitors pesticides that are in the market to ensure that only registered products that meet minimum qualifications are available to the farmers due to presence of counterfeits and black markets. Other than PCPB, other relevant governmental and national institutions in the country contribute towards wise use of pesticides in the country through; creation of by the laws of the country discussed below or mandated to effect such regulations. Government provides extension services while at the same time getting involved in research to provide best farm practices that farmers should adopt to reduce pest damage and also ensure farmers have net gain from pesticide use. Different institutions and stakeholders are involved in pest management and influence adoption of IPM programs.

These include:

5.3.1 Functions of the Ministry of Agriculture, Livestock, Fisheries and Irrigation

90. The functions of various agricultural sector State departments are hinged on various policy documents, guidelines and institutional structures. Some of the services provided by the State departments include the provision of National direction on agriculture and livestock development, husbandry and management through Agricultural Policy and Services. The Ministry of Agriculture, Livestock, Fisheries and Irrigation (MOALF&I) is instrumental in guaranteeing national food security through the National Food Policy. Many of the food security policies in Kenya are closely linked to Poverty Reduction Strategies (PRS) and Sustainable Development Goals (SDGs). The Ministry also provides

extension services to the lowest administrative levels in the country though it is constrained by various economic, human resource and geographical factors. Many extension services do not only include the development of these natural resources but a high level of pest management; even though, there are institutions charged with express mandate of crop and animal pest management in Kenya.

91 Various research institutions such as Kenya Agricultural and Livestock Organization (KARLO) are involved in applied research in both crop and animal production. The main focus has been on high yielding varieties of crops and animals as well as development of early maturing and disease resistant varieties.

92. The key public institutions that support production and marketing have been merged to create Agriculture and Fisheries Authority (AFFA). Some of the Institutions merged include Tea, Coffee, Sugar and Pyrethrum Boards among others.

93. There are several public and private institutions that play a major role in pest management in Kenya: KEPHIS, PCPB and NEMA, Agro Chemical Association of Kenya (AAK).

94. Several commercially oriented institutions, parastatals and companies have been created to address specific enterprises. These include sugar companies, agro- chemical industries, NGOs and farmer organizations (e.g., FPEAK, KENFAP, and Kenya Flower Council).

95. There are international and regional institutions that are involved in pest management of crops and animals which includes, ILRI, ICIPE, IITA, CYMMIT, CIP, ICRAF (WAC), CIAT, ICRISAT and DLCO

5.4 Legal Framework

96. There are many statutes that deal with pests and diseases directly and others that are indirectly connected with pest control and management. These include:

5.4.1 Chapter 324 – Plant Protection Act

97. This Act makes a provision for the prevention of the introduction and spread of diseases destructive to plants. The most applicable parts of this Act to Integrated Pest Management are specified in Sec. 3, 4, 5, 6, 7 and 8.

98. The act creates specific rules to support plant protection in various crops. These includes: sugarcane (L.N.294/1962. Rule 3, Sch. 2), Maize and Sorghum (L.N.216/1956. Schedule (rr. 7 and 8), Sisal (L.N.522/1957, L.N.365/1964, L.N.153/1958, L.N.177/1959, L.N.558/1960) and Banana (Cap.178 (1948), Sub. Leg.L.N.365/1964).

5.4.2 Chapter 326 – Seeds and Plants Variety Act

99. This Act regulates transactions in seeds, including provision for the testing and certification of seeds; for the establishment of an index of names of plant varieties; to empower the imposition of restriction on the introduction of new varieties; to control the importation of seeds; to authorize measures to prevent injurious cross-pollination; to provide for the grant of proprietary rights to persons breeding or discovering new varieties. The act includes subsidiary legislation on seeds and plant varieties (seeds) regulations, registration of seed growers, seed certification and seed importation and exportation.

5.4.3 Chapter 347 on irrigation

100. The Act makes regulations for the administration and day-to-day control of national irrigation schemes and standards of good husbandry and the control of pests and diseases in national irrigation schemes

5.4.4 Chapter 346: Pest Control Products

101. This Act covers the use, application, importation and trade in pest products. It includes regulation on:

a. Prescribing for the purposes of this Act the nomenclature of pests, pest control products and classes and kinds of pests and pest control products;
b. Prescribing the form in which applications for registration shall be made and the information to be furnished therewith;
c. Respecting the registration of pest control products and establishments in which any pest control products are and led by manufacturers or dealers and

prescribing the fees therefore, and respecting the procedures to be followed for the review of cases involving the refusal, suspension or cancellation of the registration of any such product or establishment;

d. Prescribing the form, composition, and all other standards relating to the safe use of pest control products, including toxic residue effects;
e. Respecting the manufacture or treatment of any pest control product to facilitate its recognition by change in colouration or other means;
f. Respecting the standards for efficacy and safety of any pest control product;
g. Respecting the manufacture, storage, distribution, display and use of any pest control product;
h. Respecting the packaging, labelling and advertising of pest control products;
i. Respecting the taking of samples and the making of analyses for the purposes and provisions of this Act;
j. Prescribing the information to be supplied and the form of such information in respect of any pest control product that is to be imported into Kenya;
k. Prescribing the circumstances and conditions under which pest control products that have met the requirements of the Cattle Cleansing Act may be deemed to be registered as prescribed under this Act;

5.4.5 Chapter 343 -Tea

102. The Act establishes the Tea Board of Kenya and charges it with various responsibilities and gives it powers to promote the tea industry in Kenya that includes pest control and management.

5.4.6 Chapter 335 –Cotton

103. The Act establishes The Cotton Lint and Seed marketing Board mandated to monitor cotton growing, cotton ginning, and management of cotton diseases and pests;

5.4.7 Chapter 338 - National Cereals and Produce Board

104. This Act regulates and controls the marketing and processing of mainly maize, wheat and scheduled agricultural produce.

5.4.8 Chapter 364 - Animal Diseases

105. This Act provides regulation on matters related to the diseases of animals. The Legislation regulates importation of animals and provisions affecting infected areas such as prohibition of the importation or the exportation of all animals or any specified kinds of animals, or of carcasses, meat, hides, steins, air, wool, litter, dung, semen, live viruses capable of setting up infections in animals, sera, vaccines and other biological or chemical products intended to be used for the control of animal disease or fodder, from any specified country, port or territory.

5.4.9 Chapter 128 – Chiefs' Authority

106. The Act has two items on pests and diseases:

a. Section 11 giving the Chiefs powers to issue orders for suppressing or controlling animal or insect pests or plant pests, noxious weeds or diseases and

b. Section 12 giving Chiefs power to require work or services in emergency in connection with an emergency consequent on fire, flood, earthquake, violent epidemic or epizootic disease, invasion by animal or insect pests or plant diseases or pests, or arising from circumstances which would endanger the existence of the whole or any part of the population, to be done or rendered, he may, in writing, authorize any chief to issue orders under this section to persons within the jurisdiction of such chief, and any chief so authorized may by any such order require any able-bodied adult person to perform any such work or render any such service as aforesaid specified in such order.

5.4.10 Chapter 325 - Suppression of Noxious Weeds

107. The act regulates declaration of plants as noxious weed (G.N.1721/1955, L.N.173/1960) and to eradicate it. The Local Authorities have powers under Cap. 265 (L.N.256/1963) **to** eradicate any noxious weed from land within its area and for compelling owners or occupiers of land to cause any such weed to be eradicated from their land, and for such purposes by-laws may appoint or provide for the appointment of inspectors.

5.4.11 Chapter 265 Local Government

108. The act empowers the council to make laws (L.N.22/1984) in respect of all such matters as are necessary or desirable for the maintenance of the health, safety and well-being of the inhabitants of its area or any part thereof and for the good rule and government of such area or any part thereof and for the prevention and suppression of nuisances therein.

109. As can be seen from these sections of the statutes, there is no central coordinating body in ensuring that all the institutions, statutes and players carry out the pest and disease control in a systematic and coordinated body as each of the legislations specifies the authorized officers to implement these laws. One of the problems that could be facing pest management strategies in Kenya seems to lie in the weak policy, institutional and legal linkages among the key players. This weakness forms one of the major gaps to be addressed in the proposed Integrated Pest Management Plan in this report and especially on the Participatory Monitoring and Evaluation Framework.

6.0 PROCEDURES AND METHODOLOGIES FOR IPM PLANNING, DESIGN AND IMPLEMENTATION OF MICRO-PROJECTS TO BE FINANCED

6.1 Introduction

110. In chapter 3, Integrated Pest Management (IPM) was defined. In this chapter, the reasons for having an IPM plan are discussed and the various methodologies for PM planning, design and implementation of the micro-projects proposed in the NARIG Project. Annex 2 presents an Integrated Pest Management (IPM) Plan Template for Use by Farmers throughout the country.

6.2 Planning

111. To effectively plan, design and implement an IPM program, there is need to understand the agro-ecological zones where the NARIG Project will be based (Fig.1). This is important since IPM relies on the ecosystem approach in its implementation. NARIGP will be implemented in Counties that have different agro-ecologies; hence the IPM elements will also depend on the location of the project.

IPM Plan is important for:

- Minimizing pest-caused losses.
- Saving time and money.
- Reducing health risks to the farmers, their families and workers.
- Producing a healthy, nutritious crop or healthy livestock.
- Avoiding expensive (time and money) surprises.
- Allowing time to research all the options, so as to choose the best ones for a given situation.

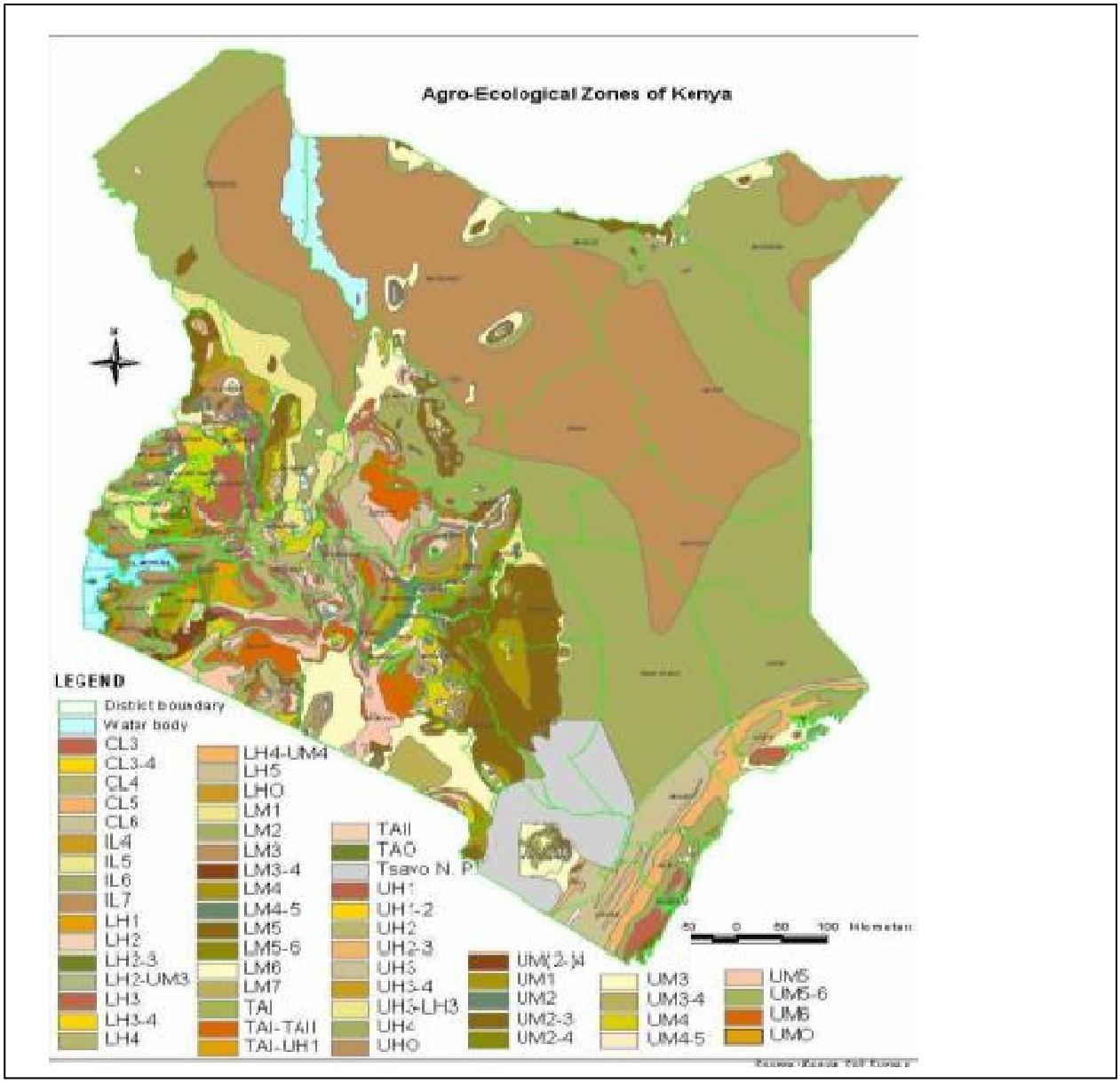


Figure 1: Agro-ecological zones of Kenya

Source: RoK (2009). Integrated Pest Management Framework for Kenya Agricultural Productivity and Agribusiness Project (IPM-KAPAP)

6.3 Planning for micro projects

112. To effectively plan, design and implement an IPM program, there is need to understand the agro-ecological zones where the project will be based. This is important since IPM relies on the ecosystem approach in its implementation. The sub projects will be implemented in different agro-ecological zones; hence the IPM elements will also depend on the location of the projects.

113. In addition to the agro-ecologies and enterprises, IPM planning involves consideration of the inputs required in the production processes of the target enterprise. For example, what support does the project provide to the target farmers in terms of acquiring key farm inputs? Are the inputs used by farmers complementary and do they empower the farmer economically? Are there simple and cheap methods that farmers can adopt in their production systems? Some of the key inputs applied include seeds, fertilizers and pesticides.

6.4 Set up of an IPM Program

114. Planning is at the core of an IPM program and needs to be tailored for every crop that is to be considered. Early planning, prior to a growing season, is crucial for the program as it will help to minimize reliance on pesticides.

115. A good Integrated Pest Management program has four parts:

a. Identifying problems;

b. Selecting tactics;

c. Considering economic and environmental factors; and

d. Evaluating the program.

6.4.1 Identifying Problems

116. You have to know what's happening in your fields before you can make good management decisions. You should scout your crops often and on a regular basis to identify problems. Scouting is, in fact, the key feature of any IPM program. By scouting, you will be able to detect potential problems early. The earlier you discover a problem,

the better your chances are of avoiding economic losses.

117. To scout effectively, you have to:

- **Know** the crop's growth characteristics to recognize abnormal or damaged plants.
- **Identify** the cause of the problem to know what kind of pest you are dealing with. If you encounter something you cannot identify, consult an expert in NARIGP.
- **Determine** the stage of growth of the pest and the crop. This is essential for proper timing of control methods.
- **Decide** whether the infestation is increasing or decreasing.
- **Assess** the condition of the crop.
- **Map out** problem areas. It may be possible to limit the area that needs treatment.
- **Use** the right scouting method for the specific pest.

6.4.2 Select Tactics

118. Once you've identified the problem, you should consider how to control it. Your goal in selecting control tactics is to use methods that are effective, practical, economical, and environmentally sound. To select the best control tactics, one has to:

Understand the life cycle and habits of the pest. Some control methods will work only if they are used at the right time.

Decide whether the infestation is serious in terms of economic loss.

Compare the costs and benefits of various control methods.

Make plans for the future. Not every part of an IPM program can be put into effect immediately. Some tactics, such as planting resistant varieties or rotating crops, require long-range planning.

6.4.3 Consider Economic Factors: Know When It Pays to Use pesticide

119.. Despite efforts to avoid using chemicals, there are times when only pesticides can control the damage. Even so, it may not pay to use them. Pesticides should be used in an IPM program only when the benefits (yield, quality, aesthetic value) exceed the costs of control. Otherwise time and money are wasted. It is not easy to figure out when it pays to use pesticides. There are many variables: the pest population, variety, and crop growth

stage, value of the crop, weather, and cost of the control. The following economic concepts are helpful in determining the point at which it pays to use pesticides:

a) Economic damage (ED) occurs when the cost of preventable crop damage exceeds the cost of control. For example, if Maize is worth Kshs 1,500 a bag and an insecticide costs Kshs 10,500 an acre, then economic damage occurs when insect damage causes a yield loss of seven or more bags an acre.
b) Economic Injury Level (EIL) is the lowest pest population that will cause economic damage. For many pests it is important to use control measures before this level is reached.
c) Economic Threshold (ET) is the pest population level at which a control tactic should be started to keep the pest population from reaching the EIL. (The ET is also called the action threshold.) Economic thresholds have been established for a number of crop/pest systems, in particular those involving insects. This information is available from the Agricultural Extension Service. It has been harder to develop economic thresholds for weeds and diseases, but research is being done to develop ETs for these systems.

6.4.5 Evaluating IPM Program

120. Evaluation means deciding how effective a program is and whether any changes are needed. To evaluate an IPM program, the following steps are to be followed:

(a) Monitor your fields and keep records. Each time you visit your fields, make a note of crop and pest conditions—record crop yields and quality and record any counts on pest populations.

(b) Record control measures. Records should include dates, weather conditions, pest levels, application rates and timing, and costs. Good records are a guide if the same problem occurs. They are also a good legal safeguard.

(c) Compare effectiveness. Whatever control tactics are chosen, use a different method on some strips. That way you can compare them; which worked better, taking into account costs and environmental impacts

6.4.6 Pesticide reduction and judicious use

121. There are no quick and easy answers to concerns about pesticide use. When pesticides are properly used according to the label, risks are minimized.

122.. Pesticides vary greatly in their level of toxicity, so during training in integrated pest management an ecological approach to pest control we stress the importance of using a product that is effective, but as nontoxic as possible to non-target organisms. A reduction in pesticide use can only be achieved with a greater understanding of plant selection, placement and care. Farmers can do a great deal to reduce and, in many cases, eliminate their use of pesticides. There may be a cultural, mechanical, physical, biological and/or chemical approach that effectively controls the problem with minimal impact on humans and the environment, and integrated pest management considers all those approaches. Whatever the situation, it is always important to first identify the problem, monitor the severity and spread, and know at what time or stage control is necessary.

