THE UNITED REPUBLIC OF TANZANIA

AGRICULTURAL SECTOR DEVELOPMENT PROGRAM (ASDP)

INTEGRATED PEST MANAGEMENT PLAN (IPMP)

REVISED VERSION

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Abbreviations and Acronyms

AIDS	Acquired Immunodeficiency Syndrome
AFSP	Accelerated Food Security Project
ASDP	Agricultural Sector Development Programme
ASDS	Agriculture Sector Development Strategy
ASP	Agriculture services providers
ASSP	Agricultural Services Support Programme
AVRDC	Asian Vegetable Research Development Centre
CBB	Coffee Berry Borer
CBD	Coffee Berry Disease
CBO	Community Based Organisation
CBSD	Cassava Brown Streak Disease
CLR	Coffee Leaf Rust
CMD	Cassava Mosaic Disease
CORMA	Client-Oriented Research and Development Management Approach
DADP	District Agriculture Development Plans
DGIC	Directorate General for International Cooperation
DPPO	District Plant Protection Officer
DRDP	District Rural Development Programme
EC	European Community
ECGA	Eastern Cotton Growing Area
ESMF	Environmental Social Management Framework
FAO	Food and Agriculture Organisation
FFS	Farmers Field Schools
FRG	Farmer Research Groups
FS	Field Service
GLS	Grey Leaf Spot
GTZ	Gesellschaft fur Technische Zusammenarbeit
HPR	Host Plant Resistance
ICIPE	International Centre of Insect Physiology and Ecology
IDA	International Development Agency
IFAD	International Fund for Agricultural Development
IPM	Integrated Pest Management
IPN	Integrated Plant Nutrition
IPPM	Integrated Pest Production Management
JICA	Japan International Cooperation Agency
KAEMP	Kagera Agricultural Environmental Management Project
LGA	Local government authority
LGB	Larger Grain Borer
LVEMP	Lake Victoria Environmental Management Project
LZARDI	Lake Zone Agricultural Research and Development Institute
M&E	Monitoring and Evaluation
MAFS	Ministry of Agriculture and Food Security
MANREC	Ministry of Agriculture, Natural Resources, Environmental and Cooperatives
MARA-FIP	Mara Region—Farmers' Initiative Project
MCM	Ministry of cooperatives and marketing
MOA	Memorandum of Agreement
MSV	Maize Streak Virus
MWLD	Ministry of Water and Livestock Development
NAEP	National Agricultural Extension Programme
NALP	National Agricultural and Livestock Policy
NARS	National Agricultural Research Systems
NEMC	National Environmental Management Council
NGO	Non governmental organizations
NPV	Nucleopolyhedrovirus
OPEC	Organization of Petroleum Cooperation
PADEP	Participatory Agriculture Empowerment Project
PCS	Pest Control Services

PHS	Plant Health Services
PMD	Powder Mildew Disease
PMP	Pesticides Management Plan
POP	Persistent Organic Pollutants
PPD	Plant Protection Division
PRA	Participatory Rural Appraisals
RAS	Regional Administrative Secretary
RYMV	Rice Yellow Mottle Virus
SGR	Strategic Grain Reserve
SIIC	Smallholder Irrigation Improvement Component
SMS	Subject Matter Specialist
SPFMV	Sweet potato feathery mottle virus
SPFS	Special Programme for Food Security
SPSVV	Sweet potato sunken vein virus
SPVD	Sweet Potato Virus Disease
SUA	Sokoine University of Agriculture
URT	United Republic of Tanzania
TPRI	Tropical Pesticides Research Institute
UDSM	University of Dar es Salaam
ULV	Ultra Low Volume
VEO	Village Extension Officer
WCGA	western cotton growing areas
WFF	Ward Farmers Forum
WHO	World health organization
ZARDEF	Zonal Agricultural Research and Development Funds
ZARDI	Zonal Agriculture Research and Development Institutes
ZEC	Zonal Executive Committees

Executive Summary

The Government of Tanzania (GoT) has asked the World Bank for support for a broad package of complimentary programmes comprising of the following two operations:

- Accelerated Food Security (AFSP) - a new operation to support the government's national agriculture inputs voucher scheme (NAIVS) for fertilizers and seeds (US$ 150M).
- Additional Financing for the Agricultural Sector Development Programme (ASDP)- an on-going operation for rehabilitation of small scale irrigation schemes and support scaling up of integrated soil fertility management (US$ 30M)

The activities funded under these two operations will lead to the increased use of agricultural pesticides, inter alia, in the sector. To ensure these issues are managed using an integrated management approach and that this approach is mainstreamed more broadly and nationally across the sector, and also for compliance with the World Banks own Operational Policy OP4.09 on Pest Management and the GoT own requirements, the GoT is required to have in place an effective and sustainable Integrated Pest Management Plan (IPMP) beyond the lifetime of these operations.

The GoT would like to adopt and mainstream the current IPMP prepared under the ASDP in August 2004, for use generally in Tanzania, and particularly also to cover the use of agricultural pesticides in each of the two operations listed above. The World Bank reviewed the current IPMP to substantiate its adequacy, specically to confirm/acertain:

1. The overall comprehensiveness of the original IPMP to ensure it captures all of the activities being funded in each of the two operations thereby ensuring continuing compliance with OP4.09 and the GoT's own requirements.
2. GoT's performance in implementing the original IPMP in the ASDP which has been effective since 2006.
3. Any gaps in the institutional and regulatory framework within the GoT to effectively implement the IPMP and develop a tangible plan to address these gaps in these operations.

The objective is to ensure that the GoT prepares, adopts, maintains and effectively implements and monitor's one IPMP throughout the Agriculture Sector during and well beyond the life of these operations. The review:

1. Revised and Updated IPMP including Monitoring Plan for its implementation (IPMP).
2. Developed Capacity Building Plan document including monitoring plan for its implementation.

The review of the overall comprehensiveness of the IPMP Final Report of August 2004 was carried out as detailed in section 1 (Approach) in the context of the Accelerated Food Security Project (AFSP) and Additional Finacing for ASDP. The ASDP/AFSP request will support the government's National Input Voucher Schemes (NAIVS) aimed to improve small scale farmer access to fertilizers and improved seed. The additional Financing for ASDP will support long-term productivity enhancing interventions expansion of small scale irrigation and integrated soil fertility management to complement NAIVS. Although the NAIVS and ASDP Additional Financing would not directly support purchase of any pesticides, improvements envisioned under the programme i.e. increase use of inputs—particularly chemical fertilisers, improved seeds and irrigation facilities, are likely to cause an increases in pest pressure (new pests and upsurge of historically minor pests) which may lead to an increase in the use of synthetic pesticides, and associated potential human and environmental hazards, and hence the requirements for a mitigation plan. The IPMP is the instrument designed to minimize potential adverse impacts on human and environmental health through promotion of integrated pest management (IPM).

Due to factors associated with 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.), it has not been possible to provide a list of anticipated pests. This requires frequent pest risk surveillance and continuous updating of the existing pest list.

Tanzania has the potential for growing a wide range of crops (staples, cash and horticultural) across different agro-ecological zones. The pest complexes associated with the crops are complex. The country has also to deal with outbreak migratory pests as well as non-migratory outbreak pests and alien invasive species. Overall, pesticide use has been the first line of pest control in many of the crops grown for many years. However, in recent years, starting from 1990s, the government in collaboration with other development agencies have been experimenting and piloting with integated pest management in various parts of the country, on different crops and farming systems. Overall, there is a wealth of experience on IPM in the country that needs to be scaled up. Tanzania has an IPM supportive policy framework that should be used as the platform to further IPM promotion nationwide.

The PPA 1997 and Regulations 1997 including related policies and regulations: the National Environmental Policy (NEP) 1997, the Environmental Act (EA) 2004, the Environmental Impact Assessment and Audit (EIA&A) Regulations, 2005, and the Environmental Management [EM) (Soil Quality Standards) Regulations, 2007, provides a framework for environmental protection considerations by different sectors into the mainstream of decision making to ensure minimum environmental negative impacts due to agricultural practices and use of external inputs. The NEP 1997, EA 2004, the EIA&A Regulations 2005 and EM (Soil Quality Standards) Regulation 2007 requires the agriculture sector to ensure food security and eradication of rural poverty through the promotion of production systems, technologies and practices that are environmentally sound, with emphasis on strengthening of environmentally sound use, monitoring, registration and management of agro-chemicals use.

Despite Ministry of Agriculture Food Security and Co-operatives efforts to implement the plant protection policies and regulations, there are still key weakenesses in the enforcement of the respective policies and related regulations. In particular, there is a need for (1) Review and update of the PPA 1997 and Regulations 1999 to keep pace with changing global environment (International Regulations and Standards, trade liberalizationa and climate change), (2) Regulators should be capacitated (provided adequate resources) to monitor and control illegal trading of pesticides (3) extension services in pesticide use should be improved (4) Farmers should be given quality education in pesticide use (5) Awareness creation and sensitization on the PPA 1997 and regulations 1999 should be done at national level and cover all zones and districts to be effective (6) Sensitization should target all leaders at district, ward and village levels (7) Increase the number of pesticide inspectors at district, ward and village levels (8) MAFSC to facilitate regular inspections preferably every six months (9) Train agrochemical stockists and retailers at all levels (9) Strengthen the inspectorate services at all levels.

Sustainable establishment of proposed irrigation schemes will depend on effective M&E that focuses on the environmental and social safeguards plan. A comprehensive M&E framework has been developed for ASDP to provide guidance for effective tracking of progress towards achievement of the objectives of ASDP and expected impacts. Although the framework provides a revised set of indicators for measuring impact, outcomes and outputs, environmental issues are not adequately integrated in the activities of ASDP, and yet, according to the Environmental Impact Assessment (EIA) and Audit Regulations, 2005 G.N. No 349 of 2005, 1st schedule of the EIA Regulations, EIA is mandatory for all irrigation schemes prior to implementation. According to EIA Regulations, 2005, the role of NEMC is enforcement, review EIA reports, auditing and advisory. However, currently National Environmental Management Council (NEMC) does not have the capacity to enforce the regulations as required, an issue that needs to be addressed.

1. Approach

Reviewing and up-dating of the IPMP Final Report August 2004 was a process that involved literature reviews and consultations with relevant government departments and project staff. Literature review included:

- Desk review of the IPMP final report of August 2004
- Desk review of the ASDP (Support through basket fund) Government Programme document, ASDP Credit 41920, ASDP Aide Memoire for the 3rd Joint Implementation Review/IDA MTR September/October 2008 draft report, JIR 3 Annexes
- Relevant Policy and legal document between 2004 and 2009: Environmental Management Act 2004, the Environmental Impact Assessment and Audit Regulations, 2005-G.N. No 349 of 2005, The Environment Management Act CAP 191: Environmental Management (Soil Quality Standards) Regulations, 2007.
- World Bank Safeguard Policies in particular OP 4.09 and BP 4.01, Annex C
- Plant protection related reports and publications for work done in Tanzania 2004 to 2009
- Web search for additional information

List of Institutions and persons consulted Annex 1b.

2. Description of the Programme

The Government of Tanzania with financial assistance from the World Bank, International Fund for Agricultural Development (IFAD) and other bilateral donors is planning to implement an Agricultural Services Support Programme (ASSP), which is part of the overall Agricultural Sector Development Programme (ASDP). The ASDP has two main objectives (1) to enable farmers to have better access to, and use of agricultural knowledge and technologies, marketing systems and infrustracture, all of which contribute to higher productivity and farm incomes, and (2) to increase private sector investment in agriculture based on improved regulatory and policy environment. The Accelerated Food Security Project (AFSP) will provide complementing support to scale up the national agricultural input voucher scheme (NAIVS) as a strategy to ensure sustainable agricultural growth and food security through improved small scale farmer access to fertilizers and improved seed. The requested additional financing for ASDP will support the expansion of small scale irrigation schemes. The additional funding and AFSP are fully in congruent with the Country Assistance Strategy (CAS) which is aligned to the Government's National Strategy for Growth and Reduction of Povert (MKUKUTA 2005-2010). The MKUKUTA focuses on outcomes in three broad themes (1) growth and reduction of income poverty (2) improvement of quality of life and social well being and (3) governance and accountability. The ASDP and AFSP are aligned to the first cluster. The additional financing will continue to support the Government of Tanzania's programme to enable farmers have better access to and use of agricultural knowledge, technologies, marketing systems and infrustracture, all of which contribute to higher productivity, profitability and farm incomes.

It is planned that the AFSP will be about US$ 150 million equivalent. The proposed additional funding for ASDP will be US$ 30 million, aimed at complementing the national voucher system interventions of the AFSP. Although both AFSP and the additional financing for ASDP would not provide for purchase of any pesticides, improvements envisioned under the programme i.e. increase use of inputs—particularly chemical fertilisers, improved seeds and irrigation facilities, are likely to cause increases in pest pressure (new pests and upsurge of historically minor pests) which may lead to an increase in the use of synthetic pesticides. According to the World Bank OP-4.09, a good pest management plan (PMP) is a basic tool that will facilitate reduction of potential negative impacts of agricultural intensification. A pest management plan is a comprehensive plan developed when there are significant pest management issues e.g. new land use development or changed cultivation practices for example through introduction of irrigation schemes, increase in the use of inorganic fertilisers, diversification into new crops and use of improved seeds and varieties which will happen under the AFSP and the ASDP additional financing.. The PMP is designed to minimize potential adverse impacts on human and environmental health through promotion of integrated pest management (IPM).

The Bank Safeguard Policy OP 4.09 stipulates that “in assisting borrowers to manage pests that affect either agriculture or public health, the Bank supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides”, and “in appraising a project that will involve pest management, the Bank assesses the capacity of the country’s regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such as capacity”.

The main purpose of preparing this Integrated Pest Management (IPM) guidelines is to: (i) assess the current and anticipate pest problems in the programme areas; (ii) review the country experiences on IPM; (iii) develop a pest management plans (PMPs) using recommended best-practices; (v) develop monitoring and evaluation systems for the various pest management practices of the PMPs based on the government laws and regulations under the World Bank policy.

Sector Related Goal: The Programme would contribute to the ASDP objective i.e. to achieve sustained agricultural growth rate of 5%/year primarily through the transformation from subsistence to commercial agriculture, which is in line with the Tanzania Development Vision (TDV) 2025. The Vision 2025 envisages raising the standard of living of Tanzanians to those of a typical medium-income country through ensuring food security, improving incomes and increasing export earning.

Development Objectives. The ASDP has two main objectives: (i) to enable farmers to have better access to and use of agricultural knowledge, technologies, marketing systems and infrastructure, all of which contribute to higher productivity and farm income and (ii) to increase private sector investment in agriculture based on an improved regulatory and policy environment.

The project has two main components that are aligned to the Government’s national and local level budget, planning and prioritization process. These are:

Component 1: Local Level Support. This component primarily supports achievement of the first project objective listed above through improvements of Local Government Authority capacity to plan, support and co-ordinate agricultural services and investments in a more efficient, participatory and sustainable manner. Support is provided to develop and implement District Agricultural Development Plans (DADPs) (financed through District Agricultural Development Grants (DADG)), including increasing farmer influence in resource allocation decisions for services and investments; progressing agricultural services reform and improving the quality of public expenditure. In addition support to achieving the second project objective is provided through improvements in the local regulatory environment for economic activities in agriculture. The local component has three sub-components aligned with the local level block grant system of the Government of Tanzania: (i) local agricultural investments, (ii) local agricultural services, and (iii) local agricultural capacity building and reform. The component finances advisory services, training, and infrastructure, including small scale irrigation development at district level. Access to resources by Local Government Authorities is linked to performance on local level planning and implementation, agricultural services reform, the quality of local investments, and the local policy and regulatory environment. With regard to irrigation, the component is primarily financed through the DADG, supporting demand driven small scale irrigation investments in DADPs. The District Irrigation Development Fund (DIDF), a competitive funding mechanism provides supplemental support for small scale irrigation on competitive basis.

Component 2: National Level Support: This component supports achievement of both project objectives. The first objective is supported through improvements to the relevance and responsiveness of the agricultural research system including greater linkages with extension. The second objective is supported through improvements to the national level policy environment, and through developing mechanisms for greater public-private partnerships. Support is provided to reform agricultural services, primarily research and extension; to improve the overall sector policy framework; to carry out preparatory work and investment in national level irrigation through public-private partnerships; to simulate market development; and to improve food security and sector co-ordination. With regard to irrigation, the Development Partner

Basket Fund support 1.4 percent of the proposed national level expenditures for National Irrigation Development Fund (NIDF) irrigation activities. The activities financed are preparatory work for small, medium and large scale infrastructure investments in National and International Basins, including: the participatory development and operationalization of appropriate identification, screening and ranking mechanisms for national level irrigation investments; support for technical designs, studies and environmental impact assessments, including the Strategic Environment Assessment (SEA); capacity strengthening; awareness raising activities; and improvement of the policy environment for public-private partnerships. Upon the completion of this preparatory work, the Development Partner Basket Fund will additionally finance though the NIDF physical infrastructure investments in irrigation at the national level in National Water Basins only, through public-private partnerships.

Programme Component outline

Component 1: Local Level Support
Sub-component 1.1: Local Agricultural Investment
Sub-component 1.2: Local Agricultural Services
Sub-component 1.3: Local Agricultural Capacity Building and Reform

Component 2: National Level Support
Sub-component 2.1: Agricultural Services
Sub-component 2.2: Natioanl Irrigation Development
Sub-component 2.3: Marketing and private Setor Dvelopment
Sub-component 2.4: Food Security
Sub-component 2.5: Coordination , Monitoring and Evaluation

Organization and implementation arrangements

Implementation arrangements of ASDP are organized in two levels. (i) Local level which includes district, ward and village levels targeted by componenet 1 of the program; and (ii) national and zonal levels. The primary responsibility for implementation of the local level component is the Prime Minister's Office, Regional Administration (PMO-RALG) and Local Government Authorities (LGAs), while implementation of national level component is the responsibility of Agriculture Sector Lead Ministries (ASLMs), (Ministry of Agriculture, Food Security and Cooperatives, Ministry of Livestock Development, Ministry of Industry, trade and Marketing and Ministry of Water and Irrigation). Regional secretariats assist LGA on matters realated to district plans. Zonal research and development institutions provide services on the basis of agroecological zones.

3. Background information and justification

3.1 The existing landuse pattern, agro-ecological and farming zones

Farming systems are dictated by altitudes, temperature, rainfall and several other factors which sum up to agro-ecological zones.

Table 1 Agrucltural zones, altitudes and rainfall classes

Zones		Altitudes (m)	Rainfall (mm)	
C	Central	0-500 (low lands	A	< 500 (arid)
E	Eastern	500-1000 (low intermediate)	B	500 – 800 mm (semiarid)
L	Lake	1000-1500 (high intermediate)	C	800 – 1000 mm (moderately wet)
N	Northern	1500-2000 (highlands)	D	1000 > 1500 mm (wet)
S	Southern	> 2000 mm (very high)		

In general, small scale subsistence farming is dominant in Tanzania due mainly to various interrelated factors;

- Over dependence on rainfed agriculture and less on irrigation agriculture
- Inadequacy of farming equipment e.g. predominance of the hand hoe
- Difficulties of acquiring inputs e.g. fertilizers; pesticides etc. either due to lack of credit facilities or simply lack of capital resources
- Unreliability of markets couples with lack of storage facilities etc.

Thus the prevailing conventional low-input and low-output agriculture production system has resulted in high rates of environmental degradation and decline in agricultural productivity.