6.4.7 Investigate the cause

123. Once you begin to understand the underlying causes for pests, disease and weed problems, you can develop long-term solutions to keep your plants healthy with fewer pesticides. Pesticides often are used as a quick and temporary solution to address a more serious underlying problem that must be corrected. As an example, some farmers see weeds in the farm and rush to apply herbicides. There are many herbicides available to help control weeds temporarily, and they may be beneficial if they are properly applied and used at the correct time. However, weeds are usually indicators of soil compaction problems that must be alleviated for long-term control.

124. Use tillage practices that aerate and loosen the soils, allowing crops to thrive in place of weeds. Add fertilizers, lime and gypsum, based on soil tests, to provide critical nutrients and adjust pH for proper plant growth. The best time to irrigate a crop field is very early in the morning or after 16:00 to prevent extended leaf wetness, which increases the potential for disease. Deep and infrequent irrigation is best. For flowers and vegetables, water plants at the base and avoid wetting leaves.

125. Insect problems also can be reduced with proper plant selection and care. For instance, select crops that are pest tolerant or resistant. Selection of the latest varieties of crops tested and released by the Kenya Plant Health Inspection Service and suitable for the agro ecological zone will minimize the need for pesticides.

126. There are many new biological alternatives (beneficial insects, fungi, bacterium,

etc.) for insect pests that can be used in an IPM program such as nematodes (steinernema species), ladybird beetles, bacteria (bacillus species) and fungus (Beauvariabassiana).

6.4.8 Choosing controls

127. There is no such thing as a completely safe and natural pesticide. Pesticides can vary greatly in their level of toxicity to non-target organisms such as people, pets or beneficial insects. Even organically approved pesticides can pose a danger to people and the environment if they are not used properly.

128. Take care with all pest-control products and use them as directed. Products will list the specific pest or pests they control and the plants onto which they can be applied. They must be used at the proper concentration in order to be effective without posing additional risks to the applicator or the environment. It is illegal to misuse them.

129. Pesticides are grouped into various types or categories. For example, there are fungicides, insecticides, herbicides (for weeds), nematicides (for nematodes) and miticides (for mites). While many pesticides control specific problems, there are still some broad spectrum controls. In addition, there are many products that are only effective if they are used at a specific growth stage of the pest, so timing is critical.

130. It is never wise to use blanket applications of pesticides on large areas or to use them based on a calendar alone. The improper use of pesticides can pose a risk to the applicator, family, plants, beneficial organisms and the environment. There are times when pesticides are needed to prevent major losses of plant material. The judicious and proper use of pesticides can occur with a sound IPM program.

Application of non-chemical means of pest control:

131. Some of the main features of IPM involve the non-chemical methods of pest control:

a) Biological controls: the use of natural enemies of crop pests, often called beneficials, which include parasites, predators and insect pathogens. Environmental friendly chemical interventions sometimes are included in the biological controls, such as the use of semi-chemicals, including pheromones and feeding attractants, and bio-pesticides, for example specific and beneficial

friendly insecticides.

b) Cultural and crop or livestock management controls: tissue culture, disease-free seed, trap crops, cross protection, cultivation, refuge management, mulching, field sanitation, crop rotations, grazing rotations, steam cleaning, trapping, freezing and intercropping.

c) Strategic controls: planting location, timing of planting and harvesting.

d) Genetically based controls: insect and disease resistant varieties/breeds and rootstock.

6.5 Implementation

132. This will utilise such tools as the general micro-projects screening checklist as per ESMF which is followed by a more detailed investigation undertaken as guided by specific IPM questions using Appendix 1: Questionnaire on Pest Management

6.5.1 Step One: Understand IPM and its advantages over other pest control methodologies

133. To understand IPM and its advantages, you have to recognize some of the fundamental ways it differs from more traditional pest control programs: IPM addresses more than just the symptoms of a pest problem. Non-integrated pest control programs tend to focus on killing pests while ignoring the reasons why pests are there in the first place, which doesn't do much to prevent recurring problems. By removing or altering the conditions that attract or are conducive to pest infestations, IPM practitioners can better cure existing infestations and prevent future ones.

Scheduled chemical treatments are not IPM

134. Many pest control plans call for routine pesticide applications whether pests are present or not. These applications are seen as "protective barriers" that will prevent infestations. They are not. In fact, unnecessary applications may even lead to the development of pesticide resistance in target pest populations and increase problem infestations instead of reducing them. And an application of a pesticide on a regular schedule is not IPM. IPM instead relies on routine inspection and monitoring for pest presence. Pesticides are considered only when there is clear evidence of pest presence (e.g., pest sightings, droppings or pest catches in monitoring traps, and when non-chemical approaches such as vacuuming, trapping and exclusion (i.e., physically blocking

pests' entrance) have been unsuccessful or are inappropriate.

IPM techniques are less toxic, more targeted

135. Some pest controllers will apply pesticide to exposed areas far from where it is really needed and use more of it than necessary. IPM practitioners apply pesticides with precision and choose the least-toxic formulation to get the job done.

IPM is not a one-person job

136. Long-term pest management solutions typically depend on daily pest monitoring and a variety of sanitation, breeding, tillage, management and appropriate agronomic practices. No one person can do it alone. Without cooperation from land owners, land occupiers management and staff, the IPM model falls apart and chemical treatments will be difficult to avoid. IPM requires greater expertise than traditional programs

137.. Managing pests with less pesticide requires a strong working knowledge of pest biology and behavior, current pest control technologies and practices, climate and its effects on pest proliferation, greenhouse and storage structural characteristics and staff behavior. Without this knowledge, it will be difficult, if not impossible, to prevent infestations without routine chemical applications.

IPM ineffective

138. Simply put, IPM is more effective in controlling pests over long periods than unitary use of the conventional chemicals which do imbalance the ecosystems. This is not surprising, since IPM combines many control techniques instead of relying on any one technique. IPM's efficacy advantage has been confirmed by research and in practice. IPM approach is recommended by pesticide management stakeholders.

IPM costs less long-term

139. It is a common misconception that IPM programs are more expensive than traditional programs, partly because it can cost more up front to implement an IPM strategy. But IPM is analogous to preventive health maintenance. In the long term, it's almost certainly more cost-effective in terms of time, personnel and materials to prevent problems than to remediate the same symptoms again and again.

IPM poses less risk

140. Farm workers may have compromised immune, neurological, and digestive and respiratory systems that put them at increased risk of suffering harmful effects from exposure to pesticides. Chemically sensitive individuals, pregnant women, infants, children and the elderly may be especially vulnerable to the effects of pesticides. By reducing pesticide use, IPM helps reduce the potential for negative impacts on human health and the environment.

6.5.2 Step Two: Identify the implementation team

141. As with any successful initiative, the transition to an IPM program requires a diverse, action-oriented team. The leader of this team should be familiar with pests, pesticides, pesticide regulations

142. Pest management principles and environmental issues have a direct link to supporting leadership and have the time and authority to supervise IPM implementation. Other team members could include environmentalists, agronomists, crop protection experts (entomologists, pathologists) animal production experts, animal health experts, veterinarians, maintenance staff, public health experts, food services, industrial hygiene, environmental services, safety and infection control.

143.. If you do not have IPM expertise in-house and plan to contract out IPM services, you may wish to identify your prospective vendor and make use of their information and support as you develop implementation plans.

6.5.3 Step Three: Decide on scale of implementation

144. To determine the scale and strategic approach you need to take, first discuss what IPM is— and what it isn't—with key staff and committees. If you are outsourcing and have identified a prospective IPM vendor, ask a representative to accompany you to committee meetings to help explain the IPM approach and give examples of documented success in facilities like yours. Through these discussions you can build understanding and address potential objections with solid information. Having well-positioned members of your designated IPM committee present before department heads, board of directors and other committees may create sufficient buy-in to allow you to make changes in your pest control methods across the board.

145. Feeling resistance? Try a pilot/ demonstration plot to accommodate concerns, work out the kinks and build support. Problems can more easily be seen as a learning process when you start small. When determining where to carry out your pilot, remember that IPM involves altering the environment to reduce pest entry points, and food and water sources, so it works best when it encompasses an isolated area. For example, choose a single building if possible, rather than one floor of a building, where pests can easily travel from another floor to continue to invest your pilot areas. Remember, IPM takes time to achieve positive results, and even successful programs may go through a period of static as you discover problem areas and adjust accordingly.

6.5.4 Step Four: Set goals and measurable objectives for your IPM program

146. Measurable goals to track could include pest management costs, monitoring of pest activity before and after implementation of an IPM program, number of calls related to pest problems and toxic chemical use reduction. When will your IPM program be up and running? Know how much will it cost? What is to be accomplished by choosing IPM?

When will the shift to IPM occur?

147. The first step is to develop an implementation timeline that includes time to execute all of the steps outlined in the implementation plan. Make sure to include time to obtain administration and staff buy-in, conduct any staff training and manage an RFP process if you expect to outsource to a pest management professional.

How much will it cost?

148. The budget for the program will be critical to administration. Be sure to design a budget that differentiates the costs of initial implementation from the costs of maintaining the program, which should be less than the implementation cost. Talk to industry colleagues whose facilities have implemented IPM programs. How long did it take them? Do they outsource, and if so, to whom? Are they satisfied with their service? What is their budget? What does it include? Be sure to analyze the marginal cost of your IPM program when compared to the costs of your current pest control effort. It may be less than you think.

How will you know if IPM is succeeding?

149. The advantages of IPM—efficacy, cost and safety—are laudable but probably won't

do you much good when it comes to asking for budget if you don't have a system in place to measure the program's achievements. Build measurable objectives for each of those goals into your program plan from the beginning.

150. Efficacy: Since IPM is better at controlling pests, you should see a measurable reduction in pest sightings, client complaints and monitoring station counts over time. But if you're planning to measure against these or similar metrics later, you'll need benchmark data on them now. Consider how you will obtain and compile that data before the switch to IPM. Once you've implemented your IPM program, you'll want to allow the program sufficient time—at least six months— to make a real difference before you measure. Remember, IPM's not an overnight event but a process.

151. Cost: Do you expect to see cost reductions overtime as IPM gains momentum? When? Set specific dollar-figure parameters for your IPM costs so you can measure against them later.

152. Safety: IPM's ability to create a safer environment is predicated in large part on reducing pesticide use. If you're already outsourcing to a professional, ask them if records are available as to the volume of pesticides applied in the facility for the previous year (or more if available). If you're just starting a contract with a professional for the IPM program, be sure the company can provide detailed information on how any decision to apply pesticides will be made, their advance notification procedures for pesticide application, and how they will supply you with pesticide usage records when pesticides are applied (see Step 10). In either case, the information will help you prepare for, benchmark and track pesticide usage. The goal should be a downward trend over time or ideally, a specific reduction amount, with the end result a reduction to only very occasional usage of highly toxic pest control chemicals.

6.5.5 Step Five: Analyse current housekeeping, maintenance and pest control practices

153. As you prepare to make the switch to IPM, it helps tremendously to have a clear idea of your facility's current policies and practices when it comes to structural maintenance, sanitation and pest control. In some cases, current practice may be in line with IPM principles. In others, you may have a long way to go. The more you know about what

your facility is doing now, the better you can prepare for the necessary changes. Here are a few considerations to keep in mind as you lay the groundwork.

Structural Maintenance

154. One of the best (and maybe most obvious) ways to keep pests out of a facility is to physically stop them from entering wherever possible. As part of your regular IPM inspections, you'll need to inspect cracks, crevices or other unnecessary openings in the building exterior that can be used by pests as harborage areas or entry points—no matter how small—and seal them as appropriate. Is your maintenance staff or pest management provider already doing this? If not, who will be responsible for this activity under the IPM program? Will training be required? What are the cost implications?

Sanitation

155. If pests can't find the food and water they need in your facility, they have much less reason to be there. That's why sanitation will always be one of the most powerful tools in the IPM arsenal. The cleaner the facility, the less need there will be for chemical pest control treatments. Does your facility already follow a written sanitation plan indicating cleaning schedules, procedures and responsible parties? If so, make sure the routine sanitation inspections focus on areas of high pest pressure (e.g., receiving docks, food service areas, admissions areas, break rooms or bio-hazard rooms). You may need to work with the appropriate parties to implement a sanitation plan that pays special attention to these sensitive areas. Also consider how daily staff sanitation practices play into the overall cleanliness of the facility.

156. When it comes to pest control, a sanitation plan is only as strong as its dirtiest station. Be prepared for staff pushback and the chance that staff may need some special training (see Step9)

6.5.6 Step Six: Establish a system of regular IPM inspections

157. Whereas many pest control programs still revolve around regularly scheduled pesticide applications, IPM revolves around regular facility inspections. These inspections are the "engine" for an ongoing cycle of IPM activities that may or may not include chemical treatments. These activities include:

a. Inspections
b. Pest Identification
c. Selection of Control Methods
d. Monitoring
e. Evaluation

158. IPM inspections must focus on the five “zones” or “triggers” of pest activity: entry points, water sources, food sources and harborage areas. During inspections, all existing pest issues and potential problem areas, inside and out, must be noted for follow-up (see Step 7). If your facility chooses to outsource IPM services, it will be the provider’s job to perform a thorough inspection during each scheduled visit and determine appropriate treatment methods. For in-house IPM programs, the greatest inspection challenge will be establishing routine, proactive surveillance by trained specialists (see Step9).

6.5.7 Step Seven: Define policy treatment selection

159. Even in the cleanest facility, pests will appear from time to time, so you need a clear, written policy on how your facility will respond when they do:

a) The policy should define non-chemical and chemical treatment options and the order in which they should be considered. It should be very clear on when and where chemical treatments are appropriate. Finally, it should include an “approved materials” list to ensure smart choices when chemical treatments are applied.
b) Keep in mind as you develop your policy that the first step in any IPM response is to correctly identify the pest that has invaded. Because pest behavior varies so much from one species to the next, the appropriate response will vary just as widely.
c) Once the pest is identified and the source of activity is pinpointed, the treatment policy should call for habitat modifications such as exclusion, repair or better sanitation. These countermeasures can greatly reduce pest presence before chemical responses are considered.
d) Additional treatment options—chemical and nonchemical—can then be tailored to the biology and behaviour of the target pest.
e) The final step in the response cycle is Monitoring. The information you gain through continuous monitoring of the problem will help determine additional treatment options if they are needed.
f) If you outsource to a pest management professional, work with the provider to

agree on a policy and a written approved materials list. But don't forget that the policy applies to facility staff as well as the provider.

6.5.8 Step Eight: Establish communication protocols for environmental services, facility maintenance, facility management and service provider

160. Because IPM is a cooperative effort, effective communication between various parties is a prerequisite for success. Clients and employees must document pest sightings, the pest management professional must make recommendations and notify appropriate parties of chemical treatments, environmental services must communicate with maintenance to make necessary repairs, and so forth. Consider the "bird's eye view" of an effective IPM communication flow above.

6.5.9 Step Nine: Develop worker training plans and policies

161. As mentioned in Step 6, the greatest challenge for in-house IPM programs will be establishing routine, proactive surveillance by trained specialists. Whether you outsource or not, remember that your employees can serve as a vast pool of "inspectors" charged with reporting pest sightings, which will quicken response times and help limit the scope of new infestations. Host training sessions to acquaint employees with IPM principles and the role they will play in a successful IPM program. Some pest management providers will offer IPM training for your staff. Take advantage of it. A little on-the-ground help from employees will go a long way toward achieving your IPM goals.

6.5.10 Step Ten: Track progress and reward success

162. Remember the measurable objectives you set and data you gathered in Step 4? Your goals will not mean much if you do not measure the IPM program's performance against them at least once a year. Detailed service records will be critical to these evaluations, so make sure your pest management professional or in-house program provides the following documentation:

a) Detailed description of the parameters and service protocols of the IPM program (i.e., what are the ground rules?) Specific locations where pest management work was performed
b) Dates of service
c) Activity descriptions, e.g., baiting, crack-and crevice treatment, trapping, structural repair. Log of any pesticide applications, including:

i. Target pest(s)
ii. The brand names and active ingredients of any pesticides applied
iii. Registration numbers of pesticides applied
iv. Percentages of mix used in dilution
v. Volume of pesticides used expressed in pounds of active ingredient
vi. Applicator's name(s) and certification identity (copy of original certification and recertification should be maintained.)
vii. Facility floor plan on which all pest control devices are mapped and numbered
viii. Pest tracking logs (sightings and trap counts)
ix. Action plans, including structural and sanitation plans, to correct any pest problems
x. Pest sighting memos for staff to use in reporting pest presence to the pest management provider

163. Using these records, and assuming the goals of your IPM program are increased efficacy, lower costs and reduced pesticide use (see Step 4), you should see:

- Fewer pest sightings and client complaints. Lower monitoring-station counts overtime.
- Lower costs after the first 12-18 months, once IPM's efficacy advantage has had time to take effect.
- Downward trend in volume or frequency of pesticide usage.

164. Report the program's successes following each evaluation and encourage good practices by recognizing individuals who played a role. Remember, IPM is a team effort. Communicating the success of your program in reducing toxic chemical use and exposure, reducing pest complaints and lowering costs will help facility staff understand the purpose of the program and appreciate its success. The more they understand, the more likely they will participate willingly in helping you expand and institutionalize IPM in your facility.

165. When the program has been in place for long enough to show significant results, one can work with his/her own community affairs' department to publicize the successes more broadly and to demonstrate environmentally responsible approach to effective pest control. Last but not least, one should lead by example by sharing one's success with other stakeholders.

7.0 MONITORING AND EVALUATION SYSTEMS FOR THE VARIOUS PEST MANAGEMENT PRACTICES OF THEPMP

166. Successful implementation of the NARIGP in the Counties will require regular monitoring and evaluation of activities undertaken by the CIGs. The focus of monitoring and evaluation will be to assess the build-up of IPM capacity in the Farmer Groups and the extent to which IPM techniques are being adopted in agricultural production, and the economic benefits that farmers derive by adopting IPM. It is also crucial to evaluate the prevailing trends in the benefits of reducing pesticide distribution, application and misuse.

167. Indicators that require regular monitoring and evaluation during the programme implementation include the following:

(a) The IPM capacity building in membership of Farmer Groups: Number of farmers who have successfully received IPM training in IPM methods; evaluation the training content, methodology and trainee response to training through feedback Numbers of Farmer Organizations that nominated members for IPM training; emphasize the number of women trained; assess Farmer Groups understanding of the importance of IPM for sustainable crop production

(b) Numbers of farmers who have adopted IPM practices as crop protection strategy in their crop production efforts; evaluate the rate of IPM adoption

(c) In how many crop production systems is applied IPM? Are the numbers increased and at what rate?

(d) How has the adoption of IPM improved the production derive by adopting IPM Economic benefits: increased in crop productivity due to adoption of IPM practices; increase in farm revenue resulting from adoption of IPM practices, compared with farmer conventional practices;

(e) Social benefits: improvement in the health status of farmers

(f) Numbers of IPM networks operational and types of activities undertaken

(g) Extent to which pesticides are used for crop production

(h) Efficiency of pesticide use and handling and reduction in pesticide poisoning and environmental contamination

(i) Levels of reduction of pesticide use and handling and reduction in pesticide poisoning and environmental contamination

(j) Number of IPM participatory research project completed

(k) Influence of the results of IPM participatory research on implementation of IPM and crop production

(l) Overall assessment of: activities that are going according to plans; activities that need improvements; and remedial actions required

168 The following indicators will be incorporated into a participatory monitoring and evaluation plan:

(a) Types and number of participatory learning methods (PLM) delivered; category and number of extension agents and farmers trained and reached with each PLM; practical skills/techniques most frequently demanded by counties and farmers, and food, cash and horticultural crops and livestock management practices preferred by farmers.

(b) Category and number of farmers who correctly apply the skills they had learnt; new management practices adopted by most farmers; types of farmer-innovations implemented; level of pest damage and losses; rate of adoption of IPM practices; impact of the adoption of IPM on production performance of farmers

(c) Increase in food, cash and horticultural production systems/livestock production; increase in farm revenue; social benefits: e.g. improvement in the health status of farmers, reduction in pesticide package and use; and number of community families using preventive mechanisms against diseases.

7.1 Proposed Pests Monitoring and Evaluation Régime

169. The participatory M&E system for IPM should also be enterprise-based so as to deal with a group of diseases and pests affecting any single crop. The approaches being proposed here therefore does not handle single pest to otherwise the issue of different agronomic practices for different crops would have to be taken into consideration.

170. Similarly, the animal, forestry and aquaculture pests are treated in a similar way. This approach seems to be the most cost effective in terms of mobilizing stakeholders with common interest (e.g. sugar cane farmers, tea farmers, banana farmers, aquaculture farmers, livestock farmers, etc.) as well as area of coverage and intensity of the pest problems.

171. Since pest problem is an existing problem and a major constraint to several enterprises in Kenya, it is obvious that there are already existing pest management programmes within the country. In view of these efforts, it will be advisable to use the Participatory Impact Monitoring (PIM) approach.

172. The steps involved in participatory M&E should include:

(a) Stakeholder Analysis and identification of M&E team
(b) Setting up objectives and expectations for monitoring
(c) Selection of Impacts to be monitored (Variables/Indicators)
(d) Develop Indicator sheets
(e) Develop and test the tools to be used in data collection (Usually Participatory Rural Appraisal tools are used)
(f) Collect the data from as many sources of stakeholders as possible
(g) Assessment of the data and discussion for a arranged on regular basis

7.2 Participatory Impact Monitoring (PIM)

173. Participatory Impact Monitoring (PIM) should be employed for continuous observation, systematic documentation and critical reflection of impacts of IPM, followed by corrective action (plan adjustments, strategy changes). It should be done by project staff and target groups, using self-generated survey results. The stakeholder analysis and selection of participatory M&E team is therefore very important in implementing an effective impact monitoring (See guide on 4-Step Stakeholder Analysis Templates).

174. Once an agreement on the objectives of PIM is reached among the stakeholders (development partners, implementing agency, target groups etc), their expectations and fears regarding project impact are identified, e.g. in brainstorming sessions. The more participatory the activities have been planned the more these views will overlap each other.

175. Having examined already existing M&E data regarding the selected impacts, the task is to develop indicator sheets (Shown below) which contain all important information for impact measurement: definitions of terms, indicators and their rationale, survey units and respondents, instructions for data collection, statements on limitations of the methods used.

176. Users and the key questions for which the indicator is intended (if appropriate comment on area affected, villages affected, seriousness scale, impacts on humans, environment etc., recognizing that one indicator may fill several roles in this respect).

Indicator Fact Sheets Sample

- Suggested Contents/Format Indicator Name:
- Use and interpretation:
- Meaning and potential causes of upward or downward trends Implications for of the indicator to IPM
- Units in which it is expressed (e.g. km2, number of individuals, % change)
- Description of source data: (origins, dates, units, sample size and extent)
- Calculation procedure (including appropriate methods and constraints for aggregation):
- Most effective forms of presentation (graph types, maps, narratives, etc. – give examples where possible):
- Limits to usefulness and accuracy: (e.g. rates of change – increase/decrease, poor quality data, limited scope for updating etc.)

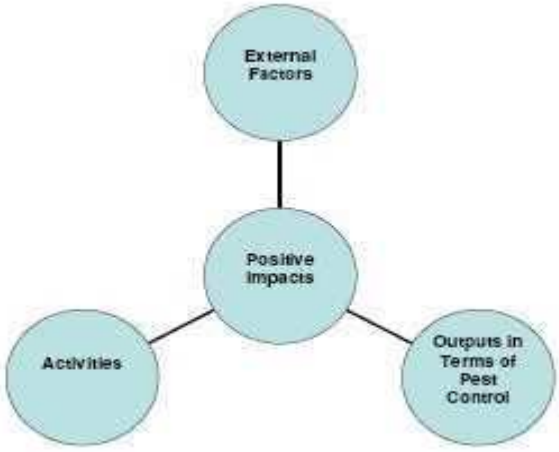
177. **Data sources and process for updating:**

- Sources could include key informants, opinion leaders, NGOs, GoK Departments, Development Agencies etc. There could be several sources of similar datasets or information
- Closely related indicators:
- Other existing or monitored indicators that give similar information for monitoring the same change or impact
- Source: (i.e. who calculated the indicator (author etc.), with contact information or references.

178. The factsheet assumes that political, legal, agro-ecological and other framework conditions are almost the same for a single enterprise; any observed differences regarding selected impacts will be largely due to the (additional) input towards IPM.

179. After the selection of impacts to be monitored, impact hypotheses are established in order to obtain a clearer picture of the IPM and the environment in which it acts. In impact diagrams, project activities / outputs that are supposed to lead to a certain impact can be arranged below, external factors above the impact in the centre of the diagram (Fig.2).

Figure 2: Participatory Impact Monitoring (PIM) approach to IPM



180. Once questionnaires and other tools (e.g. PRA instruments) have been pre- tested, and a decision on sample size and composition has been taken, impact- related information and data is collected and processed. Interviews are held with randomly selected individuals (e.g. female farmers), key persons (e.g. Village elders, teachers) or groups (e.g. Saving and Credit Groups, Development agencies, Institutions etc).

181. Joint reflection workshops with project staff, target group representatives and other stakeholders are conducted in order to (a) consolidate impact monitoring results by combining the views of various actors and (b) ensure that necessary plan adjustments and strategy changes are in line with the target groups' demands and capacities.

7.3 Integrated Pest Management Monitoring Framework

182. The Participatory M&E Framework for IPM should follow a feedback principle in which results or impact of any interventions can be traced to the activities/inputs. Either by using conventional pest management method or IPM, the feedback should allow for evaluation of the methods used and adjustment or incorporation of additional control methods (Fig. 3). The results of the activities form the basis of the factsheets to be used in monitoring.

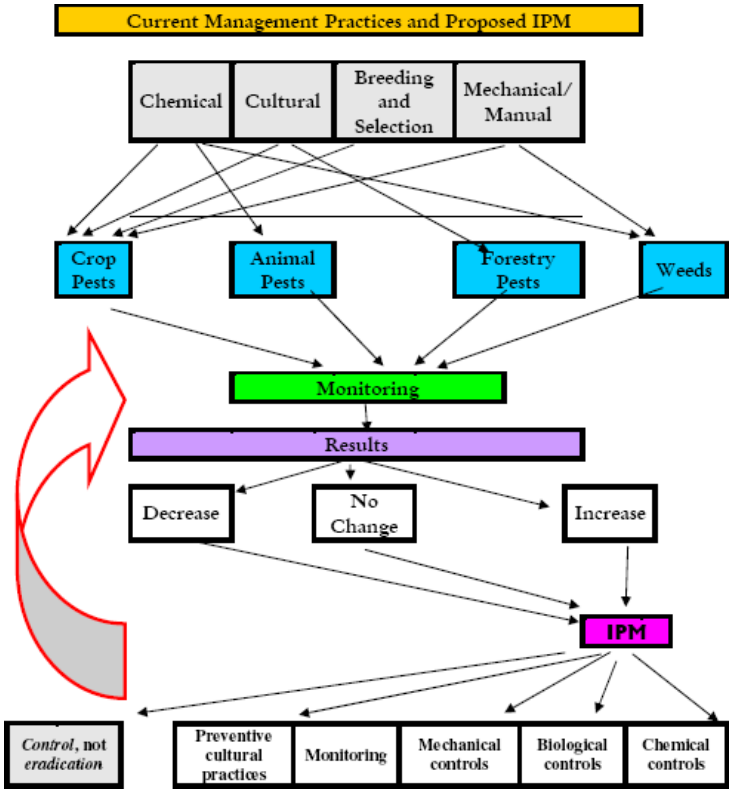


Figure 3: Monitoring framework for Integrated Pest Management based on previous practices and proposed approaches

8.0 POTENTIAL ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PEST MANAGEMENT ACTIVITIES WITHIN THE SUB- PROJECTS

8.1 Pest management in different farming systems in Kenya

183. Integrated Pest Management Plan (IPMP) ensures:

- Pest infestation does not result in economic loss to the farmers;
- Target pests do not develop resistance fast, or, the resistance development is delayed;
- There is protection of health of users and other humans,
- Environmental health,
- Non target organisms such as natural enemies and pollinators are not harmed;
- Crop and animal products meet food safety and food quality minimum standards and Social fabric of the community is protected.

184. Different productive sectors in Kenya that need PMP intervention include:

(i) Agro pastoral production systems

Agro pastoralists usually grow a wide range of crops; keep livestock and useful Insects such as bees and silkworm. Main crops include plantations, field and fruit crops and horticultural crops. Livestock include cattle, goats and sheep. In areas close to urban centers and in irrigated lands, crops consume most of the pesticides while livestock are the main consumers of pesticides in areas far from main markets.

(ii) Pastoral production systems

Livestock is the main source of income for the pastoralists in the arid and semi arid areas. These include cattle, camel, goats, and sheep. The animals are prone to arthropod pests and diseases, which require pesticide intervention as most months within the year in these areas are dry. Inadequate pasture in these areas coupled with pest infestation and disease infections can reduce animal productivity. Diseases vectored by some pests can also be devastating hence the need for pest management to ensure animals are free from these. Integrated pest management practices in such areas are important since synthetic pesticides used against ticks and tsetse flies may find their way into waterways resulting o pollution.

(iii) Rain fed Agriculture

In arid and semi arid crop production systems that rely mainly on the rainfall patterns, pest management has been mainly by cultural practices rather than use of pesticides. 166. 166. However, situational analysis could provide evidence of other pest control practices undertaken in these areas.

(iv) Irrigated Agriculture

Crop pest and disease pressure is high in irrigated agriculture, hence high demand on pesticide use and management. This type of production is a main consumer of synthetic pesticides particularly for commercial horticultural and food crop. Following the intensification of irrigated agriculture in arid and semi arid areas, there is need for introduction and diversification of crops with pest management strategies.

(v) Protected and forested areas

Most of these ecosystems are beneficial to the community by providing habitats for natural enemies of crop pests, pollinators and vertebrate animals that are key in the tourism sector and other useful products such as honey and medicinal plants. Though there is no/less pest management in protected areas, some pest management approaches on the neighbouring farmlands may affect the ecosystem. Thus, with intensification of agriculture, it will be good to consider these protected areas since pesticide use pose the main threat and source of pollution; hence IPM would be important and will contribute towards management of these areas.

(vi) Climate change

Since mitigation of negative effects of climate change pose changes on the farming systems in the country, pest problems and management strategies need a keen focus. In addition, current emphasis on increased acreage and crop diversity under irrigation by the government poses challenges on pest management hence the need for pest management plans in place. As farmers intensify agriculture especially in arid and semi arid areas, with high expectations to get high quality products, adoption of pest management strategies to ensure products that are free from pest or pest damage is paramount. Therefore, there is need to train farmers on integrated pest management options instead of relying on pesticides.

8.2 Food Crops

185. The major food crops shown in preceding tables are grown in the target project areas and include maize, rice, sorghum, millet, beans, cassava, sweet potato, banana, grain legumes (green gram, pigeon peas, cowpeas, soybeans, groundnuts) and wheat. The importance of each crop varies from one area to another and the priority list varies depending on the source of information. However, maize is the most popular staple of many Kenyans. This is followed by rice, sorghum, millet, bananas, beans, and cassava, sweet potato, wheat and grain legumes. Some of these crops such as rice, maize, beans, sorghum and millet are regarded as food and cash crops depending on area.

8.2.1 Maize

Table 8.1: Major maize pest problems and recommended management practices

Pest	Recommended management practices
Stalk borers (Busseola fusca)	Stalks are buried or burned to eliminate diapausing larvae, Early sowing reduces infestation, Intercropping with pulses (except rice), Neem (arobani) powder (4-5 gm i.e. pinch of 3 fingers) per funnel, Neem seed cake (4 gm/hole) during planting Carbofuran and carbaryl are effective insecticides, Use the extract of Neuratanenia mitis, a botanical pesticide
African armyworm (Spodoptera exempta)	Scout the crop immediately the forecast warns of expected outbreak in the area Apply recommended insecticide or botanical extract timely (Table
Seedling weevils (Tanymecus spp. & Mesokeuvus spp)	Timely planting to escape damage, Scout the crop, Apply lambda cyhalothrin if necessary (Table 4.3)
Larger grain borer (LGB) Weevils Moths Red flour beetle Dried bean beetles	Selection of tolerant varieties, Timely harvest, De-husking and Shelling, Proper drying, Sorting and cleaning of the produce, Cleaning & repair of the storage facilities, Use rodent guards in areas with rat problems, Use improved granaries, Use appropriate natural grain protectants e.g. where applicable or, Use recommended insecticides at recommended dosage (Table 4.3) and/or, Keep the grain in air tight containers and store these in a shady place, preferably in-doors, Carry out regular inspection of the store and produce. Timely detection of any damage to the grain and/or storage structure is essential to minimise potential loss or damage, Promote biological control of LGB using Teretriosoma nigrescens (Tn) to minimise infestation from wild sources. This is the task of the national plant protection services because the agents have to be reared and released in strategic sites. However, the farmers will benefit from this strategy.
Grey leaf spots (GLS)	Crop rotation, Plant recommended resistant varieties e.g. H6302, UH6010, TMV-2, Observe recommended time of planting, Removal of infected plant debris by deep ploughing
Maize streak virus	Early planting, Plant recommended resistant varieties e.g. TMV-1 in areas below 1500m above sea level, Kilima ST and Katumani ST and Staha

Northern leaf blight	Rotation, Deep plough of the crop residues, Plant recommended resistant varieties e.g. H6302, UH6010, TMV-2, H614
Maize streak virus (MSV) (Cicadulina mbila)	Observe recommended time of planting to avoid the diseases, Plant recommended tolerant varieties e. g. TMV-1, Kilima ST, Staha-ST, Kito-ST
Leaf rusts (Puccinia sorghi)	Timely planting, Crop rotation, Clean seeds, Reduce density, Allow adequate aeration
Leaf blights (Helminthosparium turcicum and maydis)	Crop rotation, Deep plough of crop residues
Common smut (Ustilago maydis)	Clean seeds, Crop rotation, Removal of plant debris by deep Ploughing
Weeds:Wild lettuce, Starber weeds, Simama (oxygonum sinuatum), Star grass, Wondering jew, Late weed, Digitaria spp.	Crop rotation, Proper land preparation, Timely weeding (at 2 and 5 weeks after planting), Use recommended herbicides when necessary, Hand pulling and hoe weeding, Intercropping, Use resistant/tolerant varieties Improvement of soil fertility, Tillage , Proper land preparation, Timely weeding (at 2 and 5-6 weeks after planting),
Witch weed (Striga spp)	Hand pulling at flowering to avoid seed formation, Use of false host plants e.g. rotation of maize with cotton or legumes, Application of high quantities of farm yard manure
Baboons, Monkeys, Wild pigs, Warthog, Birds, Rats, Hippopotamus	Farming in block, Cultivate crops that are not preferred by the prevalent vermin Hunting (farmer groups), Use of traps, Local scaring

8.2.2 Rice

Table 8.2: Major pests of rice and recommended management practices

Pest	Recommended management practices
Stem borers (Chilo partellus, C. orichalcociliellus,	Plant recommended early maturing varieties, Destruction of eggs in the seedbeds, Early planting, Proper fertilisation, Use recommended plant spacing, Observe simultaneous planting, Destruction of stubble after harvest, Clean weeding, Plough after harvest to expose the eggs to natural enemies
Stalk-eyed fly (Diopsis spp)	
African rice gall midge (Orseolia oryzivora)	
African armyworm (Spodoptera	Resistance varieties, Stalk management in dry season
Flea beetles (Chaetocnema varicornis)	Suspected to be the key vector of RYMV (Banwo, et al. in press; Kibanda, 2001). No known control measures.
Rice hispa (Dicladispasp)	
Cyperus rotandus, striga All types (see Table4.5)	Early clean weeding, Use recommended herbicides if necessary
Rice yellow mottle virus	Field sanitation including burring of crop residues and removal of volunteer plants, Use of resistant varieties
Rice blast (Pyricularia oryzae)	Destruction of crop residues, Clean seeds, Avoid use of excessive nitrogen fertilizers, Use of wide spacing to avoid overcrowding, Use resistance varieties, Appropriate crop rotation, Timely planting, Burying crop debris
Brown leaf spot (Helminthosporium spp)	Use of resistant varieties, Proper crop nutrition, Avoid water stress, Clean cultivation
Sheath rot (Acrocylindrium oryzae)	Use healthy seeds, Field sanitation, crop residue management, control of weeds,
Birds, Wild pigs, Hippopotamus, Rats	Scaring, Bush clearing, Early weeding, Early harvesting, Spraying against Quelea Queleas