Agro-ecological zones
According to the JICA report of 2002 agro-ecological zones of Tanzania are categorizable as follows:-

- Coastal plains
- Eastern plateaux and mountain blocks
- High plains and plateaux
- Volcanoes and rift depressions
- Central plains
- Rukwa-Ruaha rift zone (in alluvial plains)
- Inland sedimentary sediments
- Western highlands

The zones have distinguishing features in terms of soils and topography but it is pertinent to quickly add the fact that there is no clear distinction between zones. For example most high plains and plateaux are at relatively high altitude; but in the same zone there are also places of low altitudes; in fact as low as 500m. Similarly, in the volcanoes and rift depressions most soil/topographical characteristics are of medium altitude plains with mainly sandy and loam of low fertility. However there are also high altitude plateaux with volcanic ashes of high fertility in low zones.

3.2 Pest management practices

Until half a century ago crop protection practices were integral parts of any cropping system. Growing world population required dramatic increases of agricultural production. From the 1940's to the 1970's, a spectacular increase in yield was obtained with the aid of an intensive development of technologies, including the development of synthetic agro-chemical inputs (fertilizers and pesticides). In many countries

this advancement was coupled with the development of farmer education through efficient extension services. In many developing countries, however, this foreign technology was dumped without adequate support systems. Indiscriminate use of synthetic agro-chemical inputs is rampant partly because of high government subsidies and inefficient extension services. Tanzania under the ASDP / AFSP project will promote agricultural intensification through more use of fertilizers, improved seeds and establishment of irrigation facilities, a situation that could lead to increased pest pressure and more use of synthetic pesticides.

Many developing countries adopted a system of technology transfer in which research apparatus developed or adapted technology that was transferred to farmers by an extension unit. Crop protection measures were often reduced to easy-to-use pesticide application recipes, aimed at immediate and complete destruction 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 fertilisers made farmers more dependent on high external inputs.

Recently, it was realised that this conventional approach has its disadvantages. Conspicuous drawbacks are:

Undesirable side-effects of pesticides

- human toxicity; poisoning and residue problems
- destruction of natural enemies and other non-target organisms
- development of resistance in target organisms
- environmental and water pollution

Pesticides are expensive and good management of their use requires skills and knowledge. Proper use of pesticides can contribute to poverty reduction. However, if misused, they can increase poverty of end users: the existence of sub-standard inefficient products in the market can increase production costs (financial, environmental and human health). It is therefore imperative to put in place a good integrated pest management plan (IPMP) to ensure responsible use of pesticides and effective management of potential pest occurences.

4. Existing and anticipated pest problems

Existing pest (insect pests, diseases, weeds, vermines, nematodes, bird pests etc) problems in Tanzania are described in this chapter. This list is based on current key staples, cash and horticultural (fruits and vegetables) crops (Table 2). 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 occurance of new pest problems. This requires frequent pest risk surveillance and continuous updating of the existing pest list, an issue already being addressed under the MAFC/One UN Joint Programme (JP) 6.2-FAO project UNJP/URT/129/UNJ: Strengthening National Disaster Preparedness and Response Capacity

4.1 Staple Crops

Staple crops (cereals, tubers and roots, banana and grain legumes) vary between different parts of Tanzania largely due to variations in agro-ecological conditions. The importance of each crop varies from one area to another and the priority list varies depending on the source of information. However, maize, rice, banana, grain legumes and cassava are the most popular staple for many Tanzanians, followed by sorghum, millet, sweet potato and wheat. Depending on areas, some of these crops e.g. rice, maize, beans, sorghum, chickpea and millet are regarded as food and cash crops (Table 2). In the Lake zone, rice and chickpea are major cash crop, which gives better returns than cotton in most seasons while maize is a major cash and food crop in some parts of the Southern Highlands. Similarly, production of cash and horticultural crops vary between the major agroecological zones (Table 2).

Horticultural (fruits and vegetable) production in Tanzania is gradually gaining importance over other crops largely because they have higher cash returns/unit area compared to the traditional cash crops. The sub-sector is predominantly a cash cow for youth and women, most of who do not own large tracks of land but depend on hired pieces of land. Unfortunately the sector is still largely under developed and under resourced, lacks essential infrastructure, is threatened by a wide range of pests including allien invasive species (AIS).

Table 2 Summary of major staple, cash and horticulture crops grown in different agro-ecological zone of Tanzania

Zone	Regions	Major crops		Horticultural crops
		Staples	**Cash**	Fruit and vegetables
Central	Dodoma Singida	Sorghum Millet Maize Cassava Rice beans Sweet potato Potatoes	Sunflower Tobacco Cotton Sunflower Sesame Grapes	Tomatoes Onions Grapes
Eastern	Morogoro Tanga Coast Dar es Salaam	Maize Rice Beans Cassava Round potatoes Sorghum Banana	Coffee Cotton Cashew Sugarcane Tea	Citrus fruits Pineapples Brassicas (cabbage) Tomatoes Mangoes Coconuts Okra African egg plants, curcubits Pears, Onions, Amaranthus

Table 2 continued

Zone	Regions	Major crops	Horticultural crops	Zone
		Staples	**Cash**	Fruit and vegetables
Lake	Mwanza Shinyanga Kagera Mara	Rice Sorghum Maize Millet Beans Cassava Sweet potato Bananas Chickpea	Coffee Rice Cotton Groundnuts Chickpea Vanilla Sunflower Sesame	Pineapples Tomatoes Citrus fruits Water melons
Northern	Arusha Kilimanjaro	Maize Finger millet Rice Beans Banana	Coffee Rice Cotton Wheat Barley Sisal	Tomatoes Onions Brassicas (cabbage, kale) Irish Potatoes Mangoes Peas African egg plants Water melons Amaranthus and okra
Southern Highlands	Iringa Mbeya Ruvuma Rukwa	Maize Sorghum Finger millet Rice Beans Cassava Sweet Found potatoes	Tea Tobacco Coffee Rice Cotton Sunflower Wheat Cashew Pyrethrum and palm oil	Bananas Tomatoes Mangoes Pineapples Round Potatoes Peas Brassicas (cabbage) Onions
Southern	Mtwara Lindi	Sorghum Maize Cassava	Cashew	Coconuts
Western	Tabora Kigoma	Maize Sorghum Rice Cassava Sweet potato Beans	Tobacco Coffee Rice Groundnuts	Sweet Potatoes Mangoes Bananas

4.1.1 Maize

Maize is grown in all the agro-ecological zones (Table 2). It can be grown over a wide range of altitude ranging from 0-2400 m.a.s.l. The crop requires an optimum rainfall of 1800 mm. According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 1,564,000 ha and 2,810,490 ha were put under maize cultivation in 1995/6-2002/03 respectively with overall production of 1,831,200 and 3,415,600 tons. In terms of percentage contribution in 2002/03, the Southern Highlands produced 45%, followed by Lake Zone (20%), Northern Zone (11.0%), Western Zone (10%), Eastern Zone (8%), Central Zone (4%), and Southern Zone (2.5%). The southern highlands supplies 90% of the strategic grain reserve (SGR), thus making it the national grain basket.

The major insect pests limiting production in Tanzania include the African maize stakeborer (*Buseolla fusca*), pink stalkborer (*Sesamia calamistis*), spotted stalkborer (*Chilo partellus*) the African armyworm (*Spodoptera exempta*) and post harvest insect pest particularly the larger grain borer, *Prostephanus truncates.* The major diseases include leaf rusts (*Puccinia sorghi* and *P.polysora*), leaf blights

(*Helminghtosporium turcicum* and *maydis)*, Maydis leaf blight (*Helminthosparium maydis*), maize streak virus vectored by *Cicadulina mbila*, grey leaf spot (GLS) (*Cerospora zaea-maydis*) and Gibberella ear rots.

Because the crop is grown under different agro-ecological zones, pest problems (pre and post harvest) associated with it and the recommended management options vary accordingly (Table 2.1).

Table 2.1 Major maize pest problems and recommended management practices

Zone	Pest			Recommended management practices
S. Highlands	Insects	Pre-harvest	Stalk borers (*Busseola fusca*)	• Destroy (make compost, burn or feed livestock) crop residues to eliminate diapausing pupae • Early sowing reduces infestation • Intercropping with pulses • Neem(arobani) powder (4-5 gm i.e. pinch of 3 fingers) per funnel • Neem seed cake (4 gm/hole) during planting • Use the extract of *Neuratanenia mitis*, a botanical pesticide
			African armyworm (*Spodoptera exempta*)	• See details under commun ity-based earlywarning and control (section 4.4.2.3)

Table 2.1 continued

Zone	Pest			Recommended management practices
	Diseases		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, 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
Lake Zone	Insects	Pre-harvest	Stalk borers (*Busseola fusca)* Leaf hoppers (*Cicadulina mbila*)	• Crop rotation • Time of planting and destruction of crop residues • Intercropping • Using resistant varieties like TMV-1, Staha • Apply recommended insecticides
			African armyworm (*Spodoptera exempta*)	See details under community-based earlywarning and control (section 4.4.2.3)

Table 2.1 continued

Lake zone contned		Pest		Recommendation
	Diseases		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*)	• Observe recommended timely planting • Effective crop rotation • Use disease free certified seeds • Plant at recommended spacing and seed rate
			Leaf blights (*Helminthosparium turcicum and maydis*)	• Crop rotation • Deep plough of crop residues
			Common smut (*Ustilago maydis*)	• Use disease free planting seeds • Crop rotation • proper removal of crop residue after harvest
	Weeds		all types	• Crop rotation • Proper land preparation • Timely weeding (at 2 and 5 weeks after planting) • Use recommended herbicides when necessary
			Witch weed (*Striga* spp)	• Hand pulling before 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
	Vermines		Baboons, monkeys, wild pigs, birds, rats, hippopotamus	• Farming in block • Cultivate crops that are not preferred by the prevalent vermin • Hunting (farmer groups) • Use of traps for rats • Bird, monkey and baboon scaring • Hippo trenches to deter hippos

Table 2.1 continued

Zone	Pest			Recommended management practices
Northern	Insects	Pre-harvest	Stalk borers	• Use of botanicals, e.g. Neem, and pyrethrum extract • Use of wood ash • Biological control. • Intercropping with beans and sunflower • Sanitation/crop hygiene (removal of all stalks after harvest)-crop residues used as fodder
			Armyworms (*Spodoptera exampta*)	• See details under migratory pests (section 4.4.2.3)
		Post harvest	Larger grain borer (*Prostephums truncates*) Weevil (*Sitophilus* spp.)	• Use air tight metal containers for starage • Dehusk and thresh after aharvest • Ensure grain in properly dried, cleaned before storage • Dust with recommended insecticide and/or botanical extracts
	Diseases		Maize streak virus (MSV) (*Cicadulina mbila*)	• Timely planting to avoid the diseases • Plant recommended tolerant varieties e.g. TMV-1, Kilima ST, Staha-ST, Kito-ST
			Leaf blights (*Helminthosparium turcicum and maydis*)	• Crop rotation • Deep plough of crop residues • Breeding of resistant varieties
			Leaf rusts (*Puccinia sorghi*)	• Cultural practices, e.g. timely sowing, field hygiene (feeding crop residues to livestock) • Crop rotation • Breeding of resistant varieties • Clean seeds • Reduce density • Allow adequate aeration
			Grey leaf spot (*Cercospora zeae-maydis)*	• Crop rotation • Stubble tillage and removal of crop residues • Timely planting of recommended early maturing varieties e.g. Kilima, TMV-2 UH6010

	Weeds		All types	• Proper land preparation • Crop rotations • Intercropping with legume crops • Timely weeding • Apply recommended herbicide when necessary

Table 2.1 continued

Northen Zone continued			Pest	Recommendations
			Mexican poppy (*Argemone mexicana*) (Anon, 2000) –a new invasive weed	• Plough land long before the short (vuli) rains so that the weed seeds are buried. • . Plough under when at 4-6 leaves and/or before they begin to flower. • Intercrop maize and macuna. Plant the labalab 5-6 weeks after maize at a spacing of 30cm between plants. • Practice a two-season maize/macuna rotation. Leave the field fallow under macuna after every two seasons. • Use gyphosate or gramaxone if necessary
Western	Insects	Pre-harvest	Stalk borers (*Busseola fusca*)	• Biological control • Intercropping • Sanitation/crop hygiene (removal of all stalks after harvest) • Use of botanicals, e.g. Neem, extract • Use of wood ash
			Armyworms (*Spodoptera exampta*)	• See details under commun ity-based earlywarning and control (section 4.4.2.3)
		Post harvest	Larger grain borer (*Prostephums truncates*) Weevil (*Sitophilus* spp.)	As for Northern
	Diseases		Maize streak virus (MSV) (*Cicadulina mbila*)	• Observe recommended time of planting • Plant recommended tolerant varieties e.g. TMV-1, Kilima-ST, Staha-ST, Kito-ST
			Northern (*Turcicum*) leaf blight	New problem. No local solutions as yet.so
	Weeds		All types	• Proper land preparation • Timely weeding (at 2 and 5 weeks after planting) • Apply recommended herbicide when necessary

Table 2.1 continued

Eastern	Insects	Pre harvest	Stalk borers	• Follow recommended time of planting • Proper disposal of crop residue
			Armyworms	• See details under community-based earlywarning and control (section 4.4.2.3)
		Post harvest	Larger grain borer (LGB) Weevils Moths	As for Northern zone
	Diseases		Maize streak virus	• As for northern zone
	Weeds		All types	• As for northern zone
Central	Insects	Pre-harvest	Armyworms	• See details under community-based earlywarning and control (section 4.4.2.3)
			Stalk borers	• Follow recommended time of planting • Proper disposal of crop residue
		Post harvest	As for S. Highlands	As for S. Highlands
	Weeds		All types	• Proper land preparation • Timely weeding (at 2 and 4 weeks after planting) • Use recommended herbicide

Table 2.1 continued

Zone	Pest			Recommended management practices
Southern	Insects	Pre harvest	Armyworms	• See details under community-based earlywarning and control (section 4.4.2.3)
			Stalk borers	• Follow recommended time of planting • Proper disposal of crop residue
		Post harvest	As for S. Highlands	As for S. Highlands
	Diseases		Maize streak virus	• Observe recommended planting dates • Plant recommended tolerant varieties e.g. Kito-ST, Staha-ST, Kilima-ST
	Weeds		All types	• Proper land preparation • Early weeding (at 2 and 4 weeks after planting)

: MAFS: Plant Pests Field Book: A guide to management, 2002; LZARDI-Ukiriguru, 2000 Mbwaga et.al. 1993.

Table 2.1.1: List of pesticides recommended for use on maize in all zones

Chemical		Chemical common name	Formulation	Application rate	Target pest	Comments
Insecticides	Pre-harvest	Endosulfan*	4%D	25kg/ha	Stalk borers & armyworm	Apply 3-4 weeks after emergence
		Endosulfan*	4%G	20kg/ha		
	Post harvest	Cypermethrin	0.5% D	100gm/100kgs	LGB	
		Permethrin	0.5%D	100gm/100kgs	LGB	
		Pirimiphos methyl	2% D	200-500gm/100kgs	All storage insect pests for all grains	Not good enough against LGB
		Pirimiphos methyl + permethrin	1.6% + 0.3%D	100gm/100kgs	All storage insect pests for all grains	
Herbicides		Atrazine + metalochlor	50% FW	4l/ha	All types	Apply pre-emergence
		Atrazine	80% WP	2.5 to 3.0 l/ha	All types	Pre/post emergence

Notes:
1. All herbicides are applied using knapsack sprayers
2. All the insecticides for storage pests are in dust form and therefore used as supplied without mixing with anything else.
3. The list of pesticides can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the retailer/stockist, the nearest plant protection extension worker if in doubt and/read the label

*** Use should be discouraged because it has human and environmental health hazards. Already banned in 56 countries because of its high toxicity and environmental persistent, endosulfan has been nominated by the EU for a global ban under the Stockholm Convention (PAN Aotearoa New Zealand and Soils & Health Association of New Zealand Joint Press Release 13 May 2008). Already recommended for de-registering and phaseout (Nyambo 2001) but still on the November 2007 Oficial list of pesticide register.**

4.1.2 Rice

Tanzania is the largest producer and consumer of rice in the East, Central and Southern African region after Madagascar (Banwo (2001). According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 439,300 ha and 626,300 ha were put under rice cultivation in 1996/97-2002/03 respectively with overall production of 549,700 and 1,283,700 tons. The major producing areas are the coastal zone, western zone, Lake Victoria basin (Mwanza, Shinyanga, Kahama), Kilombero valley and southern plains. The crop is grown under different agro-ecological conditions (upland, lowland and irrigated environments) and therefore, the pest pressure varies accordingly (Table 2.2). Overall, upland rice contributes 80% while lowland rice is only 20% of the total production (Kanyeka, et.al.1995).

Locally, the economic value of rice depends largely on where it is grown. In Mwanza and Shinyanga regions, it is grown mostly for cash whereas in Morogoro, it is a cash-food crop. Because it is grown in many parts of the country and under different management systems (rain-fed and under irrigation), the pest problems and management tactics also vary (Table 2.2). Unfortunately and until recently, issues related to pest management in rice production were given low priority (Banwo *et al.*2001), and therefore, available information on pest control options is scanty (Table 2.2).

The most devastating pest of rice in Tanzania is the rice yellow mottle virus (RYMV). Although indigenous to Africa, the disease was reported in Tanzania in 1980s and now has spread to all the major growing areas

notably in Morogoro, Mbeya and Mwanza (Banwo, *et al.* 2001). The disease can cause up to 92% yield loss on "super", the most popular rice variety in Tanzania (Banwo, 2003).

The only viable control option for the disease is by planting resistant varieties). Unfortunately, only a few of the local varieties in the SSD-1, SSD-3, SSD-5, SSD-7, SSD-35 series have same level of resistance to the disease.

Table 2.2 Major pests of rice and recommended management practices

Pests		Recommended management practices
Insects	Stem borers (*Chilo partellus, C. orichalcociliellus, Maliarpha separatella, Sesamia calamistis*)	• 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 • Biological control for *C. partellus* (already introduced and released) • Plough after harvest to expose the eggs to natural enemies
	Stalk-eyed fly (*Diopsis* spp)	
	African rice gall midge (*Orseolia oryzivora*) Small rice grasshoppers (Oxya spp.)	
	African armyworm (*Spodoptera exempta*)	See details under community-based earlywarning and control (section 4.4.2.3)
	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 (*Dicladispa* sp)	
Weeds	All types	• Early clean weeding • Use recommended herbicides if necessary
Diseases	Rice yellow mottle virus	• Field sanitation including burning of crop residues and removal of volunteer plants • Use of resistant varieties where available
	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 where available • Appropriate crop rotation • Timely planting • Burying crop debris
	Brown leaf spot (*Helminthosporium* spp)	
	Sheath rot (*Acrocylindrium oryzae*)	

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Table 2.2 continued

	Pests	Recommended management practices
Vermines	Birds: quelea spp Rats	• Scaring • Bush clearing • Early weeding and field sanitation • Early harvesting • Monitoring and management of outbreak flocks • 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 (carried out by PHS) • Spot spraying, targeting roosting sites (carried out by PHS)

Source: MAFS: Plant Pests Field Book: A guide to management, 2002; LZARDI-Ukiriguru, 2000

4.1.3 Sorghum

Sorghum is an important subsistence food crop in Tanzania that is grown mainly in Morogoro, Lindi, Tabora, Dodoma, Singida, Mwanza, Shinyanga and Mara regions. Sorghum is a drought resistant crop. According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 622,400 ha and 557,323 ha were put under sorghum cultivation in 1996/97-2002/03 respectively with overall production of 498,500 and 461,400 tons. Sorghum needs a minimum of 300-380 mm of rainfall during growth and has a wide range of pests (Table 2.3). The recommended pest management strategies under different production areas are summarised in Table 2.3.