8.2.3 Sorghum

Table 8.3: Sorghum major pests and recommended management practices

Pest	Recommended management practices
Shootfly (Atherigoma soccata)	Observe recommended time of planting to avoid the pest, Plant recommended varieties, Destroy infected crop residues by burying, Apply recommended insecticides if necessary e.g., endosulfan or fenitrothion
Stalk borers (Busseola fusca & Chilo partellus)	Stalks are buried or burned to eliminate diapausing larvae, Early sowing reduces infestation, Intercropping with pulses (except rice), Neem(arobani) powder (4-5 gm i.e. pinch of 3 fingers) per funnel, Neem ssed cake (4 gm/hole) during planting, Carbofuran and carbaryl are effective insecticides, Use the extract of Neuratanenia mitis, a botanical pesticide
African armyworm ((Spodoptera exempta) Cutworms (agrotis ipsilon)	Plough a month before sowing, Rapid seedling growth, Weeding early, Use of plant treated seeds, Treat the seed bed with wood ash, Scout the crop immediately the forecast warns of expected outbreak in the area, Apply recommended insecticide or botanical pesticide timely
LGB, weevils and moths	Use of botanicals, e.g. Neem or pili-pili, Bio-control (use of natural enemies)
Grain moulds	Plant recommended tolerant/resistant varieties, Observe recommended time of planting, Field sanitation, Practice good crop rotation
Grey leaf spot (Cercospora sorghi)	Observe recommended time of planting, Field sanitation, Practice good crop rotation, Use clean planting material
Anthracnose (Colletotrichum graminiocola)	Plant recommended tolerant varieties, Observe recommended time of planting, Field sanitation
Rust (Puccinia purpurea)	Use disease free seeds and follow recommended spacing, Plough in crops immediately after harvesting, Crop rotation, Observe recommended time of planting, Field sanitation
Leaf blight (Exserohilum turcicum)	Plant recommended tolerant varieties, Observe recommended, time of planting, Field sanitation
Ladder leaf spot (Cercospora fusimaculans)	Observe recommended time of planting, Field sanitation, Practice good crop rotation, Use clean planting material
Sooty stripe (Ramulispora sorghi)	Crop rotation, destruction of affected leaf debris, Use of resistant hybrids
Zonate leaf spot (Gleocercospora sorghi)	Crop rotation, Deep tillage
Witchweed (Striga asiatica)	As for maize
Quelea quelea spp Warthog Hippopotamus	Scaring, Bird trapping, Farmers to scout potential breeding sites and destroy nests, Monitoring and organised aerial spraying using fenthion 60%ULV at the rate of 2.0l/ha, Spot spraying, targeting roosting sites

8.2.4 Pearl millet

Table 8.4: Pearl millet major pests and recommended management practices

Pest	Recommended management practices
Shootfly (Atherigoma soccata)	Observe recommended time of planting to avoid the pest Plant recommended varieties, Destroy infected crop residues by burying, Apply recommended insecticides if necessary e.g. endosulfan or fenitrothion
Stalk borers (Busseola fusca & Chilo partellus)	Stalks are buried or burned to eliminate diapausing larvae Early sowing reduces infestation, Intercropping with pulses (except rice), Neem (arobani) powder (4-5 gm i.e. pinch of 3 fingers) per funnel Neem seed cake (4 gm/hole) during planting, Carbofuran and carbaryl are effective insecticides, Use the extract of Neuratanenia mitis, a botanical pesticide
African armyworm ((Spodoptera exempta) Cutworms (agrotis ipsilon)	Plough a month before sowing, Rapid seedling growth, Weeding early Use of plant treated seeds, Treat the seed bed with wood ash Scout the crop immediately the forecast warns of expected outbreak in the area, Apply recommended insecticide or botanical pesticide timely
Leaf spot	No recommendation
Rust (Puccinia penniseti)	Observe recommended time of planting Field sanitation
Smut (Moesziomyce bullatus)	Plant resistant varieties
Downy mildew (Sclerospora graminicola)	Early sowing Use of disease free seed Transplanting the crop suffers less from the disease
Witchweed (Striga spp)	Farm yard manure Weeding
Quelea quelea spp	Scaring, Bird trapping , Farmers to scout potential breeding sites and destroy nests, Monitoring and organised aerial spraying using fenthion 60%ULV at the rate of 2.0l/ha Spot spraying, targeting roosting sites

8.2.5 Bananas

186. Bananas are growing in association with various other crops, such as coffee, beans, maize, and fruit trees. Farmers apply no chemical control measures to protect the crop. The major disease to bananas is Panama wilt (Fusarium), while Black Sigatoka or Black leaf streak disease is of lesser importance. Both diseases are caused by fungi and can destroy all susceptible varieties within a large area. Panama disease are caused is soil borne and spreads through soil and infected planting materials. Black Sigatoka is soil borne and spreads by wind, water dripping or splashing, but also by infected planting materials. Farmers' control of both diseases is limited to removal of diseased plants, application of large quantities of farmyard manure and avoidance of planting susceptible varieties. Options for their control by IPM include field sanitation (such as rotation), use of clean suckers and planting of resistant varieties. Application of farmyard manure reduces the damaging effect of the two diseases.

187. Two important pests causing great loss of harvest are banana weevils and nematodes. The latter cause toppling of the plants because the rooting system is seriously weakened. Weevils cause snapping at ground level of the bananas. Both pests may be present in planting materials and hence infect new fields. The extent of damage by weevils and nematodes is further enhanced by poor soil fertility management. Weevils can be trapped and removed by using split pseudo stems and corns, but application of botanicals, such as Tephrosia, tobacco and Mexican marigold can also be tried.

Table 8.5: Banana major pests and recommended management practices:

Pest	**Recommended management practices**
Banana weevil (Cosmopolites sordidus) (Temnoschoita delumbrata)	Practice crop rotation Intercropping with legume which reduce weevil movement Sanitation/crop hygiene, Use healthy planting material (use a combination of corm paring and hot water (at 550C for 20 minutes or solarisation) treatment, Sequential planting to avoid nematode infested areas Rational use of weevil trapping with using bate (split pseudostems or discs and corns), Use of repellent botanicals, such as Tephrosia, tobacco, Mexican marigold, Neem and Iboza multiflora, Improved soil fertility management and crop husbandry, Mulching, Deep planting to discourage egg-laying Application of high quantities of manure to improve soil fertility Harvest hygiene
Ants	Trapping
Panama disease or Fusarium wilt (Fusarium oxysporum f.sp. cubense) Kiswahili name: Mnyauko panama	Grow banana cultivars with resistance to pest and disease Fallow or rotation Sanitation/crop hygiene, Planting of clean suckers Establish new crop on disease free sites
Black and yellow sigatoka (Mycosphaerella fijiensis)	Resistant cultivars Uproot and burn the affected parts Use of large quantities of farmyard manure Plant and field sanitation, Use disease free seeds Prune, remove suckers and weed frequently
Burrowing nematodes, e.g. Pratylenchus goodeyi, Radophilus similis, Meloidogyne spp. and Helichotylenchus multicintus	Improved farm management, including sequential replanting and soil fertility Practice crop rotation Sanitation/crop hygiene Farmer training in disease identification and control measures Use healthy planting material Establish new crop on disease free sites Mulching to enhance beneficial soil organisms to suppress nematodes Treatment of infested suckers with hot water
Rodents	Trapping by using local methods Cleanliness of the farm

8.2.6 Cassava

Table 8.6: Cassava major pests and recommended management practices:

Pest	Recommended management practices
Cassava mealybugs (Phenococcus manihot)	Improve the soil fertility by manuring, mulching and intercropping Practice crop rotation, Use clean planting material Resistant varieties, Plant health stem cuttings
Cassava green mites (Mononychellus tanajaa)	Improve the soil fertility by manuring, mulching and intercropping, Practice crop rotation, Use clean planting material, Resistant varieties, Plant health stem cuttings
Cassava root scale (Stictococus	Plant health stem cuttings, Plant as the beginning of the wet season
Cassave white scale (Aonidomytilus	Plant health stem cuttings, Plant as the beginning of the wet season
Variegated grasshopper (Zonocerus variegates)	Destructing the breeding sites Dig egg-laying sites of variegates grasshopper in the wet season to expose and destroy egg pod of the pest Biological control: use fungal pathogens, e.g. Metarlizium spp
Spiraling whitefly (Aleurodicus dispersus)	Crop rotation Plant health stem cuttings Plant as the beginning of the wet season
White fly (Bemisia tabaci)	Eliminate the sources of the virus Plant health stem cuttings Plant as the beginning of the wet season
LGB, Weevils and Red flour beetle	Use of botanicals, e.g. Neem or pili-pili Bio-control (use of natural enemies)
Cassava mosaic disease (CMD)	Improve the soil by manuring, mulching and intercrops Plant health stem cuttings After harvesting destroy infected cassava stems Use resistance varieties that tolerate CMD Manipulate sowing date and planting spacing to reduce incidence of the disease
Cassava bacterial blight (Xanthomorias ampestris)	Plant cuttings from health plants without leaf chlorosis After harvesting destroy discarded infected cassava stems Cleansing of farmers tools Crop rotation Avoid growing cassava consecutively on the same field Check field regularly Fallow practice
Cassava Anthracnose (Colletotrichum graminiocola)	Plant cuttings from health plants without leaf chlorosis After harvesting destroy discarded infected cassava stems, Cleansing of farmers tools, Crop rotation, Avoid growing cassava consecutively on the same field Check field regularly
Cassava brown streak disease	Plant cuttings from health plants without leaf chlorosis After harvesting destroy discarded infected cassava stems, Cleansing of farmers tools, Crop rotation Harvest early Grow resistance varieties.
Cassava root rot disease (Phytophtora, Pithium and Fusarium spp)	Harvest early Plant cuttings from health plants without leaf chlorosis After harvesting destroy discarded infected cassava stems Cleansing of farmers tools

Acanthospermum spp	Cultural methods
Baboons, Monkeys and rats (Lake Zone)	Hunting farmer groups Use of traps

8.2.7 Common Beans (Phaseolus)

Table 8.7: The major pest problems of beans and recommended management practices

Pest	Recommended management practices
Bean stem maggot (Ophiomyia spp)	Observe recommended time of planting, Apply mulch Apply manure/fertilizers, Practice hilling/earthing up when weeding, Using of resistant varieties such as G11746 and G22501
Bean aphids (Aphis fabae)	Promote build-up of indigenous natural enemies, Observe recommended time of planting, Apply wood ash in case of a heavy attack, Carry our regular crop inspection to detect early attacks, Apply recommended insecticide when necessary
Bean leaf beetle (Ootheca benningseni)	Practice good crop rotation, Observe recommended time of planting
Bean bruchids (Acanthoscelides obtectus)	Early harvesting and good drying of the beans, Ensure the beans are dry and well cleaned before storage, Apply recommended storage insecticide/ botanical extracts, Storage in airtight containers, Vegetable oil seed coating
Angular leaf spot (Phaeoisariopsis griseola)	Practice good crop rotation, Use of healthy and clean seeds Use certified seeds, Post-harvest tillage, Removal of crop Plant tolerant/resistant varieties
Anthracnose (Colletotrichum lindemuthiamum)	Use of resistance varieties, Use of healthy seeds, Crop rotation Seed dressing, Post-harvest tillage, Field sanitation, Plant tolerant/resistant varieties
Bean stem maggot (Ophiomyia spp)	Seed dressing, Apply recommended insecticide or botanical extracts within five days after emergence, Plant tolerant/resistant varieties if available, Improvement of soil fertility through application of manure and/or fertilisers
Bean aphids (Aphis fabae)	Practice early planting, Apply recommended insecticides or botanical extracts if necessary
Bean leaf beetle (Ootheca benningseni)	Observe recommended time of planting, Practice good crop rotation, Post-harvest ploughing where possible, Apply recommended insecticides
Bean pod borer (Helicoverpa armigera)	Apply recommended insecticides or botanical extracts
Bean bruchids (Acanthoscelides obtectus)	Ensure the beans are dry and well cleaned before storage Apply recommended storage insecticide/ botanical extracts
Bean anthracnose	Practice good crop rotation, Sanitation and crop hygiene, Use certified seed, Observe recommended time of planting, Plant tolerant/resistant varieties

Rust (Uromyces appendiculatus)	Avoid planting beans in high altitude areas, Practice good crop rotation, Sanitation and crop hygiene, Plant tolerant/resistant varieties, Observe recommended time of planting, Spray with recommended fungicide when necessary
Haloblight (Pseudomonas sp)	Plant tolerant/resistant varieties, Spray with recommended fungicide when necessary, Use certified seed
Ascochyta (Phoma sp)	Avoid planting beans in high altitude areas, Spray with recommended fungicide when necessary, Plant tolerant/resistant varieties, Sanitation and crop hygiene
Bean common mosaic virus (BCMV)	Plant tolerant/resistant varieties if available Effect good control of aphids
Bean aphids (Aphis fabae)	Practice early planting, Apply recommended insecticides or botanical extracts if necessary
Cutworms (Agrotis spp)	Early ploughing, Application of wood ash around plants Application of botanical pesticides such as Neem
Bean bruchids (Acanthoscelides obtectus)	Early harvesting and good drying of the beans, Ensure the beans are dry and well cleaned before storage, Apply recommended storage insecticide/ botanical extracts, Storage in airtight containers, Vegetable oil seed coating
Angular leaf spot (Phaeisariopsis griseloa)	Use of clean seed, Burial of infected debris, Crop rotation Use of cultivar mixtures, Intercropping with cereals Use of tolerant cultivars
Common and fuscous bacterial blight (Xanthomona phaseli)	Use resistance or tolerant varieties Use pathogen free, high quality seed, Field sanitation including burning of crop residues, Rotation sequence with cereals
Star grass, Nut grass, Couch grass, Wondering Jew, Bristly strubur	Cultural control

8.2.8 Sweet Potatoes

188. The crop suffers from two major pests, which reduce significantly its yield: mole rats and weevils that may provoke other pathogens to enter and cause rotting. Factors that contribute to the presence of these pests include mono-cropping, use of infested planting materials (weevils), drought and late harvesting.

Table 8.8: The major pests of sweet potato and recommended management practices:

Pest	Recommended management practices
Sweet potato weevil (Cylas brnneus)	Sanitation, Use of clean materials, Crop rotation, Plant varieties that form tubers at a greater depth, Early harvesting of tubers; as soon as weevil damage is observed on tuber tips, harvesting should begin, Keeping distance (at least 500m) between successive sweet potatoes plots, Destroy infected crop residues by burying, Planting of repellent species, such as Tephrosia, tobacco and Mexican, Hilling up twice (at 4th and 8th week after planting) in the season to cover soil cracks and exposed to minimize eggs laying, Traps with pheromones
Rough sweet potato weevil (Blosyrus sp)	Crop rotation, Sanitation, Planting of repellent species Botanical pesticide
Striped sweet potato weevil (Alcidodes dentipes)	Sanitation, Use of clean materials, Crop rotation, Plant varieties that form tubers at a greater depth, Early harvesting of tubers; as soon as weevil damage is observed on tuber tips, harvesting should begin
Sweet potato feathery	Use of resistant varieties, Crop rotation, Sanitation
Sweet potato sunken vein virus (SPSVV)	Avoid disease plants as a source of planting materials, Use of resistant varieties
Sweet potato virus Disease (SPVD)	Sanitation, Use of resistant varieties, Crop rotation
Mole rats (Tachyoryctes splendens)	Planting of repellent species, such as Tephrosia, tobacco, onion, garlic and Mexican marigold in the field and its boundaries, Insert pars of repellent plant species into tunnels
Monkeys, wild pigs	Local scaring

8.2.9 Coffee

189. Coffee insects and other coffee pests are some of the major factors that undermine coffee productivity by direct reduction of crop yield and quality to coffee growers. There are about 850 species of insect pest known. Coffee is much affected by pests, of which the most important species Antesia bug and white stem borer. Of less importance are leaf miner, coffee berry moth, scale insects, mealy bugs, coffee berry borer and rood-knot nematodes.

Table 8.9: Coffee pest problems and recommended management practices:

Pest	Recommended management practices
Stem borers (Anthores spp)	Sanitation and crop hygiene, Stem cleaning, Uproot and bury badly damaged trees, Scouting for attacked trees, Pick and destroy the adults (from October/November especially December, Mechanical removal of larva by using hooks, Apply cooking oil or fat around boreholes to attract predatory ants, Insert cotton wool soaked with kerosene, Paint the stem and branches with a paste out substance like lime, Spray botanicals like Neem, Tephrosia, Euphorbia, Apply recommended insecticides if necessary
Antestia bugs (Antestiopsis spp)	Use of botanicals, Conservation of indigenous natural enemies, Shade management by reducing size, Pruning and de-suckering, Scouting, Use of botanical pesticides, e.g. Tephrosia and Neem, Preserve natural enemies (parasitic wasps, Tachind flies)
Leaf miners (Leucoptera spp)	Conservation of indigenous natural enemies, Sanitation and crop hygiene, Use of botanicals, Shade management Mulching, Pruning, Crop scouting, Spray with recommended insecticides if necessary
Coffee berry borer (CBB) (Hypothenemus hampei)	Scouting, Conservation of indigenous natural enemies, Sanitation and crop hygiene, Shade management, Mulching Pruning, Use of botanicals, Burry infected berries as larvae can develop in fallen fruits, Regular harvesting, Mbuni stripping
Mealy bugs (Planococcus kenyae)	Use of tolerant or resistant varieties, Proper pruning of coffee trees, Use of botanicals and other alternative agents
Green scale insects (Coccus viridis)	Application of botanicals, such as pili-pili, Neem and Tephrosia, Curative spraying of solutions of ash, oil, soap, kerosene or clay
Coffee berry disease (Colletotrichum coffeanum)	Sanitation and crop hygiene, Shade management, Mulching Pruning, Proper plant nutrition, Stem cleaning, Spray with recommended fungicide
Coffee leaf rust (Hemileia vastatrix)	Use of botanicals, Resistant varieties, Removal of old unproductive trees, After harvest stripping berries, Simulate uniform flowering, Sanitation and crop hygiene, Shade management, Mulching, Pruning, Clean weeding, Spray with recommended fungicide
Coffee wilt caused by Fusarium spp	Uprooting and burning of affected trees, Planting of coffee in pathogens free fields, Selection of clean seedlings, Avoid transmission of the disease by soil, Improvement of crop tolerance by soil fertility management, e.g. by application of farmyard manure
All types of weeds	Clean weeding, Mulching, Use recommended herbicides
Pest	Recommended management practices
Root-knot nematodes (Meliodogyne spp.)	Grafting on resistant coffee varieties, Soil sterilization (by sun) in the nursery, Use of non-infested seedlings, Mulching (to preserve moisture), Fertilization
Antestia bugs (Antestiopsis spp.)	Pruning, Mbuni stripping, Apply recommended insecticides at recommended dosage if necessary
White stem borer and yellow headed stem borer	Sanitation and crop hygiene, Stem cleaning, Mechanical (hook the larvae out if possible)

8.2.10 Cotton

190. Similar to coffee, the cotton pest problems and the recommended management options vary depending on location. The recommended current cotton pest management strategies emphasize integration of several aspects of IPM. However not all farmers in all the cotton growing areas are aware and informed about the approaches.