Table 2.3 Sorghum major pests and recommended management practices

Pest			Recommended management practices
Insects	Pre harvest	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 pupae • 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*)	See details under community-based earlywarning and control (section 4.4.2.3)
	Post harvest	LGB, weevils and moths	for details see 4.2.1.
Diseases		Grain moulds	• Plant recommended tolerant/resistant varieties e.g. IS 9470, IS23599, IS24995, cv. Framida and cv. Serena • 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 e.g. Tegemeo, Serena, Framida and Segaolane • 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 e.g. Tegemeo and Serena • Observe recommended time of planting • Field sanitation

Table 2.3 continued

Diseases	Pest		Recommendation
		Ladder leaf spot (*Cercospora fusimaculans*)	• Observe recommended time of planting • Field sanitation • Practice good crop rotation • Use clean planting material
		Sooty stripe (*Ramulispora sorghi*)	
		Zonate leaf spot (*Gleocercospora sorghi*)	
Weeds		Witchweed (*Striga asiatica)*	As for maize in lake zone
Birds		*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 (carried out by PHS) • Spot spraying, targeting roosting sites (carried out by PHS)

Source: LZARDI-Ukiriguru 2000; Mbwaga, et.al. (1993) and MAFS: Plant Pests Field Book: A guide to management, 2002

4.1.4 Pearl millet

Pearl millet (bulrush millet) is one of the indigenous subsistence cereal crops which grow well in areas with unreliable rainfall such as those found in central Tanzania. The crop has many advantages over other cereal crops in that it is drought tolerant and therefore suitable for the semi-arid areas of the country (Mbwaga et.al. 1993). Pearl millet grows best on reasonably fertile soils but have the ability to give satisfactory yields on infertile soils as well. It is one of the most import food crops in the dry semi-arid regions, mainly Dodoma and Singida. Significant quantities of pearly millet are also produced in Shinyanga, Mwanza and Tabora regions. According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 353,360 ha and 242,100 ha were put under millet (bulrush and finger millet) cultivation in 1995/6-2002/03 respectively with overall production of 347,700 and 118,200 tons. There has been limited local research work on the crop and therefore available information on its major pest problems and management options is scanty (Table 2.4).

Table 2.4 The major pests of pearl millet and recommended management practices

Pest			Recommended management practices
Insects	Pre harvest	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 • Biologicalcontrol • Use the extract of *Neuratanenia mitis*, a botanical pesticide

Table 2.4 continued

Insects	Pests		Recommendation
		African armyworm (*Spodoptera exempta*)	See details under community-based earlywarning and control (section 4.4.2.3)
Diseases		Leaf spot	No recommendation
		Rust (*Puccinia penniseti*)	• Observe recommended time of planting • Field sanitation • Plant recommended tolerant varieties if available
		Smut (*Moesziomyce bullatus*)	• Plant resistant varieties e.g. ICMV 82132, ICMPS 900-9-3 & ICMPS 1500-7-3-2
		Downy mildew (*Sclerospora graminicola*)	• Early sowing • Use of disease free seeds • Transplanting the crop suffers less from the disease • Roughing of infected plants to avoid secondary infection
Weeds		Witchweed (Striga spp)	• Hand pulling before 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
Birds		*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(done by PHS) • Spot spraying, targeting roosting sites (done by PHS)

Source: MAFS: Plant Pests Field Book: A guide to management, 2002; LZARDI-Ukiriguru, 2000 Mbwaga et.al. 1993.

4.1.5 Bananas

Banana is a major food crop for about 4.0 million people in Kilimanjaro, Arusha, Kagera, Mbeya and Kigoma .The produce has various uses but it is mostly used as a fruit and/or vegetable. It is therefore eaten either cooked, or as desert when ripe. Bananas are of great importance to the rural population in the Chagga homegardening and to those living in the Pare and Usambara mountains. The crop provides households with both food and income, while its produce includes leaves for thatching houses and pseudostema to feed livestock (although of poor nutritional value). Bananas are grown in association with various other crops, such as coffee, beans, maize, cocoyams and fruit trees. Farmers apply no chemical control measures to protect the crop. According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 241,400 ha and 390,200 ha were put under banana cultivation in 1996/7-2002/03 respectively with overall production of 604.100 and 1,898,800 tons.

The major disease of bananas in Tanzania is Panama or fusarium wilt caused by *Fusarium oxysporum* F. *cubense*. This is a fungal disease that can destroy all susceptible varities within a large area. Panama disease is soil borne and spreads through soil, farm tools and infected planting materials. Black Sigatoka, also a fungal disease caused by *Mycosphaerella fijiensis*, is soil borne and spreads by wind, water dripping or splashing, and through planting of infected suckers. Currently farmers control both diseases by removal of diseased plants, application of large quantities of farmyard manure and avoidance of planting susceptible varieties. Additional options include field sanitation (clean weeding, desuckering or thinning, detrashing). Application of farmyard manure reduces the damaging effect of the two diseases by improving soil conditions for health plant growth.

Two other important pests include weevils (*Cosmopolites sordidus*) and nematodes: (*Pratylenchus goodeyi*- the lesion nematode, *Radopholus similes*- burrowing nematode, *Helicotylenchus multicinctus* – spiral nematode and *Meloidogyne incognata*- root knot nematode. The two pests are primarily dispersed by transplanting infested suckers and corms. Therefore, to minimise spread and damage, always remove the roots, pare corm to a depth of 0.5cm, cut off all lesions and weevil tunnels before planting, select and plant resistant cultivars (there are many naturally tolerant/resistant cultivars), practice deep planting (at least 60cm deep) since weevils prefer to lay eggs on the corm at ground level, practice field sanitation (removal of pseudostems after harvest,desuckring,) apply heavy manure and mulch to preserve soil moisture and condition. Weevils can be trapped and removed by using split pseudo stems and corms.

4.1.6 Cassava

Cassava is one of the major food crops in all areas except in the northern zone. Increased production is affected by pre-harvest and post harvest pest problems. According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it is estimated that 1,426,000 ha and 2,503,500 ha were put under casava cultivation in 1996/7-2002/03 respectively with overall production of 2,149,100 and 2,833,200 tons.

Cassava mealybugs (*Phenococcus manihot*)

The pest is widespread with frequent outbreaks in Ruvuma, Kigoma, Dodoma and Mara regions. Effective control is achieved through biological control. *Epidinocarsis* (*Apoanagrus) lopezi*, a wasp, was introduced in Tanzania through a joint MOA/IITA project in the early 1990s and resulted to significant control of the pest in most cassva growing areas of Tanzania except in parts of Mara, Mwanza, Iringa and Kigoma, where the pest is still devastating cassava (Anon, 1999). In these areas, *Hyperapsis notata*, a predator, was released to compliment the wasp. Because of limited funding, the predator has been released in a few areas only (Anon, 1999).

Cassava Green mites (*Mononychellus tanajoa*)

This pest is also widespread but is more devastating in the Lake zone. The pest can cause 60% to 80% crop loss if left uncontrolled (Anon, 1999). Like the case of the mealybugs, effective control can be achieved through biological control. To affect this, an exotic predatory mite, *Tyhlodromallus aripo*, was imported and first released 1998 (Anon, 1999). The agent has spread to many areas including the southern zone, parts of Coast, Lake and S. Highlands. Where the agent has established, the pest population has been reduced considerably (Anon, 1999).

Cassava white mites

This is a major pest in the Lake zone. Currently, the only recommended management option is uprooting and burning of infected plants. However, some local selections are known to be tolerant to the pest. Such varieties should be identified, popularised, multiplied and distributed to farmers.

Cassava mosaic disease (East AfricaCMV, ACMV)

The disease is widespread but is more devastating in Mwanza, Mara, Kigoma and Coast regions where an incidence of 60% to 80% has been recorded (Dr. Rose Mohamed, personal communication). Farmers in affected areas are advised to uproot and burn infected plants and encouraged to plant resistant varieties. Currently, multiplication of resistant varieties (TMS 60142, TMS 30337, TMS 4(2) 1425, TMS 30572) is being done at the Lake Zone Research and Development Institute in Maruku and Ukiriguru in collaboration with IITA. In addition, TMS 4(2) 1425 and TMS83/01762 (6) are being multiplied in Mara region in collaboration with MARAFIP for distribution to farmers.

An open quarantine site at Maruku, Bukoba was established in 1999 to further facilitate efforts to introduce resistant varieties from neighbouring countries (Anon, 2000).

Cassava mosaic disease Uganda variant (UgV)

The disease is devastating in the Lake zone, particularly in Shinyanga, Kagera, Geita district and Kigoma (R. Mohamed, personal communication). Use of resistant varieties is the only suitable management strategy. Such varieties are not available in the country. Through the East African cassava disease control programme, a resistant variety, Serere selection 4 (SS4), has been identified in Uganda. This material has been brought in the country for multiplication under the CMD East African programme.

Cassava brown streak disease

The problem is common along the coast (from 0-500m above sea level, from Tanga to Mtwara and around Lake Nyasa. The only viable management option is through planting of tolerant/resistant varieties. Some resistant varieties have already been identified in Kenya. These varieties will be imported through Mwele-Tanga open quarantine for multiplication and distribution to farmers. The work has not yet started due to lack of funds. It is estimated that the national programme will need about US$ 20,000 for two seasons to facilitate importation, multiplication and distribution of clean cuttings to affected areas.

Post harvest

The larger grain borer (LGB) is the most damaging pest of dried cassava. Loss of about 35% can occur in a period of 4-6 months if uncontrolled (Mallya, 1999).

Rodents, particularly the multi-mammate rat (*Mastomys natalensis*) attacks dried cassava chips and can cause high losses (quality and quantity) and therefore farmers should adopt and use recommended strategies to minimise potential attack.

The current integrated stored products guidelines (Nyakunga & Riwa, undated) if adopted, will go a long way in reducing potential losses due to LGB and rodents on dried cassava.

4.1.7 Common Beans (Phaseolus vulgaris)

Common beans or phaseolus may be regarded as one of the principal sources of protein as well as cash crop to many farmers in Tanzania.

Beans are grown throughout the country with major production in the southern highlands, northern, eastern and some parts of Lake Zone. Consequently, the pest pressure and type varies due to agro-ecological and management differences. However, production is contrained by factors related to soil fertility notably low soil nitrogen, periodic water stress, insect pests and diseases (Allen et al 1996). Angular leaf spot (*Phaeoisariopsis griseola*) can cause 50-60% yield loss (Allen et al 1996). The bean stem maggot, commonly known as the beanfly, is the second most important pest of field beans in many part of Tanzania. Yield losses of 30-100% have been recorded in some parts (Allen et al., 1996; Seif et al., 2001).

Overall, some of the major diseases have been solved through breeding and selection for tolerance/resistance (Table 2.5). Farmers in different parts of the country already grow some of the disease tolerant/resistant varieties. The pest management options as summarised in Table 2.5 have been developed for the southern and northern zones but can also be used by farmers in other areas.

Table 2.5 The major pest problems of beans and recommended management practices: southern, lake and northern zones Tanzania.

	Pest			Recommended management practices
Northern zone	Insects	Pre-harvest	Bean stem maggot (*Ophiomyia* spp)	• Observe recommended time of planting • Apply mulch • Apply manure/fertilisers • 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
				•
		Post harvest	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 • Coat seeds with edible oil at 5ml/kg
	Diseases		Angular leaf spot (*Phaeoisariopsis griseola*) Kiswahili name: *Doa pembe*	• Practice good crop rotation • Use of healthy and clean seeds • Use certified seeds • Post harvest tillage • Removal of crop • Plant tolerant/resistant varieties e.g. Lyamungo 90

Table 2.5 continued

Northern zone			Pests	Recommendation
			Anthracnose (*Colletotrichum lindemuthiamum*)	• Use of resistance varieties • Use of healthy seeds • Crop rotation • Seed dressing • Post harvest tillage • Field sanitation • Plant tolerant/resistant varieties e.g. Lyamungo 90
S. Highlands	Insects	Pre-harvest	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
		Post harvest	Bean bruchids (*Acanthoscelides obtectus*)	• Ensure the beans are dry and well cleaned before storage • Apply recommended storage insecticide/ botanical extracts and or edible oils at the rate of 5ml/kg
	Diseases		Bean anthracnose	• Practice good crop rotation • Sanitation and crop hygiene • Use certified seed • Observe recommended time of planting • Plant tolerant/resistant varieties e.g. Uyole 98, Uyole 84 & Kabanima
			Angular leaf spot	As above

			Rust (*Uromyces appendiculatus*)	• Avoid planting beans in high altitude areas • Practice good crop rotation • Sanitation and crop hygiene • Plant tolerant/resistant varieties e.g. Ilomba, & Uyole 90 • Observe recommended time of planting • Spray with recommended fungicide when necessary

Table 2.5 continued

			Pests	Recommendation
S. Highlands			Haloblight (*Pseudomonas* sp)	• Plant tolerant/resistant varieties e.g. Uyole 84 • 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 e.g. Ilomba & Uyole 98 • Sanitation and crop hygiene
			Bean common mosaic virus (BCMV)	• Plant tolerant/resistant varieties if available • Effect good control of aphids
Lake Zone	Insects	Pre harvest	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 pestices such as Neem
		Post harvest	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
	Diseases		Bean rust, anthracnose & leaf spot	• As for S. Highlands. The KAEMP IPM project is promoting Lyamungu 90 and Uyole 98 • Use proper plant spacing
			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, e.g. Lyamungu 85 and 90
			Common and fuscous bacterial blight (*Xanthomona phaseli*)	• Use resistance or tolerant varieties such SUA 90 and ROJO • Use pathogen free, high quality seed • Field sanitation including burning of crop residues • Rotation sequence with cereals

	Weeds		all types	• Early and frequent weeding

Source: MAFS: Plant Pests Field Book: A guide to management, 2002; LZARDI-Ukiriguru 2000; IPM working group in the Northern Zone 2001; Anania, et al., 2001; Paul, et al.,2000), Madata, et al., 2001.

4.1.8 Sweet Potatoes

Sweet potatoes are mainly grown under small scale farming systems. Cultivated areas under sweet potatoes in 2002/2003 were in Mbeya (69,000 ha), Kigoma (27,800 ha), Shinyanga (73,800 ha) and Mwanza (90,200 ha) regions. In 2002/2003 sweet potato production was as follows: Kigoma (233,400 tonnes), Shinyanga (164,100 tonnes), Mwanza (150,800 tonnes), Rukwa (87,900 tonnes), Kagera (69,000) and Mbeya (47,000 tonnes). According to Basic Data Agriculture Sector 1996/7/2002-2003 (MAFS 2004), it was estimated that 287,000 ha and 470,600 ha were put under sweet potatocultivation in respectively with overall production of 477,700 and 957,500 tons. Sweet potatoes play an important role during periods of food scarcity particularly in Shinyanga region where farmers process ansd store dried potatoes for up to six months as a food security strategy. The crop suffers from two major pests (Table 2.6)

Table 2.6 The major pests of sweet potato and recommended management practices

Pest		Recommended management practices
Insects	Sweet potato weevil (*Cylas brnneus)* Kiswahili name: *Fukuzi wa viazi* (adult) and *Funza wa viazi* (larva)	• Sanitation • Use of clean planting 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 • Hilling up twice (at 4^{th} and 8^{th} week after planting) in the season to cover soil cracks and exposed to minimize eggs laying
	Rough sweet potato weevil (*Blosyrus sp*)	• Crop rotation • Sanitation
	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
Diseases	Sweet potato feathery mottle virus (SPFMV)	• Use of resistant varieties where available • Crop rotation • Sanitation
	Sweet potato sunken vein virus (SPSVV)	• Avoid disease plants as a source of planting materials • Use of resistant varieties where avaialable

	Sweet potato virus disease (SPVD)	• Sanitation • Use of resistant varieties • Crop rotation

Table 2.6 continued

	Pests	Recommendation
Vermin's	Mole rats *(Tachyoryctes splendens*) Kiswahili name: *fuko*	• Trapping • Trap plants e.g. Tephrosia sp • Insert pars of repellent plant species into tunnels
	Monkeys, wild pigs	• Use scares

Source: MAFS: Plant Pests Field Book: A guide to management, 2002; LZARDI-Ukiriguru, 2000 4

4.1.9 Management of post haverst pests of cereal crops, dried cassava and sweet potatoes

Losses due to damage caused by the larger grain borer, weevils, rats, ear rots, aflatoxins, red flour beetle and grain moths can be minimized through the following IPM strategies:

- Selection of tolerant varieties
- Timely harvest
- Dehusking and shelling
- Proper drying
- Sorting and cleaning of the produce before storage
- Cleaning & repair of storage facilities
- Use rodent guards in areas with rat problems
- Use improved granaries
- Use appropriate natural grain protectants where applicable
- Use recommended insecticides at recommended dosage
- Store grain in air tight containers. Where airtight containers are used store these in a shady place, preferably in-doors on raised platform to allow air circulations and prevent attack by mould.
- 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

Biological control of the LGB using *Teretriosoma nigrescens (Tn)* to minimise infestation from wild sources will be beneficial once appropriate strains of the *Tn* are identified and validated. This is a task of the national plant protection services (PHS-Kibaha Biological Control Unit) because the agents have to be reared and released in strategic sites.

4.2 Cash crops

Coffee, cotton, cashew and tobacco are largely small holder crops. These crops have special agro-ecological requirements and therefore are grown in specific zones and areas within the zones and the pest types and pressure, and management tactics recommended varies between zones.

4.2.1 Coffee

In Tanzania coffee is one of main export crops and leading foreign exchange earner. It accounts for about 20% of total domestic export. It is predominantly a small scale crop grown by about 420,000 farmers who produce over 90% of the crop and depend on it for their income and hence social welfare (Nyange 1999).

There are two major types of coffee grown in the country. Arabica coffee (*Coffee arabica*) is grown in all coffee zones (Northern, S. Highlands, Lake and Eastern) while the robusta coffee (*Coffee canefora*) is mainly grown in Kagera with small amounts in Tanga and Morogoro regions. According to Basic Data Agriculture Sector 1996/97-2002/2003 MAFS 2004), it was estimated that overall production in the country was 52,220 and 53,220 in 1997 and 2003 tons respectively. Coffee production for mild, hard arabica and robusta was 29,835, 2,383 and 17,184 tonnes in 2002/2002.

Coffee insects and other coffee pests are some of the major factors that undermine coffee productivity by direct reduction of crop yield and quality. There are about 850 species of insect pest known (Le Pelly, 1973). In Tanzania there are more than 25 insect pests which attach coffee. The pests of economic importance and their respective management pratices are summarised in Table 2.7.

Table 2.7 Coffee pest problems and recommended management practices

Zone	Pest		Recommended management practices
Northern	Insects	Stem borers (*Anthores* spp) Kiswahili name: Bungua weupe wa kahawa	• Sanitation and crop hygiene • Stem cleaning at least once a year • Uproot and bury badly damaged trees • Scouting for attacked trees • Pick and destroy the adults (from October/ to December • Mechanical removal of larva by using hooks • Apply cooking oil or fat around borer holes to attract predatory ants • Insert cotton wool soaked with kerosene in borer holes • Paint the stem and branches with a paste out substance like lime • Apply recommended insecticides if necessary

Table 2.7 continued

Northern	Insects	Pests	Recommendation
		Antestia bugs (*Antestiopsis* spp*)* Kiswahili name: Kimatira	• Conservation of indigenous natural enemies • Shade management by reducing size • Pruning and desuckering • Scouting • Preserve natural enemies (parasitic wasps, Tachind flies)
		Leaf miners (*Leucoptera* spp) Kiswahili name: *Kidomozi*	• Conservation of indigenous natural enemies • Sanitation and crop hygiene • Shade management • Mulching • Pruning • Crop scouting • Spray with recommended insecticides if necessary

Table 2.7 continued

Zone	Pest		Recommended management practices
Northern		Coffee berry borer (CBB) (*Hypothenemus hampei*) Kiswahili name: *Ruhuka*	• Scouting • Conservation of indigenous natural enemies • Sanitation and crop hygiene • Shade management • Mulching • Pruning • Burry infected berries as larvae can develop in fallen fruits • Regular harvesting • Mbuni stripping
		Mealy bugs (*Planococcus kenyae*) Kiswahili name: *Vindungata*	• Biological control using *Anagyrus kivuensis* • Banding stems of affected plants to reduce attendant ants
		Green scale insects (Coccus viridis) Kiswahili name: Vidugamba	• Conservation of natural enemies • Curative spraying of solutions of ash, oil, soap, kerosene or clay
	Diseases	Coffee berry disease (*Colletotrichum coffeanum*) Kiswahili name: Chule buni	• Plant recommended resistant/tolerant varieties • Sanitation and crop hygiene • Shade management • Mulching • Pruning • Proper plant nutrition • Stem cleaning • Spray with recommended fungicide

		Coffee leaf rust (*Hemileia vastatrix*)	• Resistant varieties • Removal of old unproductive trees • strip mbinu after harvest • Sanitation and crop hygiene • Shade management • Mulching • Pruning • Clean weeding • Spray with recommended fungicide

Table 2.7 continued

Zone	Diseases	Pests	Recommendation
		Coffee wilt caused by Fusarium spp Kiswahili name: Fusari mnyauko	• Uprooting and burning of affected trees • Planting of coffee in pathogen 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
	Weeds	All types	• Clean weeding • Mulching • Use recommended herbicides
	Nematodes	Root-knot nematodes *(Meliodogyne spp.)* Kiswahili name: *Minyoo fundo*	• Grafting on resistant coffee varieties • Soil sterilization (by sun) in the nursery • Use of non-infested seedlings • Mulching (to preserve moisture) • Fertilization
Ruvuma sub-zone	Insects	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)

Table 2.7 *continued*

Zone	Pest		Recommended management practices
Ruvuma sub-zone		Mealybugs and scale insects	• Proper planting depth • Build the plant "skirt" soon after the first harvest to deter ants from climbing through branches to enhance build up of natural enemies
	Diseases	CBD & CLR	Management as for the northern zone
		Fusarium wilt	• Plant recommended tolerant varieties e.g. KP 423 (locally known as "nylon" • Field sanitation • Proper pruning
	Weeds	All types	• Clean hand weeding • Apply herbicide if necessary. Use recommended herbicides
S. Highlands (Mbeya, Iringa & Rukwa)	Insects	As for Ruvuma sub-zone	As for Ruvuma sub-zone
	Diseases	CBD & CLR	As for northern zone
		Fusarium wilt	• Plant recommended varieties e.g. N36, which should be obtained from certified seed multiplication farms only. • Field sanitation • Maintain good drainage • Uproot and burn any diseased plants and avoid replanting in the same hole for 2 years
Lake Zone	Insect	Coffee berry borer	• Conservation of indigenous natural enemies
		Stem borers	• As for the northern zone
		Coffee berry moth	• As for the northern zone
		Scale mealybugs	• As for the northern zone
		Antestia bugs	• As for the northern zone
	Diseases	Red blister	• Shade management • Proper pruning (leave 2-3 stems /plant) and control plant height

Table 2.7 continued

Lake zone	Disease	Pests	Recommendation
		Coffee wilt (*Trachomycosis*)	• Scout the field regularly • Uproot and burn insitu infected plants as soon as symptoms appear. Do not carry infected plants to distant places • Do not drag infected plants across the field as this may spread the disease to new areas • Disinfect (flame tools and impliments) and always begin farm operations from clean parts of the field. • After uprooting allow up to 12 months rest before replanting on same field • Establish new crop from disease free planting material • Use resistant/tolerant plant material where available. Some clones have been identified among farmers' cultivars with acceptable tolerance to the disease. These are still under evaluation by Maruku research station • Apply heavy doses of manure and/or compost to ensure good soil condition and nutrients to the plants • Encourage house hulling of coffee to minimise spread of the disease to new areas
		CLR	As for northern zone

Source: MAFS: Plant Pests Field Book: A guide to management, 2003; LZARDI-Ukiriguru 2000; IPM working group in the Northern Zone 2001

Table 2.7.1 List of recommended pesticides for use in coffee

Chemical	Chemical common name	Formulation	Lts product/ha	Comments
Insecticides	Diazinon	600EW	1.0 -1.5	
	Deltamethrin	25%EC	0.5	
	Chlorpyrifos	4 EC	1.25-2.0	
	Carbofuran	5%G	60gm/plant	Spread the granules around the plant when the soil is wet and rake it into the soil
	Fenitrothion	50%EC	1.0 -2.0	
	Profenophos	720EC	0.2 - 0.7	
	Endosulfan	35%EC	1.0 - 1.5	
Fungicides	Cyproconazole	100SL	1.0 - 2.0 kg	
	Hexaconazole	5% FL	25-100ml/100l of water	CLR
	Triadimefon	25%EC	1.0	CLR
	Propineb	25%EC	1.0kg	CLR
	chlorothalonil	50% FW	2.0 - 5.0	CBD & CLR
	Cupric hydroxide	50WP	7.0 - 8.0kg	CBD
	Cuprous oxide	50WP		CBD & CLR
	Copper oxychloride	50WP	7.0 - 8.0 kg	CDB & CLR
Herbicides	Gyphosate	36% SC	3-6l/ha	All types, post emergence
	Paraquat	20%EC	1-3l/ha	All types, post emergence

Notes:

1. All pesticides except carbofuran are applied with a knapsack sprayer.
2. The list of pesticides can change as new products are recommended and/or some are withdrawn. Therefore always consult the nearest plant protection extension worker if in doubt

4.2.2 Cotton

Cotton in Tanzania is purely a smallholder crop. The crop is grown in two major zones based on agro-ecological difference. The western cotton growing area (WCGA) include Mwanza, Shinyanga, Mara, Kigoma, Tabora, parts of Kagera, Singida and Kigoma regions, while the eastern cotton growing areas [ECGA] cover Morogoro, parts of Kilimanjaro, Coast and Iringa regions. According to Basic Data

Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it was estimated that overall production of cotton was 221,280 and 188,200 tons in 1997 and 2003 respectively.

Similar to coffee, the pest problems and the recommended management options vary depending on location (Tables 2.8.1, 2.8.1.1, 2.8.2, 2.8.2.1).

The recommended current cotton pest management strategies emphasises integration of several aspects of IPM (Tables 2.8.1 and 2.8.2). However not all farmers in all the cotton growing areas are aware and informed about the approaches.

A cotton quarantine established in 1946 (Cotton plant quarantine GN 265 of 1946: quarantine areas: Southern Province) is meant to prevent the entry of the red bollworm (*Diparopsis castanea*) from the neighbouring countries in the south (Malawi, Zambia & Mozambique) to the major traditional cotton area (the WCGA & ECGA). The quarantine has been effective in preventing the entry of the pest in the cotton area to date, and must therefore be maintained. Any attempt to grow cotton in the quarantine area should therefore be strongly discouraged. Should the pest enter the traditional cotton areas, the pest management strategies must be changed, and will probably lead to more use of pesticides, and increased health and environmental problems in the traditional cotton growing areas.

Crop scouting (regular crop inspection) was recommended in the late 1980s as additional IPM component to optimise cotton spraying in the WCGA. However, to date, only a few farmers in Shinyanga, Kagera and Mara regions practice it. Only the IPM farmer groups and their immediate neighbours practice crop scouting before spraying. It is important to recognise that scouting for a pest is a prerequisite for good crop pest management and judicious use of pesticides. There is therefore a need to mobilise farmers through appropriate training, to inform and enhance wider use of regular crop inspection as a means to optimise the benefits of pesticide use if they have to be used.

Crop scouting guidelines have not yet been developed for the ECGA but the approach developed for the WCGA could be tested and fine-tuned by farmers for adoption.

Traditionally, spraying against aphids in the WCGA was discouraged for two major reasons. First, it is not economically justified in most seasons. Secondly, aphids are usually controlled by a wide range of its indigenous natural enemies (predators and parasitoids) that builds up in the crop early in the season. In addition, the aphid populations are often washed away by the heavy rains in March/April. Occasionally, the population can build up to damaging levels (resulting to sooty mould, which can damage the quality of the crop). When this occurs, insecticides recommended for the bollworms can be used effectively.

The indigenous aphid natural enemies are polyphagous and will also feed on the eggs and larvae of *H. armigera,* the key pest of cotton in the area.

Insecticide mixtures e.g. profenophos + cypermethrin (Table 2.8.1.1) were discouraged to safeguard and promote the build up of the natural enemies to further extend integration of bio-control agents in the cotton systems.

Table 2.8.1. Cotton pest problems and recommended management practices in the WCGA

Pest		**Recommended management practices**
Insects	Jassids (*Empoasca* sp)	• Plant recommended UK varieties (resistant plant varieties) • Spray in case of a severe attack at seedling stage
	American bollworm *(Helicoverpa armigera)*	• Plant recommended UK varieties (inditerminant varieties) • Early planting • Carry out regular scouting, preferably once a week • Use scouting records to make spraying decision. Spray with recommended insecticides after scouting
	Aphids *(Aphis gossypii)*	• Effectively controlled by indigenous natural enemies • Populations often washed off by rain • In case of severe outbreaks, spray with recommended insecticides
	Spiny bollworm (*Earias insulana and E.biplaga*)	• Early palnting • Frequent crop scouting and using the information to make decisions • Observe the close seasons (uproot and burn all crop residues) Uproot all ratoon cotton to deprive the pest of food
	Lygus (Lygus vosseleri)	Spray with insecticides in case of an early season attack
	Cotton stainers (*Dysdercus* spp)	• Observe the close season • Early and frequent picking to avoid build-up of stainers • Sanitation in and around cotton ginneries and buying posts • Uproot and destroy all ratoon cotton • Apply 1 to 2 sprays of recommended insecticides if necessary (inspect the crop before spraying)

	Blue bugs *(Calidea dregii*)	• Observe the close season • Early and frequent picking avoid build-up of stainers • Sanitation in and around cotton ginneries and buying posts • Apply 1 to 2 sprays of recommended insecticides if necessary (inspect the crop before spraying)

Table 2.8.1 continued

	Pests	Recommendation
Diseases	Bacterial blight (*Xanthomonas malvacearum)*	• Rotation • Plant recommended UK varieties (these are resistant to the disease) • Observe the close season • Crop sanitation
	Fusarium wilt (*Fusarium oxysporum* f.sp. *vasinfectum)*	• Rotation • Crop sanitation • Plant recommended UK varieties for the area
	Alternaria leafspot (*Alternaria macrospora)*	• Rotation • Field sanitation
Weeds	All types (See Table 3.4)	• Proper land preparation • Early clean weeding • Use recommended herbicides
Vermines	Field rats, monkeys and baboons	• Scaring • Trapping

Source: MAFS: Plant Pests Field Book: A guide to management, 2003; LZARDI-Ukiriguru 2000;

Table 2.8.1.1 List of pesticides recommended for use on cotton in the WCGA

Chemical	common name	Formulation	Application rate g a.i./ha	Comments
Insecticides	Endosulfan	25% ULV	625	Should have been banned and deregistered
	Cypermethrin	1.8% ULV	45	
	Fenvalerate	3% ULV	75	
	Flucythrinate	1.7% ULV	42.5	
	Lambda cyhalothrin	0.6% ULV	15	
	Esfenvalerate	0.5% ULV	12.5	
	Alpha cypermethrin	0.8% ULV	20	
	Biphenthrin	2%ULV	50	

	Betacyfluthrin	0.5%ULV	12.5	
	*Profenofos + cypermethrin	1% + 16% ULV	400+ 25	
	*Deltamethrin + dimethoate	0.3+ 12 % ULV	7.5 + 300	

Table 2.8.1.1 continued

Chemical	Common name	Formulation	Application rate g a.i./ha	Comments
	Flucythrinate	1.33% Me/ULV	33.25	
Fungicides	Bronopol	10% dust	5/100kg	
	Cuprous oxide	45% dust	5/100kg	
Herbicides	Diuron	80W	1000	For use on light soils only
	Fluometuron	500FW	2000	For use in light soils only
	Metalachlor + Dipropetrin	400EC	800+1200	For use in light soils only

Notes:

- All the insecticides are applied using ULV pumps at the rate of 2.5l/ha at a swath width of 4.5 meters. The target pest is the American bollworm and farmers are advised to scout the crop starting from when the first buds are formed or 10 weeks after planting until first boll split before spraying.
- Early season (before first flower) spraying is strongly discouraged, as this will interfere with the build up of indigenous natural enemies of aphids and the bollworms.
- All herbicides should be applied pre-emergence.
- The list of pesticides can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the nearest plant protection extension worker if in doubt

*These pesticides are unnecessary for the WCGA as continued use will jeopardise conservation and use on natural bio-control in the cropping system.

Table 2.8.2 Cotton pest problems and recommended management practices in the ECGA

Pest		Recommended management practices
Insects	Jassids (*Empoasca* sp)	• Plant recommended IL varieties (resistant plant varieties) • Spray in case of a severe attack at seedling stage
	American bollworm *(Helicoverpa armigera)*	• Plant recommended IL varieties • Early planting
	Aphids (Aphis gossypii)	• Spray using recommended insecticides

	Cotton stainers (*Dysdercus* spp)	• Observe the close season (mid-September to early November) • Early frequent picking • Apply 1 to 2 sprays of recommended insecticides if necessary (inspect the crop before spraying) • Sanitation in and around cotton ginneries and buying posts • All ratoon cotton should be uprooted and destroyed
	Pink bollworm (*Pectinophora gossypiella*)	• Early planting and early picking • Close season • Uproot an destroy all ratoon cotton

Table 2.8.2 continued

	Pests	Recommendation
Diseases	Bacterial blight (*Xanthomonas malvacearum)*	• Plant recommended IL varieties (resistant varieties) • Observe close season
	Alternaria leafspot (*Alternaria macrospora)*	Plant dressed seed only
Weeds	All types see Table 3.4	• Cultural control • Good land preparation • Early hand weeding • Use recommended herbicides

Table 2.8.2.1 List of pesticides recommended for use on cotton in the ECGA

Chemical	Chemical common name	Formulation	Application rate g a.i./ha	Lts product/ha	Comments
Insecticides	Endosulfan	25% ULV	625	2.5	Should have been banned and deregistered
		35% EC	700	2.0	
	Cypermethrin	1.8% ULV	45	2.5	
	Cypermethrin	10%EC	45	0.45	
	Fenvalerate	20% EC	75	0.375	
	Flucythrinate	10% EC	42.5	0.425	
	Lambda cyhalothrin	0.6% ULV	15	2.5	
		5% EC	20	0.4	
	Esfenvalerate	2.5% EC	20	0.8	
	Deltamethrin	0.3% ULV	7.5	2.5	
		0.5% ULV	12.5	2.5	
		2.5%EC	7.5	0.2	
	Fluvalinate	2%EC	100	0.2	
Fungicides	Bronopol	10% dust	5/100kg		
	Cuprous oxide	45% dust	5/100kg		
Herbicides	Fluometuron	500W	2500-3000 3500	5.0 - 6.0 7.0	Light and medium soils Heavy soils

Note:

- The herbicides should be applied pre-emergence only.

- All ULV formulations are applied using the ULV pump at the rate of 2.5 l/ha and a swath width of 4.5 m. Spraying is done once a week beginning 8 weeks after planting and should continue until boll split.
- All the EC formulations are applied by knapsack sprayers at the rate of 120l/ha
- The list of pesticides can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the nearest plant protection extension worker if in doubt

4.2.3 Cashewnuts

Widespread planting of cashew in southern Tanzania was carried out beginning from 1945 after which it developed to an important smallholder cash crop. Expansion first started on the Western Makonde Plateau from where it spread northwards into Lindi and Coast regions and eastwards into Ruvuma. Cashew is mostly grown on poor soils in the coastal districts and the south of the country. Mtwara, Lindi and Ruvuma areas produces about 70% of the crop. By 1960, production reached 40,000 tonnes of nuts which were exported. At that time, cashew became the fourth valuable export crop. Production continued to increase and reached a peak of 145,000 tonnes in 1973/4 after which there was drastic decline to low of 16,500 tonnes in 1986/7. The reported production decline was a combination of biological and socio-economic factors (Brown, et al., 1984). The biological factors which are relevant in the context of this report include:

- The onset of powdery mildew disease (*Oidium anacardii* Noack) in 1973, a disease that can cause up to 100% crop loss if uncontrolled.
- Insect pest problems: mirids (*Helopeltis* spp) and coreid bugs (*Pseudotheraptus wayi).* Infestation by these insect pests can result in more than 75% shoot damage and at early flowering stage, they can cause up to 98% flower drop and 80% loss in yield. Heavy infestation can also results in diminishing market value of the produce due to shriveled kernels caused by the sucking insects.
- Overcrowding of trees

According to Basic Data Agriculture Sector 1996/97-2002/2003 (MAFS 2004), it was estimated overall production of cashewnuts was 65,400 and 92,200 in 1997 and 2003 respectively.

Powder mildew disease (PMD) *Oldium anacardii*

A range of different control measures against PMD have been developed by research. Very fine sulphur dust (usually 99% pure) has been used in Tanzania for more than 15 years to control PMD; the dust is blown on the trees using motorized blowers. However, only 22% of the dust is deposited on the tree and if dew is absent at the time of application, the percentage deposited on the tree drops off dramatically (Smith et al.,1995). Most of sulphur ends up on the soil which has resulted to soil acidification in various parts of the Makonde plateau in Mtwara region (Ngatunga, 2001).

Other diseases but of less economic importance in Tanzania include anthracnose (*Colletrotrichum gloeosporides* Penz), dieback (*Phomopsis anacardii* Punith), cercospora leaf spot (*Pseudocercospora anacardii* Nova), pestalotia leaf spot (*Pestalotia hetercornis* Guba) and wilting syndrome which causes shedding of leaves and sometimes death (Sijaona 1997). Another threatening disease is the recently reported exotic and most probably invasive leaf and nut blight caused by *Cryptosporiopsis* spp recorded in Tanzania in 2002 and now observed in Mozambique and Uganda (Sijaona et al 2006, http://www.bspp.org.uk/ndr/jan2006/2005-75.asp)

Although the current pest management options advocate use of IPM approaches (Table 2.9) there is evidence to suggest that there is an increase in insect pest pressure due to excessive use of sulphur to control powdery mildew (Anon, 2000). Alternative pesticides have been identified and registered since 1994 (Anon, 2000) but the new products have not yet been popularised among growers.

Education and mobilisation of farmers is needed to promote wide adoption and use of the recommended disease tolerant/resistant clones and cultural practices to reduce over reliance on chemical pesticides (Table 2.9.1) for the control of the major diseases.