Table 8.10: Cotton pest problems and recommended management practices:

Pest	**Recommended management practices**
Jassids (Empoasca sp)	Plant recommended UK varieties (resistant plant varieties), Spray in case of a severe attack at seedling stage
African bollworm (Helicoverpa armigera)	The host plants should be inspected regularly, Scouting, Encourage natural enemies, Use botanical pesticides like neem, Plant recommended varieties, Early planting Spray with recommended insecticides after scouting
Aphids (Aphis gossypii)	No spraying, Encourage buildup of natural enemies like birds, Populations often washed off by rain
Spiny bollworm (Earias insulana and E.biplaga)	The host plants should be inspected regularly, Scouting, Encourage natural enemies like birds, Use botanical pesticides like neem, Early planting
Lygus (Lygus vosseleri)	Spray with insecticides in case of an early season attack
Pest	Recommended management practices
Holopetlis bugs (Helopeltis anacardi)	Biological control using the African weaver ant (Oecophilla longinoda). (Maji Moto), Not intercropping pigeon pea with cashew, Apply recommended insecticide at recommended dosage in case of severe outbreaks
Cashew mealybugs (Pseudococcus longispinus)	Crop sanitation (removal & proper disposal of affected plant parts) Biological control
Thrips (Selenothrips rubrocinctus)	Control should mainly target larvae stage during early stages of flowering
Stem borers, Weevils, (Mecocorynus loripes)	Adults should be collected and destroyed by hand, Mechanical, using a recommended hooks, If the tree is severely attacked, cut and dispose properly
Powdery mildew (Oidium anacardii)	Prune to provide good ventilation and aeration within trees making microclimate not conducive to the pathogen multiplication, Scouting, For established plantations, practice selective thinning, Remove off-season young shoots which can be sources of fresh inoculum during the season, Sanitation, Thin densely populated trees and leave them well spaced, to reduce or delay mildew epidemic due to changes in microclimate in the field, Plant recommended tolerant clones and at recommended spacing, Apply recommended fungicides as appropriate
Anthracnose (Colletotrichum gloeosporioides)	Remove and burning of all infected organs before the start of the cashew season, Plant recommended tolerant clones and at recommended spacing, Apply at recommended pesticide at correct rate and time
Dieback (Phonopsis anacardii)	Remove and burning of all infected organs before the start of the cashew season, Apply at recommended pesticide at correct rate and time

Wilt syndrome Coreid bugs (Pseudotheraptus wayi)	Biological control using the African weaver ant (Oecophilla longinoda). T o enhance effectiveness of the bio-control agents, farmers are advised to do the following, Apply Hydramethyl to control Brown house ants (Pheidole megasephala) when necessary, Interplant coconut with recommended suitable host trees of weaver ants, Construct artificial aerial bridges to facilitate mobility of weaver ants between trees, Plant weaver ant nests in areas where they do not occur naturally, Apply recommended insecticide at recommended dosage in case of severe outbreaks
Cotton stainers (Dysdercus spp)	Observe the close season, Early and frequent picking avoid build-up of strainers, Sanitation in and around cotton ginneries and buying posts, Apply 1 to 2 sprays of recommended insecticides if necessary (inspect the crop before spraying)
Blue bugs (Calidea dregii)	Observe close season, Early and frequent picking avoid build-up of strainers, Sanitation in and around cotton ginneries and buying posts, Apply 1 to 2 sprays of recommended insecticides if necessary (inspect the crop before spraying)
Bacterial blight (Xanthomonas malvacearum)	Rotation , Plant recommended UK 82 varieties (resistant plant varieties), Observe the close season, Crop sanitation
Fusarium wilt (Fusarium oxysporum f.sp. vasinfectum)	Rotation, Crop sanitation, Plant recommended UK 77 or 91 varieties (resistant plant varieties)
Alternaria leafspot (Alternaria macrospora)	Rotation, Field sanitation
All types of weeds	Proper land preparation, Early clean weeding, Use recommended herbicides
Field rats, monkeys and baboons	Scaring, Trapping

8.2.11 Coconuts

Table 8.11: Coconut pest problems and recommended management practices:

Pest	**Recommended management practices**
Coreid bugs (Pseudotheraptus wayi)	Biological control using the African weaver ant (Oecophilla longinoda). To enhance the effectiveness of the weaver ants, farmers are advised to do the following, Apply Hydramethyl to control brown house ants (Pheidole megasephala) when necessary, Interplant coconut with recommended suitable host trees of weaver ants, Construct artificial aerial bridges to facilitate mobility of weaver ants between trees, Plant weaver ant nests in areas where they do not occur naturally
African rhinoceros beetle (Orytes monoceros)	Cultural removal of breeding sites of the pest, Mechanical, using recommended hooks
Coconut mites (Aceria guerreronis)	This is a new pest and therefore no control measures available
Coconut termites (Macrotermes spp.)	For species living above ground, the termitarium can be destroyed physically Apply recommended insecticides at the recommended dosage rates

8.2.12 Cashew-nuts

Table 8.12: Major pests and recommended control practices for cashew nut:

Pest	Recommended management practices
Phytoplasma	Plant recommended tolerant/resistant varieties. E.g. East African Tall sub populations, Proper destruction of diseased plants, Avoid movement of seedlings from infested to non-infested areas, Location specific replanting

8.2.13 Mangoes

Table 8.13: Key pests of mangoes and current farmer practices to reduce losses:

Pest	Farmer practices
Fruit flies (Ceratitis spp)	Harvest as much fruit as possible; sort out the edible fruit and bury all those that are infested, Apply chlorpyrifos when necessary, Use toxic bait sprays e.g. yeast products mixed with malathion or fenthion around the tree base, Removal of infested fruits and proper disposal (collect and bury at least 10 feet deep)
Mango weevils (Sternochetus mangifera)	Removal of infested fruits at least twice a week and proper disposal (collect and bury at least 10 feet deep), Selected less susceptible varieties , such as Ngowe, Boribo, Maintain field sanitation at the end of the season by clearing all seeds under the tree canopy
Mango mealybug	Spray contact/systemic insecticides, Control of attendant ants to reduce spread of the pest
Mango anthracnose (Colletratrichum gloesporiodes)	Apply available registered fungicides, Proper pruning to reduce excessive and minimise disease build-up, Use the recommended post-harvesting treatment
Powdery mildew (Oidium spp)	Apply recommended fungicides

8.2.14 Citrus

Table 8.14: Major pest problems of citrus and recommended management practices:

Pest	Recommended management practices
Scale insects	Normally ants protect aphids against natural enemies
Mealybugs (Planococus citri-	Trees with dead brown leaves should be uprooted and replaced
Aphids (Toxptera citricidus)	Normally ants protect aphids against natural enemies
False codling moth (Cryptophlebia	Field sanitation (collect all fallen fruits and bury them at least 50 cm deep), Remove wild castor ("Mbarika") around the orchard
Orange dog (Pappilio demodercus)	Regular scouting and hand picking of caterpillars, Apply contact insecticides in case of a severe attack
The wooly white fly (Aleurothrixus	Biological control using imported parasitic wasps, Management of attendant ants to reduce spread and facilitate the efficacy of natural bio-control agents
Black flies (Aleurocanthus sp)	Management of attendant ants to reduce spread and facilitate the efficacy of natural bio-control agents
Giant coreid bug (Anoplenemis curvipes)	New pest but farmers are encouraged to introduce and enhance the activity of weaver ants (refer to cashew & coconut approach)
Citrus leafminer	Crop sanitation and mulching, Apply recommended systemic insecticides when necessary
Greening disease (Liberobacter africana)	Propagation of disease free planting materials, Eliminate all infested trees, Strict quarantine measures, Natural enemies Hymenopterous chalcids such as Tetrastichus spp and Diaphorencytrus aligarhenses , Use clean planting material, Good plant nutrition
Gummosis (Phytophthora	Budded at least 20cm from ground should be chosen, Cut infected trees, Affected orchards should not be excessively irrigated
Tristeza (Virus localized in	Use disease free budwood
Green moulds (Pencillium italicum)	Handle fruit carefully to reduce skin injury, Treat brushes, graders, Use the recommended post harvesting treatment

8.2.15 Pineapples

Table 8.15: Major pest problems of pineapples and recommended management practices:

Pest	Recommended management practices
Mealybugs (Pseodococcus brevipes)	Use clean planting materials, Trees with dead brown leaves should be uprooted and replaced
Top and root rot (Phytophthora spp)	Use well-drained soils from pineapple growing, Plant on raised beds at least 23 cm high after settling, Provide drainage system to get rid of excess water without causing soil erosion, Deep-trip down the slope before hilling if subsurface soil compaction is evident

8.2.16 Tomatoes

Table 8.16: Major pests of tomatoes and recommended management practices for northern zone:

Pest	Recommended management practices
American bollworm (Helicoverpa armigera)	Destroy infected crop residues and fruit after harvesting, Encourage natural enemies (parasites, ants, Anghocorid-bugs and egg predators), Use maize ads a trap crop (timing of crop stage; tussling stage coincides with attack), Inspect the crop regularly for new infestations, Use botanicals like Neem extract, Apply recommended insecticides at recommended dosage rate
Cutworms (Agrotis spp)	Early ploughing to expose cutworms to predators, Apply wood ash around plants, Inspect the crop regularly soon after transplanting because this is the most susceptible stage of the crop, Mechanical (hand collect and crush them), Use appropriate trapping methods. Crush the caterpillars or feed them to chicken, Use repellent botanicals, Spray with recommended insecticide if necessary
Root knot nematodes (Meloidogyne)	Optima rotation and fallow, Deep ploughing, Avoid contaminated water, Plant tolerant/resistant varieties, Sterilise the seedbed before sowing, Avoid planting a new crop on infested areas
Red spider mites (Tetranychus spp)	Rogue infected plants, Avoid dusty conditions during extreme dry season, Encourage moist microclimate by frequent irrigation, Hedge planting to reduce dust, invasion by mites blown by wind, Encourage natural enemies by mulching and hedging, Use neem as alternative sprays, Observe recommended time of planting, Application of irrigation, Plant tolerant/ resistant varieties, Sanitation and crop hygiene, Use healthy planting material, Frequent weeding, Inspect the crop regularly for new infestations, Use neem oil with cow urine, Apply a recommended miticide if necessary
Late blight (Phytophthora infestants)	Regular crop scouting to detect early attack, Field sanitation after harvest by removal of infected plant parts, Crop rotation Avoid moist microclimate at shady places, Use wide spacing (wet season), Observe recommended time of planting, Plant at correct spacing, Shade management, Decrease humidity through pruning, de-suckering, staking and weeding, Avoiding the humid season and mulch to avoid rain splash causing infections

Early blight (Alternaria solani)	Remove infected plants staring from nursery, Weed out Solanacea plants, Try botanicals and other natural pesticides Observe recommended time of planting, Regular crop scouting to detect early attack, Apply recommended fungicide if necessary
Powdery mildew (Oidium lycopersicum)	Sanitation , remove infested leaves and plants, Practice crop rotation, Use botanical and other natural pesticides, Regular crop scouting to detect early attack, Apply recommended fungicide if necessary
Bacterial wilt (Pseudomonas solanacearum)	Practice good crop rotation, Practice deep ploughing/post harvesting cultivation to expose soil to sun, Add organic matter to the soil (cow dung, mulch, green manure), Rogue affected crops and weed- hosts, destroy or bury outside the field, Avoid transferring infested soil including soil on roots of plants, Do not irrigate with contaminated water
Fusarium wilt (Fusarium oxysporum)	Use resistant varieties are the best practical measure to manage the disease in the field, Practice good crop rotation, Sanitation and crop hygiene, Deep ploughing, Avoid transferring infested soil including soil on roots of plants, Do not irrigate with contaminated water from infested areas, Add organic matter to the soil (cow dung, mulch, green manure)
Bactoria spot (Xanthomonas compestris pv. Vesicatoria)	Use clean seed, Three year crop rotation, Avoid working in fields under wet conditions, Avoiding of injuries to fruits
Tomato yellow leaf curl (TYLC)-virus transmitted by whitefly (Bemisia tabaci)	Use disease free planting materials, Time of planting, Scouting of the disease and removal of affected plants, Intercrop with onion. This also reduces aphids in tomatoes, Intercrop with eggplants as traps to draw whiteflies away from less tolerant and virus prone crops like tomatoes, Use repellent botanicals, such as Tephrosia and Mexican marigold, Regular crop scouting to detect early attack, Good management of irrigation water, Remove and destroy crop residues immediately after the final harvest, Avoid planting Lantana camara near tomatoes, Encourage beneficial insects, such as Encasis, Spray if necessary but use recommended insecticides
Fusarium wilt (Fusarium oxysporum)	Use resistant varieties are the best practical measure to manage the disease in the field, Practice good crop rotation, Sanitation and crop hygiene, Deep ploughing, Avoid transferring infested soil including soil on roots of plants, Do not irrigate with contaminated water from infested areas, Add organic matter to the soil (cow dung, mulch, green manure)
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8.2.17 Onions

Table 8.17: Major pest problems and recommended management practices:

Pest	Recommended management practices
Onion thrips (Thrips tabaci)	Sanitation, Scouting, Separate seed bed and field to reduce danger of carrying over thrips from one site to the other, Crop rotation, Mixed cropping of carrots and onions, Observe recommended time of planting, Field sanitation and crop hygiene Transplant clean seedlings, Mulching reduces thrips infestation considerably, Plough deep after the harvest to bury the pupae Irrigation/adequate watering, Enhance beneficials (predatory mits, bugs, fungal pathogens like Metarhizium), Inspect the crop regularly, Use botanical extract like Neem oil, Tephrosia, tobacco,etc.
Downy mildew (Peronospora destructor)	Use resistant varieties (red creole) and crop rotation for at least five years, Sanitation: remove crop remains after harvest, do no leave volunteer plants in the field and avoid over fertilization, Wide spacing and good drainage to decrease humidity in the plant stand, Apply mulch to avoid rain splash, Inspect the crop regularly
Purple blotch (Alternaria porri)	Sanitation: remove crop remains after harvest, do not leave volunteer plants in the field, Crop rotation, Mulching to avoid rain splash, Plant at recommended spacing, Inspect the crop regularly, Apply recommended fungicide at correct dosage
Storage rots (Bortytis, Erwinia, Mucor, Fusarium)	Use of netted bamboo baskets, Avoid heaps exceeding 30 cm depth and use racks of 1m high, Ventilated stores, Minimize damage during handling, Drying of onions before storage, Remove tops, Avoid thick neck/split

8.2.18 Brassicas (cabbages and kale)

Table 8.18. Major pests of brassicas and recommended practices:

Pest	Recommended management practices
Diamondback moth (Plutella xylostella)	Scouting, Use botanical and other control agents, Observe recommended time of planting, Transplant healthy seedlings, Inspect the crop regularly to detect early attacks, Encourage natural enemies (predatory hoverfly larvae, coccinellids, parasitic wasps) by enhancing diversity, Application of fermented cow urine (10-14 days fermentation) , Use botanicals (Neem oil, chillies,etc.)
Aphids (Brevicoryne brassicae) Sawflies Cabbage webworms	
Blackrot (Xanthomonas compestris) Kiswahili name: Uozo mweusi	Seed dressing with Bacillus bacteria, Seed treatment with hot water, Mulching, Deep ploughing, 3-year crop rotation, Field and crop hygiene, Transplant only healthy seedlings, Plant certified seeds, Plant tolerant/resistant varieties like Glory, Amigo FI, Sterilise the seed bed before sowing, Good drainage, and mulch to avoid infections from rain Splash
Downy mildew (Peronospora destructor)	Practice good crop rotation, Observe recommended time of planting, Transplant only healthy seedlings, Plant at recommended spacing

Alternaria leaf spot (Alternatira spp)	Avoid overhead irrigation, Practice good crop rotation Observe recommended time of planting, Transplant only healthy seedlings, Plant at recommended spacing
Cabbage club rot (Plasmodiaphora brassicae)	Crop rotation, Plant in well drained soils, Adjust soil pH to alkaline by adding hydrated lime
Black rot (Xanthomonos compestris pv. Compestris)	Crop rotation, Use of pathogen free seeds, Avoid overhead irrigation, Use of resistance cultivars (Glory FA, Amigo F1) Sanitation: remove crop residues, plough under, compost or feed to animals, Good drainage, and mulch to avoid infections from rain splash
Cauliflower mosaic virus (CaMV)	Remove brassica weeds, Rogue young plants showing disease symptoms and immediately burns them
Dumpting off (Fusarium Spp, Rhizoctonia spp. Pytium spp and Phytophotra	Provide good soil structure and drainage, Avoid overwatering Apply wood ash in seedbed, Sterilise seedbed, Use treated beds, Pricking excessive seedlings (thinning)
Bacterial soft rot (Erwinia carotovora var. carotovora, Pseudomonas spp)	Avoid harvesting when the weather is wet, Handle produce carefully and store in cool, well-ventilated areas, Plough in crops immediately after harvesting, Practice crop rotation and provide good drainage, Timely planting to coincide with dry season

8.3 Management of Pests

8.3.1 Rodents

191. Rodents, particularly the multi-mammate shamba rat, (*Mastomys natalensis*), are major pests of food crops. The most affected crops are maize, millets, paddy and cassava. Maize is the most susceptible of all the crops. At the pre-harvest - stage, maize is attacked at planting (the rodents retrieve sown seeds from the soil causing spatial germination). In some cases, as much as 100% of the seeds are destroyed, this forcing farmers to replant.