Table 2.9 Major pests and recommended management practices in cashew

Pest		Recommended management practices
Insects	Coreid bugs (*Pseudotheraptus* wayi)	• Biological control using maji moto, 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
	Holopetlis bugs *(Helopeltis anacardi* & *H. schoutedeni*) Kiswahili name: *Mbu wa mikorosho*	• Biological control using maji moto, the African weaver ant (*Oecophilla longinoda*). Same as above • 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 using maji moto as above.
	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
Diseases	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 innoculum 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 e.g. AC4, AC10/220, AZA2 and at recommended spacing • Apply recommended fungicides as appropriate

Table 2.9 continued

Disease	Pests	Recommendation
	Anthracnose (*Colletotrichum gloeosporioides*)	• Remove and burning of all infected organs before the start of the cashew season. • Plant recommended tolerant clones e.g. AC4, AC10/220, AZA2 and at recommended spacing • Apply at recommended pesticide at correct rate and time
	Dieback *(Phonopsis anacardii)*	• Remove and burn all infected organs before the start of the cashew season. • Apply at recommended pesticide at correct rate and time
	Wilt syndrome	

Source: MAFS: Plant Pests Field Book: A guide to management, 2003; Topper, et, al, 2003

Table 2.9.1 Pesticides recommended for use on cashew

Chemical	Chemical common name	Formulation	Application rate	Target pest	Comments
Insecticide	Endosulfan	35% EC	6mls/tree	Thrips	Should be banned and deregistered
	Fenitrothion	50% EC	17ml/tree	Thrips	
	Profenofos	48%EC		Cashew mealybugs	
	lambda cyhalothrin	5%EC	5ml in 1 l of water per tree	*Helopeltis* & Coreid bugs	
	Hydamethyl			Brown house ants	
Fungicides	Sulphur	D	250gm/tree	Powdery mildew	Use cautiously as it could lead to soil acidity
	Hexaconazole	5%FL	10-15 ml in 0.75 -1.25 l of water, three sprays at 21 days interval		
	Penconazole	10%EC			
	Triadimenol	25%EC			
	Copper hydroxide	50%WP		Anthracnose	

Note:

1. All the pesticides except for sulphur, are applied using a knapsack sprayer or with a mist blower (Sijaona, & Anthony, 1998; Sijaona & Barbanas, 1998)
2. The list of pesticides can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the nearest plant protection extension worker if in doubt

4.3 Horticultural crops

A wide range of horticultural crops are grown in Tanzania. However, the sub-sector is still under developed and poorly exploited for several main reasons. First, resources allocated for research and development to the sub sector has always been inadequate. At the national level, the sub sector has been accorded only medium to low priority. IPM research on vegetable and fruit crops has a very low profile as reflected by the state of inadequate funding for research and development as well as lack of staff continuity in the sub sector. On-going research activities are patchy and uncoordinated. Consequently, local information on appropriate pest management tactics for the major horticultural crops is scanty except for coconut and tomatoes.

For the majority of other crops, e.g. mangoes, farmers are experimenting with borrowed ideas and fine-tuning them to solve pertinent pest problems. The cut flower industry, which is a domain of large-scale growers, operates independent of the national system, and therefore, each grower has in-house capacity and capability to address pest problems.

4.3.1 Coconuts

The coconut programme based at ARI Mikocheni has done commendable work by developing appropriate IPM approaches for coconut cropping systems that can be extended to farming communities in coconut growing areas.

Coconut production is basically a smallholder crop largely confined to the coastal belt from Tanga to Mtwara, mostly in Eastern and Southern regions. The agro-ecological conditions and the management practices of the crop are similar in all the growing areas and therefore, the pest problems and recommended control options are the same (Table 2.10).

The research and development programme at ARI Mikocheni through support by the GTZ, has developed and formulated appropriate farmer friendly IPM approaches for the coconut cropping system. However, extension of the knowledge to farmers has been hampered by a lack of adequate funding.

Table 2.10 Major pests and recommended control practices for coconut

Pest		***Recommended management practices***
Insects	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: 1- Apply Hydramethyl to control brown house ants (*Pheidole megasephala*) when necessary 2- Interplant coconut with recommended suitable host trees of weaver ants 3- Construct artificial aerial bridges to facilitate mobility of weaver ants between trees 4- 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*)	Mites will attack on-month old fertilized nutlets. Attacked nutlets will develop elongated white streaks below the prianth. These, in 2-3 months old nutlets, develop into small yellow triangular patches. The white streaks and the triangular patches are the most important initial and subsequent symptoms of infestation. Inspect the field regulary. Regular inspection of 1-2 month old inflorescences should guide the farmer in detecting mite infestation and what control strategy to take.
	Coconut termites (*Macrotermes* spp.)	• For species living above ground, the termitarium can be destroyed physically • Apply recommended insecticides at the recommended dosage rates

Diseases	Lethal Disease caused by phytoplasma	• Plant recommended tolerant/resistant varieties. e.g. East African Tall sub populations • Proper destruction of diseased plants. Cutting down symptomatic palm to prevent spread of the disease should be taken upon observing a palm in the initial stages of the disease i.e. when the palm drops nuts of all development stages and yellowing of older leaves. The early symptoms should therefore be well understood • Avoid movement of seedlings from infested to non infested areas • Practice location specific replanting

Source: Source: MAFS: Plant Pests Field Book: A guide to management, 2003; COLEACP PIP GPPGuides Coco November 2007

The only pesticide recommended for use on coconut is hydramethyl for the control of the brown house ants, which interfere with the effectiveness of the weaver ants.

4.3.2 Mangoes

Mangoes are grown for the local and export market, mostly as a smallholder crop. Despite its popularity, there has been limited research on its major pest problems and producers develop pest control tactics on a need basis (Table 2.11). Therefore, much need to be done to improve the crop, and also to address the key pest problems.

Table 2.11 Key pests of mangoes and recommended management practices

Pest		***Farmer practices***
Insects	Fruit flies (*Ceratitis* spp,and *Bactrocera* spp)	• Collect and destroy all fallen fruits at least twice a week throughout the season. Bury or burn or put in a tightly tied plastc container until they are completely rotten and all the maggots are dead. Bury fallen fruits at least 50cm deep in the soil to prevent flies from reaching the soil surface • If possible, wrap fruits in either newspapers or paper bags (create a barrier for egg-laying adults) to prevent fruit flies from laying eggs on the fruit. This has to be done well in advance before the fruit matures. • Inspect the orchard regularly, preferably once/week, to detect early infestations. This can be done using traps (chech with your plant protection extension advisor). • Use brewers' waste (machicha ya pombe) mixed with an insecticide to attract and kill the adult flies. Make sure to empty and refill the containers at least once a week. The bait can also be used as spray. Molalasses mixed with an insecticide can be used as a bait spray for fruit fly control BUT do not spray directly on fruit. The molasses will also attract beneficial insects e.g. pollinators and natural enemies of the pest, which can be killed by the insecticide.

		• Application of bait sprays should start when the fruits reach 13 mm size and should continue throughout the fruiting season until last harvest. • In large orchards (more than 20ha) bait application should target the periphery of the orchard.
	Mango weevils (*Sternochetus mangifera*)	• Orchard sanitation is very important. Remove all fallen fruits, seeds and palnt debris and bury at least 50cm deep. Alternatively, finely chop and burn fallen fruits • Inspect the orchard frequently for egg-laying marks • In areas with hidtory of high infestations, treat tree trunks aiwht an insecticide during the dormant stage of the weevils. Toensure good coverage of the trunk, mix chalk inot the spray. • Use foliar sprays as soon as the flower buds open until the fruits reach 15mm (bird-eye size). • Apply sticky bands at the upper end of the trunk before it branches to reduce weevil migration between branches for egg laying

Table 2.11 continued

	Pest	Farmer Practices
	Mango mealybug	• Destroy affected parts at initial stages of infestation • Prune heavily infested branches, especially the tender branches beforeflowering • If necessary, spot spray with selective pesticides, mineral oils or botanical extracts e.g. neem oil , mineral oil or soapy solutions(1-2%). Use soft soap. Before applying oil or a soap solution, test for possible phytotoxicity ona part of the tree, starting with a low dosage. If you use oils, it is advisable to spray late in the evening to avoid sun burn. • Control ants tending mealybugs
Diseases	Mango anthracnose (*Colletratrichum gloesporiodes*)	• Prune dead branches and twigs and remove them from the orchard. Remove dead leaves as well. • Monitor for disease weekly • Spray post-harvest leaf flush with copper-based products if rain is expected • Apply a fungicide when panicles appear BUT before flowers open, if conditions are wet. Apply another spray at fruit set (pinhead) and thereafter evry 7 to 10 days dpending on weather conditions
	Powdery mildew (*Oidium spp)*	• Plant tolerant varieties e.g. Tommy Atkins and Sensation if available • Monitor for diseases weekly during flowering stage • Apply first spray **before** the disease is visible (before bud break) to delay the start of the epidemic. Apply a systemic fungicide. Apply a second spray usinf a non systemic fungicide after three weeks. Apply a third spray with a systemic fungicide three weeks after the 2nd spray. • A solution of baking powder (6 teaspoons) with white oil (3 teaspoons) and white bar soap foam in 15l of water has been shown to give effective control of powdery mildew.

Source: A guide to IPM in mango production in Kenya (Varela, Seif and Nyambo 2006)

4.3.3 Citrus

Like mangoes, citrus fruits are produced for the local and export markets but resources allocated for research and development are insufficient and therefore, the pest management strategies used by farmers to date have been borrowed from elsewhere and fine-tuned for local use on a need basis. Table 2.12 is a summary of the key pest problems and some of the available management options.

The biological control of the woolly whitefly, which is a new pest of citrus in Africa south of Sahara, is a recent good example. The programme, a collaborative initiative between PHS and GTZ-IPM, was embarked on after promising results were reported in Uganda and Kenya where successful initial *Coles noacki*, a parasitic wasp, releases were done.

The biological control of the citrus black flies (*Aleurocanthus woglumi* Ashby) is a spill-over from releases of two parasitoids (*Retmocerous serius* in 1959 and *Encarsia opulenta* in 1966) done on the Kenya coast. The efficacy of this bio-control agent has to be facilitated by controlling the attendant ants, which facilitate the spread of the pest and also interfere with the efficacy of the wasps (Dr. Z. Seguni, personal communication). It is also important to raise farmers' awareness about the role and significance of the parasitoids in citrus orchards. Indiscriminiate insecticide application wil certainly interfere with the efficacy of the parasitoids. Farmers in the coconut and cashew cropping systems can benefit from the technology already developed for the management of attendant ants on respective crops.

Overall, local information on sustainable management of citrus, particularly pest problems, are lacking (Table 2.12). Adequate resources must be allocated to enhance development and promotion of the crop.

Table 2.12 Major pest problems of citrus and recommended management practices

Pest		***Recommended management practices***
Insects	Scale insects	Normally ants protect aphids against natural enemies
	Mealybugs (*Planococus citri-Risso*)	Trees with dead brown leaves should be uprooted and replaced
	Aphids (*Toxptera citricidus*)	Normally ants protect aphids against natural enemies
	False codling moth (*Cryptophlebia leucotrata*)	• 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 flocossus*)	• Biological control using *Cales noacki*, an imported parasitic already introduced in the major citrus growing areas in Tanzania since 1999. • Management of attendant ants to reduce spread and facilitate the efficacy of natural bio-control agents
	Black flies (*Aleurocanthus woglumi* Ashby)	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

Table 2.12 continued

Pest		Recommended management practices
Diseases	Greening disease (*Liberobacter africana*)	• Propogation 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* spp)	• Budded at least 20cm from ground should be chosen • Cut infected trees • Affected orchards should not be excessively irrigated
	Tristeza (Virus localized in phlorm tissue)	• Use disease free budwood
	Green moulds (*Pencillium italicum*)	• Handle fruit carefully to reduce skin injury • Treat bruches, graders, etc • Use the recommended post harvesting treatment

Source: MAFS: Plant Pests Field Book: A guide to management, 2002

4.3.4 Pineapples

Pineapples are largely grown for the domestic market and have few known major pest problems in Tanzania. These include the pineapple mealybugs (*Dysmicoccus brevipes & D. neobrevipes)* and pineapple wilt disease, which are transmitted by *Dysmicoccus brevipes.* The recommended pest management tactics therefore target the control of *Dysmicoccus brevipes*, the vector. The only viable approach is through effective management of attendant ants to reduce spread and build up of mealybugs in the crop.

4.3.5 Tomatoes

Tomato is the most important horticultural crop, grown by almost all small farmers in northern and southern Tanzania. There are two types of tomatoes grown in Tanzania. These are the tall or intermediate varieties e.g. Money maker and Maglobe, and the dwarf varieties e.g. Roma Vf and Tanya. Both types are grown across the country although consumer preference also influences local production.

Tomatoes are grown for cash and domestic use mostly by women and youths in Kilimanjaro, Arusha, Tanga, Iringa, Dodoma, Mbeya, Morogoro and Mwanza regions. It is also important for local processing, with processing plants in Iringa and Arusha. Some of the products from these plants are sold on the local market while the bulk is exported.

In some areas, e.g. in the northern zone, more resources are invested in tomato production than in coffee production because tomatoes gives better and fast returns (B. Nyambo, personal observation).

Production is constrained by damage caused by a wide range of insect pest, nematodes, spider mites and diseases. The key diseases in Tanzania include late and early blight, tomato yellow leaf curl virus (TLYV), tomato mosaic virus (ToMV), fusarium wilt, powdery mildew, and bacterial spot. Key insect pest include the African bollworm, thrips and white flies, spider mites particularly *Tentranchycus evansi*, an AIS, that has spread to many major tomato producing areas in Tanzania and root knot nematodes (Table 2.13). Current list of recommended pesticides is in Table 2.13.1.

Effort to improve tomato production through breeding and selection for tolerance and/or resistance to key pests, particularly diseases, in the country has been facilitated by the AVRDC World Vegetable Centre Regional Centre for Africa Arusha in collaboration with HORTI-Tengeru Arusha since 1994. This iniative resulted to the release in 1997 of Tengeru 97 (resistant to root knot nematodes, fusarium wilt, tomato mosaic virus-ToMV and tomato yellow leaf curl virus-TYLV, followed by Tanya (resistant to root knot

nematodes, tomato mosaic virus-ToMV and tomato yellow leaf curl virus -TYLV). Both varieties are very popular with farmers and consumers in the country. In 2007 and 2008 the programme released Meru (with tolerance to late blight, root knot nematodes, and ToMV) and Kiboko (with tolerance to late blight, ToMV and powdery mildew) respectively. Wide use of Meru and Kiboko varieties will reduce tomato spraying for the control of early blight by as much as 50% (B.Nyambo, personal observations, I.Swai personal communication). The East African Seed Company Arusha branch will start commercial multiplication of Meru in 2009 in partnership with the seed project at HORTI-Tengeru. The AVRDC regional programme is also researching on other related agronomic and insect pests of tomatoes. The Billgates-funded vBSS project also based at AVRDC Arusha with a regional mandate for vegetable seed improvement will play a significant role in ensuring availability of quality seeds to growers and private seed dealers through TOSCI. The AVRDC regional Centre is also researching and promoting wide use of organic indigenous vegetable production.

Table 2.13 Major pests of tomatoes and recommended management practices for northern zone

Pest		***Recommended management practices***
Insects	American bollworm (*Helicoverpa armigera*)	• 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 e.g Mexican marigold • Spray with recommended insecticide if necessary
Nematodes	Root knot nematodes (*Meloidogyne*) Kiswahili: *Minyoo fundo*	• Optima rotation and fallow • Deep ploughing • Avoid contaminated water • Plant tolerant/resistant varieties e.g Tengeru 97, Tanya and Meru • Sterilise the seedbed before sowing • Transplant clean seedlings only
Mites	Red spider mites *(Tetranychus spp)* Kiswahili name: *Utitiri mwekundu*	• Avoid dusty conditions during extreme dry season • Encourage moist microclimate by frequent irrigation • Encourage natural enemies by mulching • Frequent weeding • Inspect the crop regularly for new infestations • Apply a recommended miticide if necessary

Diseases	Late blight (*Phytophthora infestants)* Kiswahili name*: Baka jani chelewa*	• Plant tolerant varieties e.g. Meru and Kiboko • Use certified disease free seeds • 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 recommended spacing • Observe recommended time of planting • Plant at correct spacing • Shade management • Decrease humidity through pruning, desuckering, staking and weeding • Apply mulch to reduce splash and spread of the disease

Table 2.13 continued

	Pest	***Recommended management practices***
	Early blight (*Alternaria solani*)	• Remove infected plants staring from nursery • Weed out Solanacea plants • Observe recommended time of planting • Regular crop scouting to detect early attack • Apply recommended fungicide if necessary
	Powdery mildew (*Oidium lycopersicum)*	• Use tolerant varieties e.g Kiboko • Sanitation , remove infested leaves • Practice crop rotation • Use botanical and other natural pesticides if validated • 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 plants 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 from infested areas • Choose seedbed in clean uninfected area
	Fusarium wilt (*Fusarium oxysporum)* Kiswahili: *Mnyauko fusaria*	• Use resistant varieties e.g. Tengeru 97. . Tengeru 97 is resistant to both *fusarim* wilt races 1 and 2 • 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*) Kiswahili name: Madoa bakteria	• Use clean seed • Three year crop rotation • Avoid working in fields under wet conditions • Avoiding of injuries to fruits

Table 2.13 continued

	Pest	***Recommended management practices***
	Tomato yellow leaf curl (TYLC)-virus vectored by whitefly (*Bemisia tabaci*) and some thrip species Kiswahili names: *Rasta, Ngumi, Bondia*	• 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 tolant and virus prone crops like tomatoes • Good management of irrigation water • Remove and destroy crop residues immediately after the final harvest • Avoid planting Lantana camara near tomatoes fields • Spray if necessary but use recommended insecticides

Source: MAFS: Plant Pests Field Book: A guide to management, 2003, IPM working group in the Northern Zone 2001; LZARDI-Ukiriguru 2000

Table 2.13.1 List of pesticides recommended for use on tomatoes

Chemical	***Chemical common name***	***Formulation***	***Application rate***	***Target pest***	***Comments***
Insecticides	Pirimiphos methyl	50%EC		fruit worms	
	Carbaryl	85%WP	12-24gms/10l water		
	Profenofos	72%EC		Whitefly	
Miticide	Azocyclotin	25%WP		Red spider mites	Registered for use on greenhouse roses for spider mite control
Fungicides	Metalaxyl + mancozeb	7.5% + 56%WP	3.0 to 3.5 kg/ha	Early & late blight	
	Mancozeb	80% WP	1.5 to 2.5 kg/ha		
	Chlorothalonil	50%FW	2.0 to 5.0 l/ha		
	Copper hydroxide	50%WP	4.0 to 5.0 kg/ha		

Source: Paul, Mwaiko & Mwangi, 2000

All pesticides on tomatoes are applied using a knapsack sprayer. The list of pesticides (Table 2.13.1) can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the nearest plant protection extension worker if in doubt.

4.3.6 Onions

Onion cultivation takes place throughout the Northern Zone and the Central Zone, but most production is located in the cooler, higher altitude areas, such as the mountains of Mbulu, Lushoto, Pare and Usambara and the foot slopes of Mount Meru and Mount Kilimanjaro. Most onions are cultivated under irrigation during the dry season. The crop is often grown year after year on the same field without sufficient rotation, a practice that encourages the build-up of pest and disease epidemics.

Downy mildew and storage rots are among the most important diseases affecting onions. Downy mildew can be controlled by field sanitation, wide spacing and weed control, rotation and use of tolerant varieties. Storage rots, such as *Botrytis, Erwinia, Mucor and Fusarium* can be controlled by ventilation and storage of onions on racks, use of polypropylene or netted bamboo baskets, drying of onions before storage and removal of tops. These control measures are applicable by all categories of farmers and can be disseminated through leaflets and brochures.

Onion thrip is the most common insect pest affecting onion production. Development of thrips populations is favoured by insufficient rotation and poor management of crop debris. Cultural control measures include deep ploughing, field sanitation, crop rotation, timely planting, mulching and irrigation can reduce thrip damage.

Information on major pest problems in the central agro-ecological zone is scanty, and therefore Table 2.14 gives a summary of the major pests and respective management options for some parts of the northern zone only. These pest management options (2.14) can also be refined and adopted by farmers in other areas.

Table 2.14 Major pest problems and recommended management practices

Pest		***Recommended management practices***
Insects	Onion thrips (*Thrips tabaci)* Kiswahili name: *Vithripi*	• 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 mites, bugs, fungal pathogens like Metarhizium) • Inspect the crop regularly .
Diseases	Downy mildew (*Peronospora destructor*) Kiswahili name: *Ubwiri unyoya*	• 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

Table 2.14 continued

	Pest	***Recommended management practices***
Disease	Storage rots (*Bortytis, Erwinia, Mucor, Fusarium)* Kiswahili name*: Uozo ghalani*	• 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

Source: MAFS: Plant Pests Field Book: A guide to management, 2002, IPM working group in the Northern Zone 2001; LZARDI-Ukiriguru 2000

4.3.7 Brassicas (cabbages and kale)

Cabbages and kale are grown in the cool highlands. It is a valuable relish for urban dwellers where it is used as vegetable salad and as stew to accompany the starchy foods (rice, ugali, cassava etc.). To date, the crop has few major pest problems whenever it is grown in the country. The crop is mainly grown for income generation.

The most common disease affecting cabbage is black rot. The disease can reduce yield by 90% during the rainy season. Black rot is caused by the *Xanthomonas campestris* bacteria which are spread by infested seed and through crop debris. Wet warm weather conditions encourage the development of bacteria populations. Cultural control measures, such as deep ploughing, crop rotation and field sanitation considerably reduce the damage by blank rot. Other potential IPM control techniques include seed dressing with *Bacillus* bacteria, seed treatment with hot water or antibiotics, and resistant varieties.

The diamond back moth (DBM) is the most devastating insect pest of cabbage and kale. The pest can cause up to 100% yield loss if uncontrolled. Prior to 2003, farmers applied 12 weekly sprays to control the pest. In 2003 the BMZ-ICIPE led biocontrol project in collaboration with MAFSC introduced *Diadegma semicalusum* , a parasitoid of DBM in Meru district. The parasitoid was successfully established, resulting to effective control of the DBM in northern Tanzania. Based on these result and the lessons learned, the parasitoid was released in the major cabbage growing areas in Lushoto district, including Central and Southern highlands in 2006 with excellent results (B. Nyambo personal observations). Whereever the parasitoid has been established spraying for DBM declined from 12 sprays/crop season to zero in most areas,

4.4 General pest problems and their management

IPM strategies are recommended and used by majority of farmers as much as it is possible because there is no one control practice/measure that can provide acceptable control of the target pest. However, there is room for improvement as will be explained below.

4.4.1 Rodents

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. Virtually all regions are affected with more frequent outbreaks in Lindi, Mtwara, Coast, Tanga, Rukwa (Lake Rukwa valley) and in the cotton areas of Shinyanga regions.

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 (Anon, 1999). Losses of cereals are usually quite high and are in average about 15%. This loss of cereals could provide enough food for 2.3 of population for a whole year. Annual control costs for rodents are approximately 217 million Tanzanians Shillings (MAFS 2004).

Farmers in outbreak areas are strongly advised to do the following (Mwanjabe & Leirs, 1997; Bell, undated) to reduce potential damage to crops and the environment:

- Regular surveillance. The earlier the presence of rodents is observed, the cheaper and simpler any subsequent action will be and losses will remain negligible
- Sanitation. It is much easier to notice the presence of rodents if the store is clean and tidy
- Proofing i.e. making the store rat-proof in order to discourage rodents from entering
- Trapping. Place the traps in strategic positions
- Use recommended rodenticide. However, bait poisons should be used only if rats are present. In stores or buildings, use single-dose anticoagulant poisons, preferably as ready-made baits.
- Encourage team approach for effectiveness. The larger the area managed or controlled with poison, the more effective the impact
- Predation. Keep cats in stores and homesteads.

In the cotton growing areas of Shinyanga, rats are a serious problem in cotton at planting and harvesting. At planting, the rodents pick out the seeds after planting, this leading to uneven germination and poor establishment. At harvesting, the rats feed on the seeds, leaving the farmer with lint only. Through feeding the rats not only reduce the value of the crop but also affect its quality by contamination by faeces and urine.

To reduce rat damage on cotton during harvesting, farmers are advised to pick the crop frequently and to sale it immediately after picking.

4.4.2 Migratory and outbreak pests

The key migratory and outbreak pests of economic significance in Tanzania are armyworm (*Spodoptera exempta*), birds, notably the Quelea (*Quelea quelea* spp), and the red locusts

With an exception of the elegant grasshopper, the management of the rest of the pests under this heading is co-ordinated by the Plant Health Service of the Ministry of Agriculture and Food Security.

4.4.2.1Birds (Quelea quelea spp)

Birds are serious migratory pests of cereal crops, namely wheat, rice, sorghum and millet across the country. The quelea birds, which in Tanzania occur as swarms ranging from thousands to a few millions annually (Table 2.15), have been responsible for famines of varying proportions in some areas. In 2001, total loss (100%) in 700 ha of wheat was experienced in Basuto wheat farms, Hanang District (MAFS 2001). Similarly, about 25% loss of rice was experienced on 1125 has in the Lower Moshi Irrigation Rice

Project in 1997/8 due to quelea birds (MAFS 1998). 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), and hence the massive losses associated with outbreak.

Table 2.15 *Quelea quelea* outbreaks and cereal damage in some regions of Tanzania, 1998-2002

Region	**Number of hectares destroyed per year**				
	1998	1999	2000	2001	2002
Manyara	320.5	167	0	0	288
Dodoma	145	600	430	186	230
Mbeya	170	522	573	342	190
Mwanza	24	370	110	80	0
Shinyanga	56	0	350	48	357
Singida	150	0	41	194	123
Kilimanjaro	0	102	0	0	0
Mara	0	500	125	0	73
Morogoro	0	254.5	36	202.5	191
Tabora	0	215	663	0	127
Total hectares	**865.5**	**2730.5**	**2328**	**1052.5**	**1579**

Source: Ministry of Agriculture and Food Security Report, 1998-2002

Bird pest problems in agriculture have proved difficult to resolve due in large part to the behavioural versatility associated with their flocking ability as well as the array of food choices available to the flocking birds. Based on these two factors, effective control is information intensive and therefore rather challenging.

The control of migrant pests such as Quelea is a major concern to most farmers and the Ministry of Agriculture and Food Security. 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 varities and alternative cultural practices have been evaluated. 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. Aerial spraying of pesticides (parathion and later fenthion) on nesting and roosting sites, is 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 of 2.0l/ha.

The concerns over possible human health problems and environmental damage resulting from the large-scale application of chemical pesticide for quelea control call for alternative non-lethal control strategy e.g. net-catching. There is also a possibility to promote quelea harvesting for food because they are a good source of first class protein. Chemical pesticide applied for quelea control represent a risk to human, terrestrial, non-target fauna and aquatic ecosystems. The fact that non-target birds and, occasionally, other vertebrates may be killed by quelea control operations is well-established (Keita, et.al. 1994; van der Walt et.al. 1998; Verdoorn, 1998)**.**

4.4.2.2 Locust

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 that can cause huge damage to plants in a very short period of time. There are eight known red locusts outbreak in East and Central Africa, four of these are found in Tanzania. These include the Rukewa Valley and Iku/Katavi plains in the Southern West, the Malagarasi River basin in the West and Wembere Plains in the Centre. They cover a total of 8000 km^2. 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. Table 2.16 shows invaded area and treatment used for red locust in 2003.

Table 2.16 Locust nvaded area and treatment used in January-December 2003

Year	Type	Monitored sites/areas	Invaded area	Treatment		
				Area coverage (Ha)	Type of chemical used	Remarks
January 2003 to December 2003	Red locust	• Wembere Plains (Tabora) • Malagarasi Basin (Kigoma) • Iku/Katasi Plains (Rukwa)	1. Iku/Kutanvi Plains (Rukwa) 2. Wembere Plains (Tabora)	2,600 600 4500	• *Metarhizium anisopliae* • Fenitrothion technical • Fenitrothion technical	Observation, shows Metarhiziu m anisophiae as a more effective chemical in controllong the spread of Red Locusts

Source: MAFS (2004): Basic data agriculture sector 1995/96-2002/2003

Recently, the red locust regional programme has started to investigate the viability *Metarhizium anisopliae*, a biopesticide, for locust control. This is a collaborative initiative funded by DFID between NRI-UK, Tanzania and Zambia Governments. If viable, the agent can also be used as an option in the management of the elegant grasshopper and the edible grasshopper (locally known as *nsenene*).

The edible grasshopper (*Ruspolia nitidula*, Scopoli) has become increasingly damaging on cereal crops (maize, wheat sorghum, rice and millets) in parts of the country, notably northern, eastern and lake zones in recent years (PHS, pers.comm.). There being no research done on the management of the pest, farmers are forced to use any recommended insecticide whenever outbreaks occur.

4.4.2.3 Armyworm

The African armyworm (*Spodoptera exempta*) is a major threat to cereal production in a number of east and southern African countries. It 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 as depicted in Table 2.17. The problem with armworms is that they are highly migratory so that larval outbreaks can appear suddenly at alarming densities, catching farmers unawares and unprepared (Mushobozi et al., 2005.)

Table 2.17 Armywork outbreaks in Tanzania

Seasonal Year	Area Infested (Hactres)
1989/90	28,768
1990/91	15,214
1991/92	517,233
1992/3	34,844
1993/94	45,504
1994/95	4,798
1995/96	3,187
1996/97	577
1997/8	35,174
1998/9	311,560
1999/2000	50
2001/2002	157,942

Table 2.18 Armyworm outbreak and associated crop loss during the 2001/2002 cropping seasons in some areas of Tanzania

Region	District	Crops damaged	Hectares infested
Arusha	Hanang	Maize, sorghum, millet, pasture	25,910
	Kiteto	Maize, millet, pasture	15,570
	Karatu	Maize, sorghum, millet	2,500
	Monduli	Maize	100
	Babati	Maize	3,090
	Arumeru	Maize, pasture	2,500
	Simanjiro	Maize, pasture	2,230
Dodoma	Dodoma Rural	Maize, sorghum, millet, pasture	21,300
	Dodoma Urban	Maize, sorghum, millet	6,613
	Mpwapwa	Maize, sorghum, millet, pasture	5,906
	Kondoa	Maize, sorghum, millet, pasture	17,268
	Kongwa	Maize, sorghum, millet, pasture	21,328
Kilimanjaro	Hai	Maize, paddy, pasture	3,500
	Rombo	Maize	110
	Mwanga	Maize, pasture	281
	Same	Maize, paddy, pasture	251
	Moshi	Maize, paddy, pasture	15,000
Tanga	Korogwe	Maize, paddy, pasture	1,050
	Handeni	Maize, pasture	6,445
Morogoro	Morogoro Rural	Maize, paddy, sugarcane	5,483
Iringa	Kilosa	Maize, paddy	617
	Kilombero	Maize, paddy, sugarcane	747
	Iringa Rural	Maize	9
	Ludewa	Maize	113
Mbeya	Mbozi	Maize	22
		Total hectares infested	157,943

Source: Ministry of Agriculture and Food Security Report, 2001-2002

Due to its economic significance, management and control is centrally co-ordinated by PHS. Its control combines monitoring in identified breeding areas, forecasting and early warning of potential outbreaks. The national armyworm control programme based at Tengeru-Arusha, runs a network of 100 traps distributed throughout the country (Anon, 1999). The traps are placed at district offices, research stations and in large-scale farms. Weekly returns from these traps are used in forecasting potential outbreaks for the following week (Anon, 1999). The information about potential outbreaks is passed to the regions and districts 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.

The above centrally managed monitoring and early warning system could be improved by integrating the lessons learned from the USAD-ARS /MAFSC community-based armyworm forecasting (CBAF) project conducted from 2003 to 2006. This project was piloted in Hai, Kilosa and Moshi districts. It combined forecasting of armyworm outbreaks with the utilization of the natural disease of the armyworm, *Spodoptera exempta* nucleopolyhedrovirus (SpexNPV). The results indicated that CBAF achieved a high level of forecasting accuracy, with 75% of all positive forecasts having corresponding outbreaks (Mshobozi et al., 2005). The researchers also were able to demonstrate that ground and aerial sprays of *SpexNPV* gave effective control of outbreaks and therefore could be used to replace chemical insecticides for armyworm

control. The team went furher and developed a step-by-step manual /guide for preparation of *SpexNPV* as public goods that can be used by private entrepreneurs for commecrialization of the product.
CBAF is ready for scaling up to other parts of the country, and the model could be adopted for other outbreak pests including locusts and quelea birds. 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 central system of early warning. Secondly, farmers can use less toxic and environmentally friendly proven alternatives to pesticides e.g. botanical extracts and/or biopesticides at relatively low cost with minimum environmental hazards. Thirdly, if well co-ordinated, 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 regional levels.

4.5 Allien Invasive species (AIS)

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 occurance of new pest problems. This requires frequent pest risk surveillance and continuous updating of the existing pest list, an issue already being addressed under the MAFC/One UN Joint Programme (JP) 6.2-FAO project UNJP/URT/129/UNJ: Sterengthening National Distater Preparedness and Response Capacity. To date the country is still having 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. MAFSC in collaboration with the ICIPE-Led BMZ fruitfly project is already piloting on biocontrol programme in collaboration with some mango growers as one of the IPM strategies.

Cashew production has to develop management strategies for the fast spreading disease caused by *Cryposporiopsis* sp, a new devastating disease reported in Tanzania (Sijaona 2006).

The horticultural sub-sector (fruits and vegetables) is struggling with the control of *Tentranchycus evansi* (the tomato spider mite), a devastating polyphagous spider mite (attacks a wide range of solanaceous crops and weeds) that is difficult to control and has few known natural enemies. In addition, the country has to deal with international quarantine insect pests e.g *Liriomyza huidobrensis*, *Thrip palmi*, *Bactrocera invadens*, *Helicoverpa armigera* etc.

In staple food production, the country is stil trying to develop sustainable coping stragies to deal with the grey lef spot of maize, the larger grain borer (LGB), the rice yellow mottle virus reported in the country since 1980s, cassava mosaic diseases (East Africa CMV and ACMV), cassava mosaic disease Uganda variant (UgV) and cassava brown streak disease, to name just a few.

The frequent occurrence of AIS is a threat to food security and trade (domestic, regional and international), an issue that has to be given adequate resources. The joint UN/FAO/MAFSC 2008/09 is only a temporary measure that has to be beefed up in order to improve the PHS capacity to deal with new pest problems.

5. Pesticide use and registration in Tanzania

It is important to recognise that, all the registered pesticides in Tanzania are recommended as part of IPM components in all production/cropping systems as indicated in the previous sections of this report.

5.1 Synthetic pesticides

All the pesticides included on the pesticide registrer's list have been registered by TPRI Act, 1979 and Pesticides Control Regulations GN 193 of 1984) [Anon, 2001b], and this is why some pesticides e.g. paraquat, one of the 'dirty dozen', is still officially registered and allowed to be used in Tanzania (TPRI November 2007). It is therefore strongly recommended that, the pesticide registrar ban all further importation and subsequent use of paraquat in Tanzania and others in the same category, with immediate effect.

Those pesticides in WHO class Ib, namely endosulfan, chlorpyrifos, quinalphos, carbofuran, and isazophos, should be deregistered with immediate effect and phased out by year three of the programme and encourage use of less toxic and more IPM friendly pesticides.

Both WHO class I and II are still featuring on the list of registered pesticides mostly because, the WHO class III, which are new generation pesticides known to be less toxic and therefore more environmentally and IPM friendly, are relatively more expensive and therefore beyond the means of most smallholder agricultural producers in Tanzania. In addition, the majority of such pesticides are not locally available. Therefore, judicious use of through integrated use of other pest management options is recommended to ensure reduction of potential health and environmental hazards.

It is evident, albeit from Table 2.19, that, the current list of registered pesticides is outdate and also not in line with international standards (Rotterdam Covention and the FAO Code of Conduct). It is therefore strongly recommended that, the registrar of pesticides review the current list of registered pesticides in line with the WHO guidelines immediately. Tanzania ratified the Stockholm Convention on POPs in April 2004 (URT 2005) and there after formulated the National Implementation Plan (NIP).

The current list of pesticides registered in Tanzania indicates trade name, registration number, common name, registrant and usage. This is not informative enough given the wide range of its users. It is therefore recommended that, the proposed revised list should include the WHO class, oral LD50, active ingredient, and application rate.

Table 2.19 List of recommended and TPRI registered pesticides for crop production in Tanzania: Oral LD_{50} and WHO classification

Chemical	*Common name*	**Oral LD50/kg*	*WHO class*	*Comments*
Insecticides	Betacyfluthrin	500-800	II	
	Biphenthrin			
	Carbaryl	850	II	
	Chlorpyrifos	135-163	Ib	Deregister & Phaseout
	Cypemethrin	251-4125	III	
	Cypermethrin + Dimethoate	251-4125 + 2350	III	
	Deltamethrin	153-5000	III	
	Dealtamethrin + Dimethoate	153-5000+2350	III	
	Diazinon	220	II	
	Dimethoate	2350	III	
	Endosulfan	55-110	Ib	Deregister & Phaseout
	Esfenvalerate	451	II	
	Fenitrothion	800	II	
	Fenvalerate	451	II	

Table 2.19 continued

Insecticides	Common name	***Oral LD50/kg***	***WHO class***	***Comments***
	Fenvalerate + Fenitrothion	451+ 800	II	
	Flucythrinate			
	Hydrmethyl			
	Lambda cyhalothrin	243	II	
	Permethrin	430-4000	III	
	Pirimiphos methyl	2050	III	
	Pirimiphos methyl + permethrin	2050 + 430-4000	III	
	Profenophos	358	II	
	Profenophos + cypermethrin	358 + 251-4123	II	
	Quinalphos	62-137	Ib	Deregister & Phaseout
Nematicides	Carbofuran	8-14	Ib	
	Dazomet	520	II	
	Isazophos	40-60	Ib	Deregister & Phaseout
Herbicides	Atrazine			
	Diuron			
	Fluometuron			
	Glyphosate			
	Metolachlor + Atrazine			
	Metalachlor + Dipropetrin			
	Paraquat			Dirty Dozen: should be banned with immediate effect

Table 2.19 continued

Chemical	*Common name*	**Oral LD50/kg*	*WHO class*	*Comments*
Avicides	Fenthion			
	Cyanophos			
Rodenticides	Bromodiolone			
	Coumatetralyl			
	Diphacinone			
Fungicides	Bronopol			
	Chlorothalonil	10,000+	III	
	Copper hydroxide	1,000	II	
	Copper oxychloride	70-800	II	
	Cupric hydroxide	1,000	II	
	Cuprous oxide			
	Cyproconazole	1,000	II	
	Hexaconazole	2189	III	
	Mancozeb	5000+	III	
	Metalaxyl + Mancozeb	633 + 5000+	III	
	Penconazole			
	Propineb	1,000	II	
	Triadimefon	1,000	II	
	Sulfur			

Sources: TPRI: List of Pesticides Registered in Tanzania, November 2007

It may be noticed that Tanzania has ratified the Convention on Persistent Organic Pollutants (POPs) in April 2004 (Riwa, 2007), but has not yet banned the highly harardous pesticides (WHO classes Ia, Ib, II). However, projects involving use of chemical pesticides under WHO Class Ia, Ib and Class II will not be financed under the proposed ASDP programme.

5.2 Botanical Pesticides

Assessment of botanical pesticides for pre and post harvest is being done by a number of institutions in the country and some of the potential ones have been recommended for use in crop production (Paul et al. 2001). In beans, extracts of *Tephrosia vogelii* and *Neuratanenia mitis* have been recommended and farmers are using them because they are easily available and less costly. Where these do not occur naturally, farmers have also established the plants in their home gardens to ensure availability when needed.

The GTZ-IPM project in Arusha in collaboration with IPM farmer groups and the extension staff has compiled a list of useful botanical pesticides (Table 2.20) that could be used on a wide range of vegetables and other food crops. The information is useful but has to be used with caution. Most of the botanical extracts are already in use by small-scale farmers as crude in-house preparations. However, they should be used with caution.

It has to be remembered that ***not all*** botanical extracts are safe.

Tobacco extract is one of the deadly substances and should therefore not be promoted for use on vegetable production. *Tephrosia* spp extract and leaves are toxic to fish (local fishermen use the leaves for fishing) and therefore should be used with caution.