(a) Farmers in outbreak areas are strongly advised to do the following to reduce potential damage to crops and the environment:

(b) Regular surveillance. The earlier the presence of rodents is observed, the cheaper and simpler any subsequent action will be and losses will remain negligible

(c) Sanitation. It is much easier to notice the presence of rodents if the store is clean and tidy

(d) Proofing i.e. making the store rat-proof in order to discourage rodents from entering

(e) Trapping. Place the traps in strategic positions

(f) Use recommended rodenticide. However, bait poisons should be used only if

rats are present. In stores or buildings, use single-dose anticoagulant poisons, preferably as ready-made baits.

(g) Encourage team approach for effectiveness. The larger the area managed or controlled with poison, the more effective the impact

8.3.2 Birds (Quelea quelea spp)

192. Birds are serious migratory pests of cereal crops, namely wheat, rice, sorghum and millet across the country. The quelea birds, which in Kenya occur are swarms ranging from thousands to a few millions, have been responsible for famines of varying proportions in some areas.

193. Bird pest problems in agriculture have proved difficult to resolve due in large part to the behavioural versatility associated with flocking. The array of food choices available to birds is also complex, hence forth; necessary information is needed for successful control strategies. The total damaged per bird per day, if the bird is exclusively feeding on cereal crops, has been estimated at 8 g (Winkfield, 1989) and 10 g (Elloitt, 1989).

194. Several techniques have been tried to reduce bird populations to levels where crop damage is minimal. Traditional methods, slings, bird scares, and scarecrows, are still being used in many parts. Modern techniques of frightening devices, chemical repellents, less preferred crop varieties and alternative cultural practices have been evaluated.

195. All the methods have minimal value in situations where bird pressure is high and where habitation is likely to develop through repetitive repellent use and other methods, which may alleviate damage in small plots or in large fields for a short time. The aerial spraying of chemical (parathion and later fenthion) on nesting and roosting sites, the most widely used technique to date. Currently, only fenthion 60%ULV aerial formulation is being used. The pesticide is recommended to be used at the rate of2.0l/ha.

196. The concerns over possible human health problems and environmental damage resulting from the large-scale application of chemical pesticide for quelea control have led to a proposal for alternative non-lethal control strategy. Chemical pesticide applied for quelea control represent a risk for human, terrestrial, non-target fauna and aquatic ecosystems. The chemical pose risk by directly poisoning or by food

contamination/depletion. Among the terrestrial non-target invertebrates, there are beneficial species. Some are responsible for organic matter cycling; others are predators, and parasitoids of crop pests. Some assure pollination of crops and wild plants, while others again produce honey and silk. The fact that non-target birds and, occasionally, other vertebrates may be killed by quelea control operations is well-established.

197. The risk of human health problems and environmental damage can be mitigated considerably by development of integrated environmentally sound control strategies including Net-Catching. These methods will educate farmers become custodians of the environment. A new emphasis is the possibility of harvesting quelea for food. Since quelea is a good source of protein and preferred by many people. This method offers more rapid prospects for implementation which enable farmers to continue making their own decisions important for the control of quelea in their area. While present indications are that harvesting is probably not an option as a crop protection technique, it offers the possibility of providing income to rural populations in compensation for crop losses.

198. In respect of quelea birds, FAO is currently encouraging the use of IPM approaches to the problem of bird attacks on cereal crops. This means working with farmers in examining all aspects of farming practice in relation to quelea damage, and seeking to minimise external inputs, especially pesticides. In includes modifying crop husbandry, planting time, week reduction, crop substitution, bird scaring, exclusion nesting, etc. and only using lethal control for birds directly threatening crops when the other methods have failed. It is also important for farmers to be aware of the costs of control using pesticides, and in the case of commercial farmers, for them to bear some or all of the costs. A major likely benefit of IPM is reduced environmental side-effects resulting from decreased pesticide use. Although some elements of IPM have been tried in bird pest management, a major effort has yet to be made, for quelea, to focus on farmers in all aspects of the problem.

8.3.3 Locust

199. Locusts live and breed in numerous grassland plains, the best ecologically favourable ones are known as outbreak areas. During periods with favourable weather, locusts multiply rapidly and form large swarms which escape and may result into a plague. There are eight known locusts outbreak in East and Central Africa. The strategy for red locust control combines regular monitoring of breeding sites followed by aerial application of fenitrothion 96.8% ULV to eliminate potential threatening hopper populations.

8.3.4 Armyworm

200. The African armyworm (Spodoptera exempta) is a major threat to basic food production in a number of east and southern African countries Armyworm is a major pest of cereal crops (maize, rice, sorghum and millets) as well as pasture (grass family) and therefore a threat to food security and livestock. Overall losses of 30% for crops have been estimated though in major outbreak years losses in maize of up to 92% are recorded. Armyworm outbreaks vary from year to year but serious outbreaks occur frequently.

201. Due to its economic significance, management and control is centrally co- ordinated by Crop Protection Department of the Ministry of Agriculture. Its control combines monitoring in identified breeding areas, forecasting and early warning of potential outbreaks. The national armyworm control programme runs a network of several traps distributed throughout the country. The traps are placed at county offices, research stations and in large-scale farms. Weekly returns from these traps are used in forecasting potential outbreaks for the following week. The information about potential outbreaks is passed to the regions and counties from where it is further passed to farming communities through the extension system. Farmers are advised to inspect their fields for signs of infestation. If the crop is attacked, farmers should spray with diazinon, fenitrothion or chlorpyrifos, whichever is available at the nearest pesticide store. Both ULV and knapsack sprayers can be used depending on available formulation in the outbreak areas.

202. This service could be improved through a better monitoring and reporting system that empowers farmers to be partners in a co-ordinated network.

This will require the following activities:

(i) Development of community based monitoring and early warning approaches

(ii) Formulating and implementing appropriate training for county plant protection officers (CPPOs), village extension officers (VEOs) and farmers to impart simple reliable monitoring skills

(iii) Formulating and implementing a reliable community based early warning network

203. This approach is likely to have a number of benefits. One, less pesticides will be used because farmers will be able to identify and apply control measures on the most vulnerable stage of the pest, which is not possible in the current set-up. Secondly, farmers can use less toxic and environmentally friendly proven alternatives to pesticides e.g. botanical extracts and/or bio-pesticides at relatively low cost with minimum environmental hazards. Thirdly, if well-coordinated, the information generated by farming communities can be integrated in the nation monitoring and early warning system to improve the quality of the information at national and international level.

204. A new natural control for armyworm is being developed by using a natural disease of the armyworm as biological control in place of toxic chemical insecticides. This disease of armyworm is caused by specific agent, the Spodoptera exempta nucleopolyhedro virus (or NPV). It has been observed since the early 1960s the late in the season many armyworm outbreaks collapse due to the occurrence of a disease that killed up to 98% of caterpillars. NPV can be sprayed like chemicals onto pest outbreaks causing epidemics of NPV disease that kill off the pests, effectively acting as a natural insecticide. What is more, the killed insects produce more NPV spreading the disease further. The NPV produced by dying insects can infect later generations of armyworms so that the effect is longer lasting than chemical insecticides (Mushobozi, et.al.undated).

8.3.5 Striga

205. Striga (witchweed) is one of the most important pests that affect food production in the tropics. In Kenya, the parasite is a serious pest that mainly threatens maize production. Yield losses are between 65 and 100%. With increasing demographic pressure and demand for food, there has been intensification of land use, mono-cropping and consequently a decline in soil fertility. This depletion of soil fertility is one of the main causes for the increase in Striga incidence (Ransom, 1996). The popular control methods of Striga in Kenya are manual and use of fertilizers. The most popular control

method is manual which involves hand weeding and pulling of the Striga. Organic and inorganic fertilizers are also used although their use is dictated by availability and the purchasing power. Although immense research has been undertaken by various scientists on the use of pesticides and resistant varieties in Kenya the adoption seems to be low as seen from the popular control methods currently used.

206. KALRO in collaboration with CIMMYT have evaluated resistant varieties and chemicals which needs to be popularized and evaluated for their effectiveness and compatibility with the farmers' circumstances in order to enhance their adoption. A case in point is the recent introduction of commercial release of Striga -resistant maize, locally known as Ua Kayongo, led by Western Seed Company following extensive tests and farm trials and awareness creation. The new herbicide-resistant maize hybrid and seed coated herbicide technology is based upon inherited resistance of maize to a systemic herbicide (imazapyr), a mechanism widely recognized as imazapyr-resistance (I-R). When I-R maize seed is coated with the herbicide, Striga attempting to parasitize the resulting plant are destroyed.

8.3.6 Alien Invasive species (AIS)

207. Climate change, trade liberalization, and agricultural intensification (introduction of irrigation farming, increased fertilizer use, introduction of new crops and varieties, changes in land use and landscape etc.) could trigger the occurrence of new pest problems. This requires frequent pest risk surveillance and continuous updating of the existing pest list. There is also need for strengthening National Disaster Preparedness and Response Capacity. To date Kenya still has to deal with a number of AIS pests some of which are of international quarantine, polyphagous and difficult to control. *Bactrocera invadens* already recorded on mangoes, loquats, guava, grapefruit, avocado, papaya, curcubits etc (Mwatawala et al., 2006) has caused great losses to mangos both for the domestic, regional and export market.

208. Some of the invasive plants introduced for good but have turned out to be a thorn in the flesh is the famous Mathenge tree (Prosopis Juliflora) was introduced about three decades ago to help in combating desertification while the water hyacinth was a beautiful flower plant introduced by a Nun in Kisumu who let it grow in a pond and has since spread.. The major alien invasive species are shown in Annex 3.

8.3.6.1 Control of Water hyacinth

209. There are three types of control measures adopted including, manual, mechanical and biological. The local communities around the lake identified key areas that require manual removal. These included the landing sites, ports and piers, water supply points and sources, amongst others. Manual removal entails the use of simple tools such as pangas, rakes and wheel barrows as well as protection gears. Mechanical control was undertaken in Kenya during the year 1999. This involved chopping and dumping of the water hyacinth in the lake. This method is generally most expensive and mobility around the lake becomes a problem. The disposal of the harvested water hyacinth has negative effect on the environment. Lastly, biological control involved the rearing and release of two types of weevils (Neochetina eichorniae and Neochetina bruchi) into the lake. Local communities also assisted in the rearing of the weevils. Although this control method is slow it is environmentally friendly as no chemicals are used. Continued monitoring and surveillance of water hyacinth is recommended. Rearing and release of weevils should be a continuous process to keep the water hyacinth in abeyance.

8.4 Key Llivestock Pests and Diseases

210. Livestock disease is one of the major constraints to animal production in Africa (Table 7.19). 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 much of African countries south of the Sahara. In addition the tsetse flies also transmit the fatal human sleeping sickness.

Table 8.19. Major livestock pests and diseases in Kenya

Disease	Aetiology	Epidemiology	Hosts	Transmission	Sources of Vulnerability
Foot and Mouth Diseas	Caused by a virus of the family Picornaviridae, genus Aphthovirus with seven immunologically distinct serotypes: A, O, C, SAT1, SAT2, SAT3, Asia1. The virus is resistance to physical and chemical action. It survives in lymph nodes and bone marrow at neutral pH.	Epidemiologically, foot and mouth disease is one of the most Contagious animal diseases, with important economic losses. Though it exhibits low mortality rate in adult animals, but often high mortality in young due tomyocarditis	Cattle Zebus Sheep Goats Swine All wild ruminants	Direct or indirect contact (droplets), animate vectors (humans, etc.), inanimate vectors (vehicles, implements), and airborne, especially temperate zones (up to 60 km overland and 300 km by sea).	Resistance to physical and chemicalaction. (virus persists in the oropharynx for up to 30 months in cattle or and 9 months in sheep FMD is endemic in parts of Asia, Africa, the Middle East and South America Sporadic outbreaks in free areas Survives in lymph nodes and bone marrow at neutral pH.
Rinderpest	aused by virus family Paramyxoviridae,genus Morbillivirus	High morbidity rate, mortality rate is high with virulent strains but variable with mild strains	Cattle, zebus. Sheep Goats	By direct or close indirect contacts	Resistance to physical and chemical action Remains viable for long periods in chilled or frozen tissues In Africa it has been eradicated from several countries and sub-regions, and is normally absent from the northern and southern parts of the continent

Disease	Aetiology	Epidemiology	Hosts	Transmission	Sources of Vulnerability
Lumpy Skin Disease	Virus family Poxviridae, genus Capripoxvirus	Morbidity rate 5-85% Mortality rate very variable	Cattle Bos taurus Zebus, domestic buffaloes)	Transmission may occur via infected saliva in the absence of an insect vector. Though no specific vector has been identified to date, mosquitoes (e.g. Culex mirificens and Aedes natrionus) and flies (e.g. Stomoxys calcitrans and Biomyia fasciata) could play a major role	Endemism: LSD was confined to sub- Saharan Africa strict quarantine to avoid introduction of infected animals in to safe herds in cases of outbreaks, isolation and prohibition of animal movements slaughtering of all sick and infected animals (as far as possible) correct disposal of dead animals (e.g. incineration) disinfection of premises and implements vector control in premises and on animals
Rift Valley Fever	Virus family Bunyaviridae, genus Phlebovirus	High mortality rate in young animals High abortion rate in ruminants	Cattle Sheep Goats Dromedaries Several rodents	Haematophagous mosquitoes of many genera (Aedes, Anopheles, Culex, Eretmapodites, Mansonia, etc.) can transmit fever as biological, competent vectors. Mosquitoes (Aedes) are the reservoir host Direct contamination: occurs in humans when handling infected animals and meat	Resistance to physical and chemical action Survives in dried discharges and multiplies in some arthropod vectors. Can survive contact with 0.5% phenol at 4°C for 6 months For animals: wild fauna and vectors For humans: nasal discharge, blood,vaginal secretions after abortion in animals, mosquitoes, and

Disease	Aetiology	Epidemiology	Hosts	Transmission	Sources of Vulnerability
					Infected meat. Possibly also by aerosols and consumption of raw milk RVF has been recognised exclusively in African countries, with an underlying association with high rainfall and dense populations of vector mosquitoes
Sheep Pox and Goat Pox	Virus family Poxviridae, genus Capripoxvirus	Morbidity rate: Endemic areas 70-90% Mortality rate: Endemic areas 5-10%, although can approach 100% in imported animals	Sheep and goats (breed-linked predisposition and dependent on strain of capripoxvirus)	Direct contact and Indirect transmission by contaminated implements vehicles or products (litter, fodder) Indirect transmission by insects (mechanical vectors) has been established (minor role) Contamination by inhalation, intradermal or subcutaneous inoculation, or by respiratory, transcutaneous and transmucosal routes	Resistance to physical and chemical action Survive for many years in dried scabs at ambient temperatures. Virus remains viable in wool for 2 months and in premises for as long as 6 months

Disease	Aetiology	Epidemiology	Hosts	Transmission	Sources of Vulnerability
Highly Pathogenic Avian Influenza	Virus family Orthomyxoviridae, genus Influenzavirus A, B. To date, all highly pathogenic isolates have been influenza A viruses of subtypes H5 and H7	Highly contagious	to assume all avian species are susceptible to infection	Direct contact with secretions from infected birds, especially faeces Contaminated feed, water, equipment and clothing Clinically normal waterfowl and sea birds may introduce the virus into flocks Broken Contaminated eggs may infect chicks in the incubator	Resistance to physical and chemical action Remains viable for long periods in tissues, faeces and also in water Highly pathogenic viruses may remain viable for long periods of time in infected faeces, but also in tissues and water
Newcastle Disease	Virus family Paramyxoviridae, genus Rubulavirus	Many species of birds, both domestic and wild The mortality and morbidity rates vary among species, and with the strain of virus	Chickens are the most susceptible poultry, ducks and geese are the least susceptible poultry A carrier state may exist in psittacine and some other wild birds	Direct contact with secretions, especially faeces, from infected birds Contaminated feed, water, implements, premises, human clothing, etc. Sources of virus Respiratory discharges, faeces All parts of the carcass Virus is shed during the incubation period and for a limited period during convalescence Some psittacine birds have	Survives for long periods at ambient temperature, especially in faeces Strict isolation of outbreaks Destruction of all infected and exposed birds Thorough cleaning and disinfection of premises Proper carcass disposal Pest control in flocks Depopulation followed by 21 days before restocking Avoidance of contact with birds of unknown health status

Disease	Aetiology	Epidemiology	Hosts	Transmission	Sources of Vulnerability
				been demonstrated to shed ND virus intermittently for over 1 year	Control of human traffic. One age group per farm ('all in-all out') breeding is recommended Medical prophylaxis Vaccination with live and/or oil emulsion vaccines can markedly reduce the losses in poultry flocks Live B1 and La Sota strains are administrated in drinking water or as a coarse spray. Sometimes administered intra-nasally or intra-ocularly. Healthy chickens may be vaccinated as early as day 1-4 of life, but delaying vaccination until the second or third week increases its efficiency Some other infections (e.g. Mycoplasma) may aggravate the vaccine reaction. Killed virus vaccine should then be used

211. For livestock animals, the most common disease is the East Coast Fever which is a tick-borne disease. The problem as worsened in the last 10 years as most of the communal dips have collapsed and the private dips are not accessible to most of the farmers. Another reason is that the ticks 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 has led to an increase in other tick- borne diseases such as Babeiosis, heart water and anaplasmosis.

222. 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 in several regions, notably Europe and parts of South America and Asia. Foot and mouth disease is relatively easily contained through the use of vaccines. However, the many variances of the disease slow down the control process.

223. 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, southern and western Africa over the last few years. It currently affects 27 countries in Africa at an estimated annual cost of US $2 billion.

224. Another disease of importance is mastitis. The disease is related to hygiene and is common where hygiene in the livestock pens is not maintained. Similarly, nagana which is transmitted by tsetse fly is an equally troublesome disease in Livestock.

225. Tsetse fly control methods include the following:

a. Deployment of insecticide (e.g. deltamethrin) impregnated targets/traps

b. Application of pour-ons on livestock with Flumethrin
c. Cattle crush-pen spraying with Decatix, which also controls ticks and biting flies
d. Disease surveillance
e. Use of zero grazing unit protective nets

226. Since the trypanosome parasite also causes sleeping sickness in people, successful control of the disease in cattle should result in added benefits for human health. Another potential benefit is that increased use of targeted treatment of cattle with insecticide may lead to reduced incidence of malaria in some localities where mosquitoes feed on the same animals.