None of the suggested botanical extracts (Table 2.20) are registered in Tanzania because they have not been researched enough. In particular, information on dosage rate, mammalian toxicity (LD50), side effects on non-target organisms especially potential bio-control agents, biodegradation and reduce analysis data, is not available. However, 3 neem-based and 2 pyrethrum-based commercial formulations are being processed for registration. These two botanicals have been researched and registered in Kenya and elsewhere.

Table 2.20 List of potential plants that can be used to prepare botanical extracts for pre and post harvest pest control

Kiswahili name	***English name***	***Scientific name***
Mustafeli	Soursoap	Annona muricata
Mtopetope	Bull-oxheart	*A. reticulata*.
Mtopetope mdogo	Custard apple	*A. squamosa*
Vitunguu saumu	Garlic	*Allium sativa*
Mwarobaini	Neem	*Azadirachta indica*
Kishonanguo	Black Jack	*Bidens pilosa*
Pilipili kali	Chili	*Capsicum frutenscens*
Mpapai	Pawpaw	*Carica papaya*
Mnanaa	Thorn apple	*Datura stramonium*
Mnyaa/utupa	Milk bush	*Euphorbia tirucalii*
Mchunga kaburi	Barbados nut	*Jatropha curcas*
Mwingajini	Wild sage	*Lantana camara*
Tumbaku	Tobacco	*Nicotiana* spp
Kivumbasi	Mosquito bush	*Ocimum suave*
Mbagi mwitu	Mexican marigold	*Tagetes* spp
Alizeti mwitu	Wild sunflower	*Tithonia diversifolia*
Utupa	Tephrosia	*Tephosia vogelii*

Source: Paul (2000) and Madata (2001).

6. Experiences on IPM in Tanzania

Nyambo (2002) gave a comprehensive analysis of the Tanzania Mainland experience on participatory IPM. Information from the analysis and visit to key stakeholders, namely the Minsitry of Agriculture and Food Security's Plant Health Services, Zonal Agriculture Research and Development Institutes (ZARDI), Sokoine University of Agriculture, districts and farmers are summarized in this section. The national research institutions have developed IPM approaches for a wide range of key pests of the major crops mentioned earlier. Some of the information is locale specific e.g. in cotton, maize, coffee and beans. Unfortunately, a lot of the information has not reached target farmers. The information that has filtered through to farmers is not user friendly and/or not appropriately formulated and therefore farmers are unable to optimise the benefits of such options (Nyambo, Masaba & Hakiza, 1996). This is a result of the "top-down" syndrome, which dominates the national research and extension systems. A change in attitude in the national research and extension system is needed to pave way for participatory knowledge development and transfer. Researchers, extension workers, farmers and other stakeholders must work as partners to achieve effective and sustainable technology development and transfer. Farmers must be active participants in the process of problem identification, development and formulation of appropriate solutions to identified pest problems in the context of other production constraints.

In recognition of the shortcomings of the traditional top down extension system in promoting sustainable IPM approaches and to prepare a foundation to facilitate and enhance grass-root based system of extension, the Ministry of Agriculture and Food Security, in collaboration with GTZ, FAO and IFAD, has been implementing IPM pilot projects to promote farmer participatory integrated pest management (IPM) approaches in different parts of the country and cropping systems. The projects were visited during the preparation of this report to learn and draw on their experiences. The lessons from the above projects will be integrated in this report to support decision making in the dissemination and promotion of appropriate IPM options in different cropping systems under the programme.

6.1 GTZ/PHS-IPM

The IPM project was initatied in 1992 by the Ministry of Agriculture and Food Security, namely Plant Health Services (PHS) and the German Agency for Technical Cooperation (GTZ). The IPM pilot area was the western growing zone (Shinynanga). This was the area using a lot of pesticides to redcue losses emanating from pests. The IPM project was resource intensive with the GTZ granting Tshs 500 million which is 90% of the budget allocated for IPM implementation annually and the counterpar funding by MAFS was Tshs 50 million per annum. The project operated for 11 years under the following phases:

- Baseline and diagnostic surveys, training of counterpart staff, introducing IPM concept at farmers' level, etc. Phase I (1992-1994)
- Developmemnt, testing and dissemination of the IPM technical packages on priority crops in the pilot area of the western zone
- Dissemination and extension of IPM technical packages to other regions in the western and northern zones respectively: Tabora, Kigoma, Kagera, Mara, Mwanza, Arusha, Kilimanjaro, Tanga. Phase II (1997-2002)
- Handing over and consolidating the achievements. The project came to end in September 2003. Phase IV (2003)

Other IPM recommendations accomplished by the project indlcude:

- 6 recommendations in cereals (maize and sorghum)
- 4 recommendations in cassava
- 12 recommendations in beans
- 8 recommendations in onions

The project was also instrumental to the production of the Plant Protection Act 1997, and Regulations 1997 which was operationalized in July 2001.

The knowledge base and capacity of the project is centred in PHS and its zonal plant health services offices in the country.

Approach & Organizational structure: The project used a modified farming systems approach for planning, development and field evaluation of IPM options. This was a mixture of participatory and exploratory methods, as deemed appropriate depending on the level of training of the extension workers and the problem to be addressed. The key elements in the approach included socio-economic baseline (knowledge, attitude & practices) and diagnostic technical plant protection surveys done by experts. These surveys generated a wide range of background information and a basis for M&E. This was followed by participatory technology development and transfer through farmer groups, referred to as *IPM Working Groups*, in different agro-ecological areas in respective regions. The baseline information was later used in the extrapolation of data and options to other areas in the project areas. In this approach, the *IPM Working Groups* are equivalent to the Farmers Research Groups used in the farming systems approach.

Group formation: The *IPM Working Groups* (self formed groups) were initiated by the project with assistance from VEOs and local community development officers for purposes of training and promoting IPM. However, if there were already existing self-formed farmer groups in the village, these were also considered for collaboration.

After clarification of the expectations and roles of the partners, the groups were recruited.

Group management and promotion of IPM: The project technical staff visited the *IPM Working Groups* frequently (several times a week at the beginning of the project) to establish rapport with the group members, to set-up on-farm trials and demonstrations, test extension materials as well as plan and evaluate group activities.

The project provided technical information on IPM options, training and group facilitation (moderation).

The role of the groups was testing and fine-tuning of IPM options and other extension recommendations. Once the IPM Working Groups had approved a technology, the group results were disseminated to other farmers in other similar agro-ecological areas.

After several seasons of training, the *IPM Working Group* were transformed to IPM Farmer Training Groups and a new *IPM Working Group* were initiated in another village and the process continued.

Participatory Group Training approach: The *IPM Working Group* in collaboration with the project technical staff identified key limiting pest problems and other production constraints for each crop in the area. The project technical staff provided a range of recommended relevant solutions for testing by farmer groups. For selected crops, individual members in the groups tested the options in demonstration plots, one crop per farmer. The members made joint visits and analysis of the demonstration plots throughout the growing period until harvest.

During the training sessions, farmers were facilitated to recognise the major pest problems, potential damage, management options, insect pest's natural enemies and good post harvest practices with emphasis on IPM.

Essentially, group training involved four stages that are summarised as follows:

- Capacity building to impart knowledge on IPM and participatory methods of technology transfer, group formation and management to selected project technical staff.
- Demonstration within groups whereby the technology or information was tested for the first time by a farmer within the group under close supervision by the project technical staff. All group members made continuous visits and observations and participated in the analysis of the results.
- Adaptations in farmer own plots by group members. Farmers were encouraged to keep field records, share the information with group members and carry out joint analysis of the results.

- Village cycle spill-over whereby the technology was applied by non-IPM farmer groups in the same village.
- The technology was finally approved for dissemination to other areas with similar crops/pests and agro-ecological similarities.

Participatory evaluation of results and practices: At the end of each crop season, the project technical staff guides the group members to evaluate the trial results using simple PRA tools. To motivate the groups, a meeting of representatives from all *IPM Working Groups* is convened once a year for joint evaluation of results.

Internal M & E: The project had an established continuous internal M & E to assess project impact and spill-over. Currently the project is using an evaluation form, which is supported by regular field visits for verification.

Spill-over and role model effects: KAEMP and MARAFIP copied the project approach.

Capacity Building: The project trained 999 VEOs/DPPOs in IPM within the project area, i.e. 697 in the Western and 302 in the Northern Zones. The IPM project and the District Councils through their respective support programmes, i.e. MARA-FIP, KAEMP, Care, Farmafrica, DRDPs, Faida, Ecotrust, World Vision, LVEMP, etc. have jointly financed the training. The VEO have in turn trained 484,825 farmers in IPM, i.e. 421,487 in the Western and 63,338 in the Northern Zones.

The VEOs facilitated formation of 44 IPM working groups, each with an average of 15 farmers (14 IPM groups in the Western and 30 IPM groups in the Northern Zones). These groups were role model for IPM development, testing of recommendations, validating, implementing and disseminating.

Impacts: The extent of impact achievement with regard to the benefits of IPM such as environmental conservation, restoration of beneficial organisms, etc. has not been evaluation. The following impacts have reported (Nyakunga 2003):

- The use of conventional pesticides in cotton in Shinyanga has been reduced from 6 calender sprays to maximum 3 sprays without negatively affecting production. The evidence of this is the increased cotton production in the Western Zone from 38,000 tons in 1994/95 to 69,900 tons in 2000/01
- Safety of users against conventional pesticides
- The National Plant Protection Advisory Committee was instituted in line with the Plant Protection Act of 1997 and actively guided monitoring and implementation of plant protection activities in Tanzania.
- IPM has been integrated in the Agricultrue and Livestock Policy as a national policy on plant protectin and the ASDP has provided that IPM should be disseminated country-wide.

The success of the GTZ/PHS-IPM initiative was a result of team approach, institutional collaboration (NGOs, national research and extension institutions, and international institutions) harmonisation of technical information between collaborators, adequate flow of funds, good organisational and supervisory skills and staff continuity.

From 1998 the project team operated on a thin budget as a result of gradual phase out by GTZ sponsorship, and therefore, regular training and formation of new *IPM Working Groups* was phased out. Government contribution should have given the much-needed extra logistical support to the national counterpart for the continuation of the project activities. This has not been forthcoming, and so contact is maintained with the IPM Farmer Training Groups to host other interested farmer groups only.

Farmers and VEOs received the IPM-farmer participatory approach to extension with great enthusiasm in all the regions. However, there is a general lack of awareness among the regional and district decision making level about IPM in crop production.

In Shinyanga for example, despite the fact that the project was in the region for close to 11 years, IPM has not been internalised at the decision making level and decisions which are counterproductive to the promotion of integrated pest management are still being made (Nyambo, 2001 and personal observations during our visits to districts in Lake, Eastern, Western, Southern Highland Zones, 2004).

Currently, the IPM project include human and financial resources and infrastructure are concentrated in two (Lake and Nothern Zone) of the five plant protection zones, and the IPM core activities will be extended to other districts of the pilot areas and in the remaining 3 zones (Central, Eastern, and Southern Highlands). These IPM core activies are:

- Sensitization and awareness creation to District authorities
- Development and adaption of IPM packages
- Dissemination of IPM technologies
- Collaboration with relevant institutions
- Capacity building
- Monitoring and evaluation
- Coordination activities

6.2 Kagera Agricultural and Environmental Management Programme (KAEMP)

KAEMP was a multi-sectoral initiative of the Kagera region (Lake Zone) jointly funded by IFAD, BSF/JP and OPEC with contributions from the beneficiaries. The project was implemented by RAS Kagera and managed by the local government machinery. Its main focus was on improvement of food security and poverty elevation, and therefore, had a holistic approach (addresses agriculture, health, livestock, environment management, rural access roads and marketing) to rural development. In this setup, IPM was embraced as the key pest management in all crops.

To support gradual and sustainable adaptation of IPM and integrated plant nutrition (IPN) by resource poor farmers, the project promoted validated and recommended technologies from national and international agricultural research institution. Selected technologies had to be applicable, economically viable and environmentally friendly.

The major crops grown in the region are cotton, coffee, banana, cassava and beans.

As mentioned above, KAEMP borrowed the IPM approach (baseline studies, group formation and training, internal M & E etc.) from the GTZ/PHS-IPM Shinyanga project. In addition, the linkage between the two projects is still strong. GTZ/PHS-IPM technical staff were used as resource persons by KAEMP while Kagera farmers visits the IPM Farmer Training Groups in Shinyanga for learning purposes.

However, due to the nature of the KAEMP set-up, some modifications of the Shinyanga approach were deemed necessary in order to accommodate the overall goals of the project. In crop production, declining crop yields, soils fertility and increased pest pressure were identified as major constraints. To address the issues, the project farmer groups are known as *IPM/IPN* groups (integrated pests management/integrated plant nutrition groups).

Capacity building: Since the project was an integral part of the regional development plan, all extension staff (from the district to the village level) were given training in IPM, IPN, and participatory methods of technology transfer with emphasis on group approaches. In this approach, the district extension officer was the foci for new extension messages. It was the responsibility of each district extension officer to ensure proper technology transfer to end-users and hence the need for them to be well informed about participatory methods of extension. In summary, capacity building in KAEMP was implemented in several stages:

- District technology transfer manager (master trainer) trained in IPM/IPN concepts and approaches including participatory methods of technology transfer through farmer groups
- The master trainer trained the VEOs
- The VEOs trained farmer groups

To enhance the learning process between groups, the project facilitated farmer-farmer learning through group exchange visits between groups within and between villages and districts. A few farmer representatives visited the Shinyanga IPM farmer training groups.

To promote spillover, KAEMP organised and facilitates field days.

The IPM/IPN farmer groups were also used for the transfer of other development messages e.g health, water, environmental management etc. and therefore are a foci for all extension messages.

The KAEMP initiative started in September 1999. By May 2001, the adoption of IPM/IPN within groups was 60% whereas the spillover (diffusion) after 20 months of operation was1:3, which is quite impressive (J. B. Anania, E. A. M. Anyosisye, personal communication). KAEMP owed much of its success to the GTZ/PHS-IPM Shinyanga experience.

The entire stakeholders at regional, district, village and farm level received the approach with enthusiasm.

The achievements of the project was a result of good political support at regional level, team spirit, sufficient funding, effective capacity building, institutional collaboration, good organisational abilities and focused selection of appropriate technology for transfer to target clients.

6.3Mara Region Farmer Initiative Project (MARAFIP)

MARFIP is an initiative of Mara region whose main objective is poverty alleviation through strengthening of capacity of the local institutions to respond to farmer's felt needs related to food, agriculture and livestock. The project is organised and implemented by RAS and funded by IFAD.

As mentioned above, MARAFIP is another offspring of the GTZ/PHS-IPM project (S. O. Y. Sassi, personal communication) and therefore, has many common features. However, MARAFIP uses the FAO IPM-FFS approach of group training and technology transfer.

Capacity building: All district plant protection officers and VEOs were given training in IPM concepts to raise awareness about IPM to facilitate their supervisory role. Five VEOs (project staff) of selected villages for FFS pilot groups were given one-month split course in IPM, group management and participatory technology transfer methods to provide them the capacity to organise and conduct IPM-FFS.

There were 5 IPM-FFS groups in the region, one per district. The main focus crops were cassava, cotton, maize, sorghum, legumes (cowpeas, field beans) and sweet potato. The IPM messages/technologies introduced to the FFS groups were borrowed from the Shinyanga IPM project without further refinement. In one case, the "broken telephone message syndrome" was noted with concern.

At farmer level, the approach received with enthusiasm and adoption of some messages among group members is estimated to be about 25% (one year after IPM training).

The IPM-FFS groups used as entry points for other extension messages e.g. soil and water management, livestock management and community health, which is in line with the regional objectives. However, funding to facilitate technical support to farmer groups was limited, and scheduled activities were shelved.

6.4 Mbeya: Southern Highlands Extension & Rural Financial Services Project/IFAD

This initiative started with organised extension farmer groups in 1996/97 using a modified T&V extension method to enhance technology transfer at farm level. Essentially, the approach was still strongly based on the traditional "top-down" extension method (E.D. Y. Kiranga and A. H. Urio, personal communication).

In 1998/99 the project introduced IPM-FFS pilots in Mbeya (focused on tomatoes, cabbage, round potatoes and wheat) and Ruvuma (focused on coffee and maize) regions. The IPM-FFS and extension groups ran parallel in the same villages.

6.5 IPM-FFS capacity building (IFAD/FAO initiative)

Two VEOs (master trainers) attended a 3 months course in Zimbabwe under the sponsorship of FAO. The project supervisors visited IPM-FFS groups in Kenya for two weeks to gain some basic experience on how to organise and conduct IPM-FFS. This was followed by 2-weeks residential training course in IPM and farmer participatory methods of technology transfer for 25 VEOs in Mbeya and Mbinga districts.

The graduates reported back to their duty stations to organise and conduct IPM-FFS in their respective villages.

Similar to the GTZ/PHS-IPM project, farmer-farmer learning through exchange visits between farmer groups and within group members was facilitated. Like in the other initiatives, organised field days and exchange visits were used to encourage spillover to non-group members. Institutional collaboration was also emphasised during the project implementation phase.

Project funding and activities were phased out in year 2000. All the project activities and extension programmes were officially handed over to NAEP in January 2000. However, there has been limited technical support to the farmer groups since then due to lack of adequate funding, also observed in other projects.

The IPM-FFS approach was highly appreciated by farmers and the VEOs because it was participatory and learning by doing.

6.6 Morogoro Special Programme for Food Security (SPFS)/FAO Project

This was an initiative of the Ministry of Agriculture and Food Security in collaboration with FAO that targets Morogoro and Kilombero districts, with a focus on maize and rice (the major crops in the area) and promotion of small livestock (poultry, milk goats and chicken).

The project started in 1996 and ended in 1998. The initiative promoted farmer participatory group approaches of technology transfer. Because this capacity was not within the project staff, training in participatory approaches was organised and provided by the Co-operative College Moshi for the project core staff (E. Shayo, personal communication).

Baseline surveys and group formation was the same as for the GTZ/PHS-IPM project detailed above. Although the project benefited from the southern highlands initiative, there was limited integration of the IPM-FFS approaches in the Morogoro farmer groups. At the time of the visit, seleceted VEOs were being given a course in IPM-FFS.

Capacity building

- Master trainers were trained by Co-operative College Moshi to impart participatory methods of technology transfer to selected extension workers.
- Selected VEOs and farmers from targeted farmer groups were given whole season training at one training site on selected crop and extension messages that included aspects of plant protection. The graduates were used for field demonstrations of identified and proven extension messages in target groups in their villages. This stage has some attributes of IPM-FFS.
- The demonstration farmers in collaboration with the VEO trained group members. Once the technology is approved by the group, it is ready for dispersion to the whole village. This approach has many attributes of the GTZ/PHS-IPM and KAEMP approaches.

As in the other projects, the training groups in SPFS/FAO project were also used as entry points to transfer other extension information e.g. water control and management, exploitation of groundwater in crop production, marketing (input supply), credit system, record keeping, diversification of farm enterprises, shallow wells etc.

In the first year, the project provided free inputs to the demonstration farmers as motivation. In the second year, inputs were provided on credit with 50% advance payment to wean them off.

There has been some adoption by group members and spillover particularly of those technologies that directly addressed farmer felt needs. Farmers, village leadership, VEOs, district and regional leadership also appreciated participatory group training as a means to stimulate quick and efficient technology transfer. However, due to a lack of logistical support, new training groups have not been formed.