227. 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.

228. The major disease of poultry is Newcastle. This is a virus spread primarily through bird- to-bird contact among chickens, but it can also spread through contaminated feed, water or clothing. Outbreaks occur in most parts of the world, and there have been two major pandemics over the last century. It is a major constraint to the development of village chicken industries, particularly in Asia and 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, despite tight bio-security measures. Others diseases within the country include Gumboro, Coccidiosis and fowlpox.

229. Aquaculture is a fast growing industry in Kenya. Common diseases of fish include:

a. Bacteria – Fish remain in vertical position, white spots on the skin around the mouth.
b. Remedy – Antibiotics e.g Furaltadone
c. Fungal – cotton–like growths on the mouth and barbels. Caused by handling, netting orparasite
d. Remedy- use malachitegreen

e. Parasitical- Fish assume vertical position and rub their heads on the pond surface a) Remedy – Use formalin
f. Worms – Red-brown worms on skin and barbels a) Remedy- Use of Masoten
g. Broken head – pop eyes, soft skull and deformed caudal fin. Causes: Poor water quality
h. Remedy- Observe good quality
i. Open belly – Swollen bellies, necrotic intestines, Causes: Bacteria a) Remedy- Decrease feeding regime

8.5 Key Forestry pests and diseases

230. One of the most significant recent pests in forestry is an exotic pest, identified as the gall- forming wasp, Blue Gum Chalcid. It has been reported as a threat to *Eucalyptus* trees in Western parts of Kenya. The pest is reported to cause serious damage to young trees and nursery seedlings.

231. Another pest of significance is the *Cyprus* aphid which was reported to have invaded the county in 1991. The weed was estimated to kill as many as 50 percent of all *Cyprus* trees during the 30-year harvest cycle.

9.0 MANAGEMENT OF NEGATIVE IMPACTS OF CROP PROTECTION MEASURES

9.1 Introduction

232. The effective control of diseases and pests is pertinent for improved crop and livestock production. No single crop or plant is free from diseases and pests. There are pests and disease of economic importance that require cost effective control for improved productivity. Effective management can only be achieved when social, economic and environmental factors are taken in account', particularly when you are making a choice of the appropriate control measure. This is important for increased adoption and effective use of the selected method. Some of the major social and economic activities to be considered are presented in the Table below. In addition, an understanding of the institutional and legal frame work is also important in assessing the impacts of the current pests and disease control measures.

Table 9.1: Social and economic activities associated with the presence of pests and vectors

Pest and vectors	**Economic Activities**	**Social Activities**
Crop Pests	Cash crop Production, subsistence crop production, storage of crops, marketing of	Population movement, siting of homes
Insect borne vectors (mosquitoes, tsetse flies, black flies)	Farming, forestry, game hunting, fishing, livestock management, market attendance, population	Recreation (water and land), housing, waste disposal;, fetching water, population movements, settlement patterns leisure (siting outside the houses)
Animal-borne vectors (tick and mites)	Livestock management, Game hunting	Recreation sanitation conditions
Water-borne vectors (snails)	Fishing irrigation, livestock management, market attendance, population	Siting of homes, bathing, washing, fetching water recreation (water), waste disposal, population

Adopted from: Pest and vector management in the tropics, Youdeowei, A., 1983

233. An environmental impact of pest management is a change in the environment caused by applying or using a certain method of pest or disease control. This will involve a change in the properties of a natural or man-made resource in a way considered

important. In this case, specific environmental areas of concern will include: the quality of ground and surface water, wetlands and terrestrial communities (flora and fauna), and aquatic communities including fishery and other animals and soil properties. While the social economic impacts include: the health and personal safety of the people using the various control methods. The primary goals of any control programme against pests or diseases are, first, to establish the "optimal" level of disease or pest presence to meet a country's goals and, next, to choose the most cost-effective way of achieving that level of control.

9.2 Implication of control measures

9.2.1 Control of plant pests and diseases

234. The control of pests and diseases raises the most obvious concern of the resulting losses when there is no control, as pests populations can expand quickly from a localized outbreak to critical levels with serious infestations occurring simultaneously in several areas and neighbouring regions. The fast initial multiplication may occur unnoticed in remote and unpopulated areas and follow a natural (biologically induced) pathway. Once cropping areas are invaded, there is rarely sufficient time to prevent damage through control operations.

235. The widespread loss associated with an outbreak of pests and diseases makes it imperative for control measures to be undertaken. In view of major pests and diseases losses occurring in the lake basin, there is added need to prevent impacts on scarce food resources. Normally a control is carried out as a response to the appearance of pests and disease, with the main effort aimed at eradicating them once they appear in significant or levels. The primary response is widespread pesticide spraying to target pests, manual removal, biological control such as use of preys, use of resistant varieties, etc. All these methods have different effects on the environment, health and safety and general social setting. The rapid identification of early stages of attacks in the lake basin is critically important to minimize the damage to neighbouring regions

9.2.2 Control of Livestock pests and diseases

236. Animal diseases are spread either through natural pathways or human intervention. The transmission of certain diseases requires an insect to serve as a vector, dictated by

external environmental conditions and possibly appropriate plant hosts to carry out its life cycle. Based on biological reasons, these disease pathways have limited geographical scope, which simplifies the task of identifying pathways for disease transmission compared with plant pest introduction. In the lake- basin movement of livestock and derived products is regulated and controlled to prevent the entry and subsequent spread of exotic disease agents. Furthermore, disease surveillance systems with laboratory diagnostic support are maintained to ensure the early detection of disease outbreaks and contingency plans are in place to respond rapidly to an epidemic. In addition to these there is immense use of pesticides through spraying to control the spread of the disease and the use of acaricides to treat the disease.

9.2.3 Associated Risks

237. The control measures may be associated with risky outcomes in terms of expected profitability and is often measured by the variance. The risks may include and not limited to the following:

(a) Incorrect choice of herbicide, such that non target species are damaged,

(b) Mistakes in calibration

(c) Effectiveness of pesticides which depends on the weather or other factors.

9.3 Impacts of empirical plant and animal pests and disease control methods

9.3.1 Use of Pesticides

238. Pesticides are commonly used in the control of diseases, pests and weeds on various crops. Other than crops (food, horticultural and cash), areas where pesticides are used is livestock industry (cattle and poultry) in the control of ticks and for treatment. Pesticides/acaricides are used to control ticks and tick borne diseases as well as viral, helminth and mycoplasmal diseases of economic importance. Drugs and vaccines are popularly used to control livestock diseases.

9.3.2 Impact on Environment

239. All campaigns against invasive species of pests and disease tend to occur over large areas, thereby affecting a significant amount of territory and people. The use of pesticides in an effort to control pests, both introduced and indigenous, can lead to serious health effects in developed and developing countries. Control of animal diseases

is far less risky to people and the environment.

240. It is understood that pesticide use can be dangerous to farmers, nearby exposed populations and the affected environment. It is estimated that there are almost 5 million cases of pesticide poisoning in developing countries each year. World Health Organization (WHO) has estimated that there are 3 million severe human pesticide poisonings in the world each year, with approximately 220,000 deaths. While developed countries use about 80 percent of the world's pesticides, they have less than half of this number of deaths. It is not known how many of these poisonings should be attributed to control measures against plant pests.

241. The high concentrations of the organo-chlorine compounds in the soils where they are directly applied signal a potential problem. Other chemical compounds present include pyrethroids, traizines, etc. These compounds are also detected in water and sediments from rivers which drain through the farming areas, and that their concentration in water is influenced by their concentration in soil and sediments. Rain plays a major role in the transportation process through surface run-offs. The presence of compounds in the soil for up to five years since last application shows that the pesticides also persist in tropical soil conditions. High levels of these chemicals become harmful to man and aquatic community as the chemicals are eventually washed as run offs to the water bodies. The use of pesticides becomes injurious particularly for example as evidenced by the spray drift if the spraying is not well done it affects non-target plants or animals.

242. The table below shows the list of agrochemicals that are banned in the country. The danger is that some of these chemicals which are banned are still being used in the lake basin including DDT and dieldrin, amongst others. However, pest eradication or the prevention of spreading requires pesticides for a shorter term and in a smaller area than would be employed if the pest were to spread. Therefore, it is important to balance the risk of pesticide use for control at different stages of pest outbreaks against the potential negative impacts.

Table 9.2: List of banned or restricted pesticides in Kenya

BANNED PESTICIDES IN KENYA			
	Common name	Use	Date Banned
1.	2,4,5 T (2,4,5 – Trichloro- phenoxybutyric acid)	Herbicide	1986
2.	Chlordane	Insecticide	1986
3.	Chlordimeform	Insecticide	1986
4.	DDT (Dichlorodiphenyl Trichloroethane)	Agriculture	1986
5.	Dibromochloropropane	Soil Fumigant	1986
6.	Endrin	Insecticide	1986
7.	Ethylene dibromide	Soil Fumigant	1986
8.	Heptachlor	Insecticide	1986
9.	Toxaphene (Camphechlor)	Insecticide	1986
10.	5 Isomers of Hexachlorocyclo-hexane (HCH)	Fungicide	1986
11.	Ethyl Parathion	Insecticide All formulations banned except for capsule suspensions	1988
12.	Methyl Parathion	Insecticide All formulations banned except for capsule suspensions	1988
13.	Captafol	Fungicide	1989
14.	Aldrin	Insecticide	2004
15.	Benomyl, Carbofuran, Thiram combinations	Dustable powder formulations containing a combination of Benomyl above 7%, Carbofuran above 10% and Thiram above 15%	2004
16.	Binapacryl	Miticide/Fumigant	2004

BANNED PESTICIDES IN KENYA			
	Common name	Use	Date Banned
17.	Chlorobenzilate	Miticide	2004
18.	Dieldrin	Insecticide	2004
19.	Dinoseb and Dinoseb salts	Herbicide	2004
20.	DNOC and its salts (such as Ammonium Salt, Potassium salt & Sodium Salt)	Insecticide, Fungicide, Herbicide	2004
21.	Ethylene Dichloride	Fumigant	2004
22.	Ethylene Oxide	Fumigant	2004
23.	Fluoroacetamide	Rodenticide	2004
24.	Hexachlorobenzene (HCB)	Fungicide	2004
25.	Mercury Compounds	Fungicides, seed treatment	2004
26.	Pentachlorophenol	Herbicide	2004
	Phosphamidon	Insecticide, Soluble liquid formulations of the substance that exceed 1000g active ingredient/L	2004
27.	Monocrotophos	Insecticide/Acaricide	2009
28.	All Tributylin Compounds	All compounds including tributyltin oxide, tributyltin benzoate, trybutyltin fluoride, trybutyltin lineoleate, tributyltin methacrylate, tributyltin naphthenate, tributylin chloride	2009
29.	Alachlor	Herbicide.	2011
30.	Aldicarb	Nematicide/Insecticide/Acaricide.	2011
	Endosulfan	Insecticide.	2011
31.	Lindane	Insecticide.	2011

Source: Pest Control Products Board (2012)

9.3.3 Impact on Health and safety

243. Concerns remain about worker exposure, residues on food and harm to domestic and non- target wild animals. Fish and invertebrates are frequently vulnerable, especially aquatic arthropods. Stocks of obsolete pesticides have also become a serious health and environmental problem in many countries of Africa and the Near East. 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 country before the pesticides arrive. As a consequence of the need to be prepared for initiating a control campaign at short notice, 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.

244. The pesticide stockpiles pose a very important problem that requires urgent attention, especially for stocks near urban areas where there is a risk of the pesticides contaminating drinking-water, food or the air. However, in general they lack the resources and technology to mount appropriate disposal campaigns. The use of pesticides, fungicides and herbicides may lead to water pollution, given that water is used for drinking and other domestic purposes.

9.3.4 Use of Biological method

245. The biological control of pests and diseases entail the use of insects, bacteria or fungi on the host to eliminate the pest or disease. For example in the control of water hyacinth specific weevils' spp. are used to destroy the weed.

9.3.4.1 Impact on Environment

246. This is one of the known environmentally friendly control methods as compared to other control methods. Unlike other methods biological control is applied carefully and selectively and since no chemicals are used it has no adverse effect on the environment. In comparison to other methods it is cost effective since its application may entail community participation and can be integrated in other control methods. The natural enemies once established may spread to other remote areas as in the case of water hyacinth.

247. The only criticisms is that the control agents are slow in action and take a longer period to generate results and therefore cannot be used in emergency situations. The danger comes in when the host is eliminated if the pest is not host specific then they may attack other plants (crops) or insects and therefore create an imbalance in the ecosystem.

248. In the case of the control of water hyacinth the use of weevils damage the water hyacinth which then rots and sinks providing a substrate on which other plants thrive on; e,g. cyperus, papyrus, hippo grass. This phenomenon was observed in L.Kyoga and Victoria when the beetles were successfully used in the control of water hyacinth in the late 1990's. The new plants (ecological succession) which emerge pauses a problem on communication, water supply and fishing in the lake.

249. The use of resistant clones in the control of diseases and adoption of a fast method of propagating plantings has numerous environmental benefits. For example, providing a reliable supply of improved tree seedlings will have important benefits for the environment. By increasing and sustaining the supply of timber, pressure on forests will be reduced on natural forests, helping to preserve valuable natural biodiversity and rare habitats. The Tissue culture technology also has the potential to increase biodiversity by replacing the stocks of rare and endangered tree species. The wider environmental benefits of increasing tree cover include improving soil stability, reducing erosion, preventing desertification and stabilizing global climate.

9.3.4.2 Impact on Health and safety

250. Since no chemicals are used there are no dangers and thus the method is generally/fairly safe. Refer to the NARIGP Environmental and Social Management Framework (disclosed in Kenya and in World Bank Info Shop) for guidance for usage of Personal Protective Equipment by workers, including farmers.

9.3.5 Use of Mechanical method

251. This method involves the use of automated machines and may also be expensive depending what machines are used. For example, inter-cultivation in is done using a tractor mounted inter-cultivator to control weeds in crops such as sugarcane and use of boom sprays.

9.3.5.1 Impact on Environment

252. This may be friendly or unfriendly to the environment depending on the operation carried out and the disposal technique of the weeds or the wastes. For example, when the water hyacinth is chopped mechanically and left to rot and sink at the bottom of the lake, they result into accumulation of water hyacinth debris. These materials impact on biotic communities, the environment and socioeconomic activities. These calls for choosing a method where by the chopped materials are completely removed from the site.

9.3.5.2 Impact on health and safety

253. The wise operation of the machines and the supporting labour becomes important in the safety and handling.

9.3.6 Use of manual method

254. The manual control basically consists of the use of labour with simple implements/tools. The major concern is often the high cost involved. For example weeding is particularly expensive before the tea matures and covers the ground completely

9.3.6.1 Impact on Environment

255. It is friendly to the environment as there is no pollution of land, water or air when the method is applied. An example would be the control of mole rats using traps. In the coffee sector, it is safe to ensure that the uprooted weeds are not placed on the tree stumps as this may introduce soil borne diseases into the tree, while in the sugar sector, when smutted stools of sugarcane are uprooted and not buried in the ground they cause more infection on the cane.

9.3.6.2 Impact on Health and safety

256. The danger involved in the manual control includes the risk of bilharzias, snake bites, hippo or crocodile attacks, depending on which plant and where the operation is carried out.

9.3.7 Use of Quarantine

257. Quarantine refers to a period when an animal or person that has or may have a disease is kept away from others in order to prevent the disease from spreading. For plants it is a situation which ensures safe movement, treatment, introduction and

destruction of diseased/infected plants materials to reduce the risk of exposure of the country's plant resources (environment) to foreign pests, diseases and noxious weeds.

9.3.7.1 Impact on Environment

258. This method is fairly safe to the environment as it allows for the control and management of pests and diseases through isolation.

9.3.7.2 Impact on Health and safety

259. Quarantines ensure safe passage of animals and plants by reducing contamination or spread of diseases.

10.0 CAPACITY NEEDS AND TECHNICAL ASSISTANCE FOR SUCCESSFUL IMPLEMENTATION OF THE IPMP

260. IPM is a knowledge intensive and interactive methodology. The need to accurately identify and diagnose pests and pest problems and understand ecosystem interactions could enable farmers with biological and ecological control opportunities and in making pragmatic pest control decisions. Thus the success of IPM depends largely on developing and sustaining institutional and human capacity to facilitate experiential learning for making informed decisions in integrating scientific and indigenous knowledge to solve county, ward and village specific problems. Poor communication between farmers, extension agents and researchers from research institutes and universities has often led to poorly-targeted research or to poor adoption of promising options generated by research. The full benefits of investment in agricultural research thereby remain untapped under these circumstances. Closer farmer-research investigator interaction and adaptive research and participatory learning approaches in capacity building efforts can help to bridge this gap and make research results more applicable by farmers. The farmers will learn biological and ecological processes underpinning IPM options, and use the newly acquired knowledge to choose compatible methods to reduce production and post-harvest losses through frequent field visits, meetings, demonstrations, adaptive research trails, etc

261. Capacity building will be achieved through farmer-based collaborative management mechanisms where all key stakeholders shall be regarded as equal partners. Beneficiary farmers shall be the principal actors facilitated by other actor such as from research institutes, academic institutions, sector ministries, NGOs, etc. as partners whose role will be to facilitate the process and provide technical direction and any other support necessary for the implementation of PMP. The pilot PMP should be designed to build on, and to some extent strengthen existing national capacities for the promotion and implementation of IPM.

262. The major actors and partners will include the following:

(a) The programme beneficiary farmers: as the principal beneficiaries they will be organized into Farmer Groups for training and adoption of IPM practices. The farmers will be facilitated to set up Community IPM Action Committees to coordinate IPM activities in their areas.

(b) Agricultural sector ministries have the national mandates in implementation of crop protection and pest management research. The two projects will provide logistical and technical support to the Implementing Agencies and other stakeholders to be trained as IPM trainers and to exploit their experiences in the implementation of IPM and management of outbreak and migratory pest. NARIGP will thus provide capacity and policy guidance and/or oversight for implementation of the two projects at regional/county level. The IPM commodity team will serve as resource persons at FFS, counties or any other mechanism deemed suitable for conducting IPM Trainers and Farmer Group training sessions. The team will also be a major partner to farmer groups in the planning and execution of farmer participatory research activities related to IPM.

(c) The sector ministries within the pilot NARIGP counties should provide staff for training at FFS sand should play major role with NGOs/CBOs in the public awareness campaign, production of extension materials, radio and television programmes in the respective counties. They should also monitor the prevalence of inputs supply by the dealers.

(d) Ministry of Health (MoH)*:* the county hospitals or clinics in the NARIGP operational areas should set up databases on incidence of data on poisoning, effect of pesticides on human health and environmental contamination. This data will then be used to measure and validate the ameliorating effects of IPM adoption and pilot NARIGP implementation that is expected to reduce risks to pesticides exposure.

(e) National Environmental Management Authority (NEMA)*:* will collaborate with the counties hospitals and natural resources management offices of the counties on training beneficiary farmers in environmental management.

Partners will include the following:

(a) Research and training institutions: to formulate proposals for research and training programmes for the development of IPM protocols, and training modules for participating NARIGP- commodity IPM team and programme staff.

(b) World Bank, FAO and Global IPM facility: to be a valuable sources of technical information and to provide technical support for training, planning and field

implementation of IPM in Farmer Groups. The NARIGP programmes will also build on the knowledge, structures, facilities, and lessons learnt in other related projects in Africa and elsewhere.

(c)Agriculture Service Providers and NGOs that are working on providing services to farmers and improving agricultural productivity, environmental management and rural health matters will be identified to provide services and technical support to the field implementation of IPM and other pilot PMP.

11.0 IPMP IMPLEMENTATION AND BUDGET

263. The programme management team of NARIGP will be responsible in the implementation of this IPMP and estimated costs for the various activities under these projects will be built in the budget. The core activities will be as follows:

(a) Coordination

(b) Development of IPM packages for the pilot NARIGP counties

(c) IPM orientation workshops

(d) Training of trainers and Farmer groups training

(e) Public awareness and promoting the adoption of IPM practices

(f) Field guides/training materials for production, purchase and distribution

(g) Farmers field days

(h) Field visits and study tours

(i) Annual workshops on progress and lesson learnt

(j) Monitoring and evaluation

11.1 Implementation

264. During every 6 months all interested in IPM activities will meet to discuss the progress report and activities plan for the following 12 months. The extension staff, cooperative/association extension staff sponsored and none sponsored by NARIGP PCU and representative of farmers responsible for IPM execution will give periodic reports and planned activities for the following quarter, and should reflect the approved work program for each in association or cooperative. This should include:

(a) Name of crop and area under demonstration,

(b) Activities performed during this period (1 to 3months),

(c) Number of farmers involved,

(d) Dates of various activities,

(e) Inputs used

(f) Pest and diseases observed and control methods

(g) Person hours or days spent on each activity

(h) Field days and number of people attended

(i) Farmer to farmer visits done and number of participants

(j) Leaders invited and attended any of IPM events

(k) Lessons learnt and problems during the month

(l) Other activities done by the group

(m) Future plans

(n) Observation and suggestions

11.2 Budget

265. A tentative cost estimates of budgetary requirements is given in the table below

Table 11.1. Budget element for implementation of IPMP- NARIGP (in USD)

Line item	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Total**
1. Capacity building						
Line item	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Total**
IPM orientation	5000	3000	3000			11000
TOT	15000	15000	10000			40000
FG training	10000	10000	10000	10000	10000	50000
Surveillance	5000	5000	5000		10000	125000
Workshop	4000	5000	6000	8000		23000
Field guides/IPM materials	5000	3000	4000			12000
Public awareness	6000	6000	4000	2000	2000	20000
Pest specialist	3000	3000	3000	3000	3000	15000
M&E	10000	50000	5000	4000	4000	73000
Coordination	2000	2000	2000	2000	2000	10000
Grand total						**379,000**

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Annex 1: Questionnaire on Pest Management

This questionnaire will be used with the farmer groups for purpose of implementing the IPMP

1) Pest Control practices

a) Do you use any pesticides to control pests (Insects, diseases, weeds) of crops? Each season Yes ☐ No ☐

If No, WHY? if yes name them

Yes Name them:	If No, Why	Name of pesticide	Name of pest, disease, weed	Number of times applied/season	When did you apply (growth stage or month) Quantity

b) If you use any of the above pesticide types, do you keep records of the:

Application location Yes ☐ No ☐

Date of application Yes ☐ No ☐

Pesticide product trade name

Yes ☐ No ☐

Operator name Yes ☐ No ☐

If No, WHY?.....

c) How do you decide when to use the pesticides (tick all that apply)?

I. We use pesticides at regular intervals throughout the season (calendar) ☐

II. We use pesticides when we see pests in the field (control) ☐

III. We use pesticides after field sampling and finding a certain number of pests or a certain level of damage (scouting ☐

IV. Told by someone to apply (specify who)___ ☐

V. Other (specify)_____

d) Do you use a knapsack sprayer? Yes ☐ No ☐

(i) If yes, do you own it? Yes ☐ No ☐

(ii) Do you rent it? Yes ☐ No ☐

(iii) Do you borrow it? Yes ☐ No ☐

e) From your experience, are there any negative/harmful effects of using pesticides? Yes ☐ No ☐

f) f yes, list the negative effects:

1.……

2.....

3.……

4.……

5.……

g) Do you use any kind of protective clothing while applying or handling pesticides? Yes ☐ No ☐

If no, Why?_____

h) If YES, what kind?_____

2. Knowledge of pesticide handling and storage (tick one in each row)

a) Do you read labels on the pesticide container before using?

Sometimes ☐ Always ☐ Never ☐

b) How often do you wear protective clothing and other accessories like nasal mask, eye goggles, and boots when applying the pesticides?

Sometimes ☐ Always ☐ Never ☐

c) Do you mix pesticides with your hands?

Sometimes ☐ Always ☐ Never ☐

d) Do you observe the pre-harvest waiting periods after applying the pesticides? Sometimes ☐ Always ☐ Never ☐

e) After spraying, do you wait 12 hours before entering the field?

Sometimes ☐ Always ☐ Never ☐

f) Do you store pesticides in a secure, sound and well-ventilated location? Sometimes ☐ Always ☐ Never ☐

g) Do you make a cocktail before applying the pesticides? (i.e., mix more than one chemical and apply them at once?)

Sometimes ☐ Always ☐ Never ☐

h) Where do you store your pesticides?_____

i) Why do you store them there?_____

j) What do you do with your pesticide containers after they are empty ?

_____

k) Do you know of any beneficial insects (insects that eat harmful insects)? Yes ☐ No ☐

(i) If yes, name them:

(a)_____ (b) _____ (c) _____

3. Pesticides and Health

(a) Do you find that pesticide application is affecting the health of persons regularly applying pesticides?

Sometime Always ☐ Never ☐

(b) Persons working in fields sprayed with pesticides?

Sometimes ☐ Always ☐ Never ☐

(c) Persons harvesting the produce?

Sometimes ☐ Always ☐ Never ☐

3. Options to Pesticides

From your experience, are you aware of other methods for controlling insects' diseases and/or weeds besides pesticides? Yes ☐ No ☐

a) If yes, describe these practices:

i)_____

ii)_____

iii)_____

iv)_____

4. Information

a) What information do you think you need for improving your crop production and

marketing?

_____

5. Training

a) Have you ever received any training on any of the following topics related to crop production?

Integrated Pest Management? Yes ☐ No ☐

No. of times/past yr. …….

Pesticide Usage Yes……. No …….

No. of times/past yr.…….

Pesticide Safety Yes……. No …….

No. of times/past yr.…….

Insect Identification Yes……. No …….

No. of times/past yr.…….

Disease Identification Yes……. No …….

No. of times/past yr.…….

Quality aspects of production

Yes ☐ No ☐

No. of times/past yr.……

7) Is there anything else that you want us to know about your crop production?

_____

Thank you for your time

Annex 2. Integrated Pest Management (IPM) Plan Template for Use by Farmers

1. **Background Information**

Name of farmer……..

Type of Farming Activity…… ……

Year/Time of the Year ……..

2. Integrated Pest Management Practices

Tick (√) only the appropriate options currently practiced on your farm

A. The prevention and/or suppression of harmful organisms

Crop rotation ☐
Use of optimal sowing date ☐
Minimum cultivation ☐
Management of crop residues ☐
Soil structure and compaction ☐
Certified seed/tested home saved seed ☐
Choose disease resistant varieties ☐
Irrigation (applied to schedule) ☐
Nutrient management programme ☐
Soil testing (pH, nutrients, organic matter) ☐
Liming ☐
Clean machinery and equipment ☐
Clean crop storage areas ☐
Clean growing trays/storage boxes ☐
Protect beneficial organisms ☐

Other (specify)……

B. Monitoring of harmful organisms

Use early warning/weather forecasting systems ☐
Monitor crops for pests/diseases ☐
Use weather forecast to aid decisions ☐
Adviser monitors crops ☐
Accurate pest and disease identification ☐
Use traps/sticky pads/lures ☐

Other (specify)……

C. Application of appropriate plant protection measures

Preventative treatments ☐
Adviser-led decision ☐
Decision making with adviser ☐
Pest threshold decisions ☐
Other (specify)……

D. Use of biological, physical or other non-chemical methods ☐
Use natural enemies ☐
Use crop fleeces ☐
Use micro-organism plant protection products ☐
Use crop netting ☐
Use propane burners for weed control ☐
Use manual methods ☐
Use deterrents (bangers, kites etc.)
Use mechanical weeder ☐
Use of topper/mower/cutter for weed control ☐
Other (specify)……

E. Use of pesticides that are specific for the pest/disease

Applications usually for multiple pests ☐
Resistance development is considered ☐
Broad spectrum products avoided ☐
Different modes of action considered ☐
Different products considered ☐
Consider subsequent crops ☐
Economics are considered ☐
Familiar with different product labels ☐
Buffer zones are adhered to
Well maintained application equipment used ☐
Spray drift reduction methods ☐
Use air-assisted sprayer ☐

Use weed wiper for weed control ☐

Use adviser to help decide on product(s) ☐

Avoid pesticide use where bees are foraging ☐

Other (specify)……

F. Use of pesticides at required levels

Use appropriate application rates

Use adjuvants to reduce pesticide use ☐

Applications timed to minimise use ☐

Reduce frequency of application ☐

Partially treat/spot spray fields ☐

Other (specify)……

G. Use of anti-resistance strategies to maintain product effectiveness

Use products with multiple modes of action ☐

Use appropriate rates of pesticides ☐

Use tank mixes with multiple modes of action ☐

Keep informed of resistance development ☐

Other (specify)……

H. Checking and recording the success of the applied crop protection measures

Success or failure of intervention measured ☐

Success or failure of intervention recorded ☐

Crop yields /disease and pest incidences recorded ☐

Results discussed with adviser ☐

Member of discussion group ☐

Other (specify)……

Annex 3: Invasive species reported in Kenya.

Species	**Year of arrival**	**Impact on native plants, animals and ecosystems**	**Impact on humans (livelihood, transport, health etc.)**

1. Arthropods			
Larger grain borer *Prostephanus truncatus*	1983	Pest of stored maize and cassava	Heavy post-harvest losses in maize; trade restrictions
Serpentine leafminer *Liriomyza trifolii* (Burgess)	1976	Pest of many horticultural crops	Crop losses and loss of overseas markets due to quarantine requirements
Western flower thrips *Frankliniella occidentalis* (Pergande)	1989	Pest of many flower crops, pulses and horticultural crops	Intensified use of pesticides; loss of crop and capital due to quarantine requirements
Cypress aphid *Cinara cupressivora*	1991	Cypress trees decimated	Degraded environment
Russian aphid *Diuraphis noxia*	1995	Barley and wheat production reduced	Less food, income available
Cassava mealybug *Phenacoccus manihoti*	1989	Reduced cassava production	Less food, income available
Leucaena psyllid *Heteropsylla cubana*	1992	Reduced fodder	Loss of capital
Citrus woolly whitefly *Aleurothrixus floccosus*	1970s	Reduced fruit production	Loss of capital
Purple tea mite *Calacarus carinatus*	1976	Reduction in tea leaf production	Loss of capital
Tomato russet mite *Aculops lycopersici*	1976	Reduced tomato production	Loss of capital
Louisiana crayfish *Procambarus clarkii*	1970	Reduction of flora and fauna, increased turbidity	Harvested by man
2. Micro-organisms			
Crown gall *Agrobacterium tumefaciens*	1995	Reduced production in roses	Loss of capital
Black Sigatoka *Mycosphaerella fijiensis*	1988	Reduced banana production	Less food, income available
Panama disease *Fusarium oxysporum f.* sp. *cubense*	1952	Reduced banana production	Less food, income available

Cassava mosaic disease ACMV (UgV) (*Begomovirus*)	1994	Reduced cassava production	Less food, income available
Maize streak disease (MSV) (*Geminivirus*)	1936	Reduced maize production	Less food, income
Fruit and leaf spot *Phaeoramularia angolensis*	1972	Reduced citrus production	Less food, income
Citrus greening disease (bacterial)	1972	Reduced citrus production	Less food, income
Barley yellow dwarf virus (BYDV)	1983	Reduced barley and wheat production	Less food, income available
Napier grass smut *Ustilago kamerunensis*	1992	Reduced fodder production	Loss of capital
Coffee berry disease *Colletotrichum coffeanum*	1940	Reduced coffee production	Loss of capital
3. Plants			
Water hyacinth *Eichhornia crassipes*	1989	Serious	Very serious
Water fern *Salvinia molesta*	1984	Serious	Serious
Prosopis spp.	1983	Serious	Serious
Wild garlic *Allium vineale*	1993	NA	Serious to horticultural farmers
Prickly pear *Opuntia* spp.	1940s - 50s	Out-competes native plants, precludes grazing and browsing near it	Poisonous, spines dangerous
Mexican marigold *Tagetes minuta*	Unknown	Minimal	Increased weed eradication costs
Lantana *Lantana camara*	1950s	Out-competes other vegetation	Poisonous to livestock, habitat for tsetse flies
Morning glory *Ipomoea* spp.	1960s	Grows over and out-competes other plants	Reduced pasture
Eucalypt *Eucalyptus* spp.	1939 - 45	Minimal, though some evidence it retards recruitment of native species	None

4. Vertebrates			
Nile perch *Lates niloticus*	1960s	Greatly reduced abundance of native cichlids	Economic boost to fishers, reduced catch of smaller species
House sparrow *Passer domesticus*	Early 1900s	Displacing local sparrows	Noisy, messes buildings with nests
Lovebird *Agapornis* sp.	19th century	Competing with local species for nest holes	Pests especially for cereals
Indian house crow *Corvus splendens*	1947	Displacing native species, kills fruit bats	Urban pest, damages crops, hazard at airport

Source: Kedera, C. and Kuria, B.(2018). Kenya Plant Health Inspectorate Service,Nairobi.: http://www.fao.org/docrep/008/y5968e/y5968e10.htm, retrieved, 23rd July, 2018

Annex 4: Provides the description of these agro-ecologies in Kenya. In addition, it also provides the agro-enterprises suitable in each zone (see appendix 1 on crop production and area in Kenya).

TABLE I: AGRO-ECOLOGICAL ZONES OF THE TROPICS

Belts of Z \ Main Zones	0 (perhumid)	1 (humid)	2 (subhumid)	3 (semi-humid)	4 (transitional)	5 (semi-arid)	6 (arid)	7 (perarid)
TA Tropical Alpine Zones Ann. mean 2-10° C	Glacier / Mountain swamps	I. Cattle-Sheep Zone	II. Sheep Zone					High altitude deserts
UH Upper Highland Zones Ann. mean 10-15° Seasonal night frosts	e	Sheep-Dairy Zone	Pyrethrum-Wheat Zone	Wheat-Barley Zone	U. Highland Ranching Zone	* U. H. Nomadism Zone 4)		
LH Lower Highl. Zones Ann. mean 15-18° M. min. 8-11° norm. no frost	e c o	Tea-Dairy Zone	Wheat/Maize 2), Pyrethrum Zone	Wheat/M 2), Barley Zone	Cattle-Sheep-Barley Zone	L. Highland Ranching Zone	* L. H. Nomadism Zone 4)	
UM Upper Midland Zones Ann. mean 18-21° M. min. 11-14°	N	Coffee-Tea Zone	Main Coffee Zone	Marginal Coffee Zone	Sunflower-Maize 3) Zone	Livestock-Sorghum Zone	U. Midland Ranching Zone	U. Midland Nom. Zone 4)
LM Lower Midland Zones Ann. mean 21-24° M. min. >14	* e o L	L. Midl. Sugarcane Zone	Marginal Sugarcane Zone	L. Midland Cotton Zone	Marginal Cotton Zone 6)	L. Midland Livestock-Millet Zone	L. Midland Ranching Zone	L. Midland Nom. Zone 4)
L Lowland Zones IL Inner Lowland Z. Ann. mean >24° Mean max >31°	* o L	* Rice-Taro Zone	* Lowland Sugarcane Zone	* Lowland Cotton Zone	* Groundnut Zone	Lowland Livestock-Millet Zone	Lowland Ranching Zone	Lowland Nom. Zone 4)
CL Coastal Lowl. Z. 5) Ann. mean >24° Mean max <31°	* o	* Cocoa-Oilpalm Zone	Lowland Sugarcane Zone	Coconut-Cassava Zone	Cashewnut-Cass. Zone	Lowland Livestock-Millet Zone	Lowland Ranching Zone	Lowland Nom. Zone 4)

1) Inner Tropics, different zonation towards the margins. The T for Tropical is left out in the thermal belts of zones (except at TA), because it is only necessary if other climates occur in the same country. The names of potentially leading crops were used to indicate the zones. Of course these crops can also be grown in some other zones, but they are then normally less profitable.
2) Wheat or maize depending on farm scale, topography, a.o.
3) Maize is a good cash crop here, but maize also in LH 1, UM 1-3, LM and L 1-4.
4) Nomadism, semi-nomadism and other forms of shifting grazing.
5) An exception because of the vicinity of cold currents are the tropical cold Coastal Lowlands cCL in Peru and Namibia. Ann. mean there between 18 and 24°.
6) In unimodal rainfall areas growing periods may be already too short for cotton. Then the zone could be called Lower Midland Sunflower-Maize Zone.
* Not in Kenya