6.7 PHS IPM promotion activities: 2003/06.

Between 2003 and 2006, PHS in collaboration with the PADEP programme conducted a series of sensitization workshops for key policy makers in the agricultural high potential areas; facilitated the establishment of 875 FFs (21,875 farmers) in 11 regions, and designated four farmer training centres

(FTCs): Mkindu-Morogoro, Bihawana –Dodoma, Inyala-Mbeya and Ichenga-Iringa) for FFS training (Riwa 2007). In addition, the FAO supported special programme for food security (SPFS) established 314 FFSs (Mero 2006). TPRI conducted a limited of training courses for pesticide dealers, stockists and retailers and some of the course participants are officially registered with TPRI under the provisions of the PPA 1997 and Regulations 1997 (WH Riwa personal communication 2009, personal observations).

The PADEP/PHS joint initiative during 2005 (Riwa et al., 2005) focused on sensitization of key policy makers at regional and district levels in northern highlands, Central and parts of Southern highland to take measures that will ensure quality inputs and judicious use of fertilizers and pesticides and adoption of IPM practices at farmer level. The emphasis was on the PPA 1997 and its regulations (1999) and the enforcement modalities. The workshop participants recommended that (1) awareness creation and sensitization on the PPA 1997 and regulations 1999 should be done at national level and cover all zones and districts to be effective (2) sensitization should target all leaders at district, ward and village levels (3) increase the number of pesticide inspectors at district, ward and village levels (4) MAFSC to facilitate regular inspections preferably every six months (5) train agrochemical stockists and retailers at all levels (6) strengthen the inspectorate services at all levels.

6.8 PAN-UK ASP IPM Research project

The ASP IPM Research-PAN-UK-led project contributed to strengthening the government ASP action plan in two major activities (1) facilitated Agenda Tanzania and other NGOs to conduct multi-stakeholder awareness workshops for policy makers on safe use and environment friendly pesticides and (2) conduct courses on eco-toxicological monitoring and community-based pesticide action monitoring for other NGOs, CBOs and CSOs. Furthermore, the PAN-UK ASP IPM research project facilitated the NGO consultative workshop held in Arusha Tanzania February 2007 on how to promote IPM in Tanzania and (2) preparation of a country paper on existing opportunities for the ASP-Tanzania project to mainstream IPM and organic farming in Tanzania as strategies to minimize potential hazards of pesticide use through further promotion of IPM practices at farmer level (Nyambo 2007a, 2007b, Riwa 2007). Under this project, AGENDA Tanzania carried out a case study on trade and utilization of pesticides in the context of the ASP prevention programme. Despite efforts to raise public awarenss about the pesticide regulatory framework, the study showed that the conditions of trading an ddistribution of pesticides in Tanzania deteriorates from the national to grassroots due to a lack of efficient enforcerment of the PPA 1997 and Regulations 1999 (AGENDA 2006).
Based on this study, it is recommended that (1) there is a need to review and update the legal instruments to keep in pace with global changing environment (2) regulators should be capacitated in terms of resources to be able to monitor and control illegal trading of pesticides (3) extension services in pesticide use should be improved and (4) farmers should be given more education on pesticide use.

6.9 Lessons and general discussion

Tanzania has invested highly (resource, good will formulation of supportive legal and regulatiry framework) to promote IPM but there is still room for improvement.

Approach

All the projects visited have been actively promoting participatory technology transfer to increase food security and cash income at farm level through self formed farmer groups. Some of these groups are now officially registered. All the initiatives emphasised IPM in their farmer groups. The groups were used as entry points for other innovations on a felt need basis irrespective of the original purpose.

The IPM farmer groups were used as foci for the extension of a wide range relevant and appropriate technology and knowledge, this enhancing group cohesion and overall development.

The participatory group approach to technology transfer was received with enthusiasm by all the farmers and VEOs in all the visited projects. This is because it involved *hands-on-learning*, an observation made by all the farmers visited.

Capacity building

These model projects have a lot in common. Capacity building with emphasis on participatory methods of technology transfer, group formation and management were deemed necessary and essential for the project technical staff before training farmer groups.

Collaboration and sharing of experiences between projects was key to the success of new initiatives in different parts of the country. The GTZ/PHS-IPM project played a major role in the set up and organisation of KAEMP and MARAFIP, whereas the Morogoro region initiative benefited from the experiences of the southern highlands project.

However, the recent decentralisation interfered with smooth running of the farmer training groups because the concept is little understood by the regional and district decision-makers. There has been massive staff transfers and deployment, this affecting continuity.

Institutional collaboration

This has been observed as key input in the success of the entire visited pilot projects. Institutional collaboration (as indicated in the GTZ/PHS-IPM initiative) ensured harmonisation of technical information, optimisation of scarce resources and ensured farmers of the best remedies to priority problems. As indicated above, collaboration between projects within the country was a healthy avenue for sharing experiences that facilitated speedy setup of new initiatives.

Funding and Logistical support

This is very crucial in all the projects. Adequate and timely release of funds determined the progress of the projects.

Currently, and in particular where donor funding has been phased out, project activities have been constrained by a lack of continuous flow of funds, this resulting to infrequent visit and training of established farmer groups. Scheduled activities have been affected in most areas and technical input in existing farmer groups have been curtailed.

Fund flow from district councils to support extension services, particularly the farmer groups, after decentralisation is minimal and/or non-existence.

The lack of logistical support from the district councils is purported to be largely due to lack of awareness among district decision makers on the significance of promoting participatory group approaches in extension.

Political support

Local political support was crucial in the implementation and sustainability of group approach to IPM promotion. KAEMP is the only initiative that seems to have stronger support. This is most likely a result of the project set-up and its holistic approach that addresses the broader needs of the region.

Incentives for farmers practising IPM

Arrangement for credit facilities (to facilitate input availability) is a common factor in all the projects. However, marketing of produce was not addressed in all the projects visited. All farmers contacted indicate this as a felt need. They need to be able to sale excess produce at a profit. This will be a good incentive to IPM practitioners and also a motivation for other farmers to adopt and practice IPM.

More success was achieved where the entry point focused on the real felt needs of the farmers. KAEMP capitalised on the banana-weevil nematode problem as the entry point. In Shinyanga, the GTZ/PHS-IPM project used spraying in cotton and pest management in sweet potato. Thus, the approach should be crop/problem specific and to put it in farmers' words', must focus on cropping seasons.

7. Policy, Regulatory and Institutional Framework for Implementing PMP

The current Tanzania pesticide policy provides for improved extension services to promote responsible use of agrochemical and other plant protection inputs (URT, 1997b). In line with the policy directions, the Government reviewed and updated existing legislations, which led to the enactment of the Plant Protection Act in 1997 (URT, 1997a), followed by its Regulations of 1999 (URT, 1999). In addition, the National Environmental Policy (NEP) 1997 followed by the Environmental Act (EA) 2004, the Environmental Impact Assessment and Audit (EIA&A) Regulations, 2005, and the Environmental Management [EM) (Soil Quality Standards) Regulations, 2007, provides a framework for environmental protection considerations by different sectors into the mainstream of decision making to ensure minimum environmental negative impacts due to agricultural practices and use of external inputs. The NEP 1997, EA 2004, the EIA&A Regulations 2005 and EM (Soil Quality Standards) Regulation 2007 requires the agriculture sector to ensure food security and eradication of rural poverty through the promotion of production systems, technologies and practices that are environmentally sound, with emphasis on strengthening of environmentally sound use, monitoring, registration and management of agro-chemicals use. Thus, current policies and regulations provides for an enabling environment for IPM promotion. The proposed ASDP/AFSP project will be implemented under the above legal framework and all necessary steps will be taken to minimize potential negative impacts likely to arise due to increased use of external inputs associated with the project`activities.

Despite all the efforts, there are still key weakenesses in the enforcement of the respective policies and related regulations (sections 4.4. and 5 above) largely due to a lack of capacity and resources (Riwa et al., 2005, AGENDA, 2006, NEMC, personal communication March 2009). In particular, there is a need for (1) Review and update of the PPA 1997 and Regulations 1999 to keep pace with changing global environment (International Regulations and Standards, trade liberalizationa and climate change), (2) Regulators should be capacitated (provided adequate resources) to monitor and control illegal trading of pesticides (3) extension services in pesticide use should be improved (4) Farmers should be given quality education in pesticide use (5) Awareness creation and sensitization on the PPA 1997 and regulations 1999 should be done at national level and cover all zones and districts to be effective (6) Sensitization should target all leaders at district, ward and village levels (7) Increase the number of pesticide inspectors at district, ward and village levels (8) MAFSC to facilitate regular inspections preferably every six months (9) Train agrochemical stockists and retailers at all levels (9) Strengthen the inspectorate services at all levels.

7.1 Implememntation strategies under the ASDP/AFSP

Despite all the efforts by different stakeholders to build the national capacity to implement the IPMP, there are still a number of constraints that limits effective implementation of IPM at national level. Lack of awareness by all stakeholders on the provisions of the policy and regulations exacerbated by a lack of clarity on the policy and regulations has results to overlap of mandates between institutions and conflicting decisions (Riwa 2007). This is exacerbated by institutional weaknesses: inadequate number of pesticide inspectors, insufficient training and awareness on the PPA 1997 and regulations 1999 at different levels. Consorted effort and funding is therefore needed to support additional capacity building activities that will propel effective implementation of the PPA 1997 and Regulations 1999 in the following areas: Prevention, pest management, pesticide regulations and use, and environmental impact assessment.

Capacity building without the provision of appropriate tools, facilities, logistics and enabling policy framework will not resolve current constraints limiting the enforcement of the PPA 1997 and Regulations 1999. It is therefore envisaged that provision for capacity building and purchase of tools, facilities, equipment and logistics will be considered for funding under the ASDP/AFSP project to achieve tangible results. The FAO mission on biosecurity in the United Republic of Tanzania, February 2008 observed that the state of biosecurity operations at border posts in the country is poor and that biosecurity risks pose a real threat to the country and economy (Sakala et al 2008). Sakala et al (2008) notes with concern that deficiencies in biosecurity capacity at border posts was rampant and were characterized by lack of basic facilities, inspection tools and equipment, a situation that needed urgent redress.

7.1.1 Capacity Building

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 largey depends on developing and sustaining institutional and human capacity to facilitate experiential learning for making informed decisions in integrating scientific and indigenous knowledge to solve district, ward and village specific problems. Poor communication between farmers, extension agents and researchers from ZARDIs 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 adopted by farmers.

Capacity building will be achieved through farmer-based collaborative management mechanisms where all key stakeholders shall be regarded as equal partners.

7.1.2 The major actors and partners

Farmers: 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 (scaling up the armyworm CBAF experience).

The Ministry of Agriculture and Food Security's Plant Health Services and ZARDIs have the national mandates to implement crop protection and pest management research respectively. The programme of ASDP/AFSP will provide logistical and technical support to the PHS zonal centres to be trained as IPM trainers and to exploit their experiences in the implementation of IPM and management of outbreak and migratory pest. PHS will undertake to build the capacities of DPPOs to train VEOs and SMS in promoting IPM activities. The DPPOs will train the SMSs and VEO in IPM and the VEOs and SMSs will train farmers in IPM technologies and provide information on Farmers Field Schools (FFS). PHS will provide capacity and policy guidance for implementation of the district PMP. The ZARDIs IPM commodity team will served as resource persons at FFS and districts or any other mechanism deemed suitable for conducting IPM Trainers and Farmer Group training secessions. The team will also be a major partner to farmer groups in planning and execution of farmer participatory research activities related to IPM.

The District Councils should faciliate capacity building for DPPOs, SMS and VEOs in FFS or ZARDIs and should play a major role in partnership with NGOs/CBOs to raise public awareness about IPM, production of extension materials, radio and television programmes in respective districts. They should also monitor the inputs quality supplied by the dealers.

Ministry of Health (MoH) District Hospitals: the district hospital or clinics in the pilot ASDP/AFSP areas should set up databases on incidence of 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 that is expected to reduce risks to pesticides exposure.

National Environmental Management Council (NEMC): will collaborate with the district hospitals, ward and village health centres, NGOs and natural resources management offices of the districts to train farmer groups and communities in issues related to environmental health.

8. Monitoring and evaluation arrangements

According to the ASDP MTR and JIR aide memoire draft report September/October 2008, the number of irrigation schemes developed/rehabilitated increased from 595 in 2006 to 679 in 2008, while the total area developed for irrigation increased from 264,000ha to 289,000 over the same period. The national target by 2010 is 1.0 million hectares. The report notes that, most districts and zonal irrigation offices are largely understaffed and lack essential equipment and facilities. The report recommends to strengthen capacity in zones and districts and improve quality assurance of schemes.

Sustainable establishment of proposed irrigation schemes will depend on effective M&E that focuses on the environmental and social safeguards plan. A comprehensive M&E framework has been developed for ASDP to provide guidance for effective tracking of progress towards achievement of the objectives of ASDP and expected impacts. Although the framework provides a revised set of indicators for measuring impact, outcomes and outputs, environmental issues are not adequately integrated in the activities of ASDP, and yet, according to the Environmental Impact Assessment and Audit Regulations, 2005 G.N. No 349 of 2005, 1st schedule of the EIA Regulations, EIA is mandatory for all irrigation schemes prior to implementation. According to EIA Regulations, 2005, the role of NEMC is enforcement: review EIA reports, auditing and advisory. However, currently NEMC do not have the capacity to enforce the regulations as required, an issue that needs to be addressed.

Since there is no evidence that there is data and information that could be used for EIA during the implementationof the proposed ASDP/AFSP project, it is imperative for the project to collect and collate baseline information on current farmer practices, knowledge, attitudes, pest pressure and types, pesticide use, soil and water quality, flora and fauna for all irrigation schemes including those schemes established in 2006. The information will be used as the basis for M&E and for developing effective mitigation action plan.

Due to lack of experience within the ASDP and partner institutions, collection of the baseline information on environmental and social impact and its use could be carried out in phases to allow gradual and incremental learning for all stakeholders. The process should be supported with adequate resources including facilities for central data management. Development of field sampling tools and data collection protocols including outcomes, outputs and the M&E indicators will have to be developed by a multidisciplinary team of experts (entomologists, social scientists, plant pathologists, soil scientists, chemists, envirnmentalists, occupational health specialists, ecologists, etc) who should be responsible for the development of the required budget. Since irrigation schemes were initiated in 2006, it is essential that baseline data collection for the already established schemes begin with immediate effect to facilitate regular scheduled M&E.

9. References

Agenda (2006). A case study on trade and utilization of pesticides in Tanzania: Implications to stockpiles. AGENDA for Environment and Responsible Development August 2006, Tanzania

Ak'habuhaya, J. and Rusibamayila, C. (2000). Contamination of soils and the coffee plant by copper-based fungicides in Kilimanjaro Region; Northern Tanzania. Tropical Pests Management Bulletin, 1(1): 20

Allen DJ, Ampofo, JKO and Wortmann, CS (1996). Pests, Diseases, and Nutritional Disorders of the Common Bean in Africa. CIAT publication No. 260 ISBN 958 9439 55 1

Allertz, P., Nadhif, H., Abubakar, O., Fakih, A. and Rajab, B. (1988). Crop loss assessment trail in maize, Zanzibar (Unpublished report).

Anania, J. B. and Sayi, B. (2001). Integrated pest management (IPM) and integrated plant nutrition (IPN) programmes supported by KAEMP in Kagera region, Tanzania: synoptic view, May 2001 (unpublished)

Anon (2008). ASDP Aide Memoire for the Third Joint Implementation Review. JIR 3 Annexes

Anon (2008). ASDP Aide Memoire for the third Joint Implementation Review/IDA MTR September/October 2008 Draft report.

Anon, (1983). Coffee Manual. The Coffee Authority of Tanzania. Printed by Agri-Visual Limited.

Anon, (1996). Madawa ya Kilimo: Matumizi, tahadhari na athari zake. Kilimo/GTZ Plant Protection Division, P. O. Box 9071 Dar es Salaam-Tanzania

Anon, (1999a). Plant Protection Annual report 1999. Ministry of Agriculture & Cooperatives Tanzania

Anon, (1999b). Emergence programme to combat the cassava mosaic disease pandemic in East Africa. A system-wide whitefly IPM affiliated project. Fourth/Final Quartely Technical report, July-September 1999. IITA Nov 1999

Anon, (2000a). Mbinu za kuzuia gugu la Mexican poppy kwenye maharagwe, mahindi na ngano kanda ya kaskazini. Kituo cha Utafiti na Mafunzo Selian, Arusha

Anon, (2000b). Emergence programme to combat the cassava mosaic disease pandemic in East Africa. A system-wide whitefly IPM affiliated project. First Quartely Technical report phase 2, October-December 1999. IITA February 2000

Anon, (2000c). Annual cashew research report 2000/2001. Cashew research programme, ARI Naliendele, Mtwara, Vol 2, 2-14

Anon, (2001a). The current state of agriculture and possible future prospects. Ministry of Agriculture & Food Security, United Republic of Tanzania

Anon, (2001b). List of pesticides registered in Tanzania, March 2001, Tropical Pesticides Research Institute, Arusha – Tanzania (unpublished).

Banwo, O. O., Makundi, R. H., Abdallah, R. S. and Mbapila, J. C. (2000). Identification of vectors of rice yellow mottle virus in Tanzania. Acta phyto. Pflanz:60:1-9

Banwo, O. O., Makundi, R. H., Abdallah, R. S. and Mbapila, J. C. (2001). First report of *Dactylispa lenta* Weise (Coleoptera:Chrysomelidae) as a vector of rice yellow mottle virus. Acta Phytopathologica et Entomologica Hungarica 36(12) 189-192

Banwo, O. O., Makundi, R. H., Abdallah, R. S. and Mbapila, J. C. and Kimmins, F. M. (in press). Vector bionomics and importance of two species of *Chaetocnema* (Coleoptera: Chrysomelidae) in rice yellow mottle virus transmission in lowland rice in Tanzania. USA Journal of Sustainable Agriculture (submitted for consideration)

Bardner, R. & Mcharo, E. Y. (1988). Confirmation of resistance of the coffee leaf miner, *Leucoptera meyricki* Gesq. (lepidoptera:Lyonetiidae) to organophospate insecticide spray in Tanzania. Tropical Pest Manag. 34: 52-4

Bell, A. (undated). Integrated rodent management in post-harvest systems for smallholders, Storekeepers and rodent pest managers. GTZ publication

Bridge, J. (1984). *Coffee nematode survey of Tanzania*. Report on a visit to examine plant parasitic nematodes of coffee in Tanzania, February/March 1984. Tropical Plant Nematology Advisory and Research Unit, IPP, UK, pp 22

Bujulu, J. & Uronu, A (1985). A revise of the coffee berry disease (CBD) chemical control in Northern Tanzania for the period 1980-84 seasons. TPRI Misc. Report No. 1019

Crowe, T. J. (1964). Coffee leaf miner in Kenya. II-Causes of outbreaks. Kenya Coffee, 29: 223-31 FAO/Tanzania Seed Symposium for Zanzibar.

Furtado, I. (1969). Effect of copper fungicide on the occurrence of the pathogenic form of *Colletotrichum coffeanum*. Trans. Br. Mycol. Soc. 53(2): 325-8

Holm, L. G.; Plucknett, D. L. ; Pancho, J.V. ; Herbeger, J. P. (1977). The World's worst weeds.Distribution and biology. Honolulu, Hawaii, USA: University Press of Hawaii

Ijani, A. S. M.; Katondo, J. M. and Malulu, J. M. (1997). Effect of organochlorine pesticides on birds in the United Republic of Tanzania. Proc International Symp on “the use of nuclear and related techniques for studying environmental behaviour of crop protection chemicals” jointly organised by the International Atomic Energy Agency and FAO, Vienna, 1-5 July 1996

Kanyeka Z. L., Msomba, S. W., Penza, M. S. F. and Alluri, K. (1995). Rice ecosystems in Tanzania. Int. Rice Res. Notes, 20:1

Kibanda, N. J. M (2001). Rice insect pests of economic importance in Tanzania. Paper presented at the Rice Research Workshop at Kilimanjaro Agricultural Training Centre (KATC) Moshi, March 2001.

Kullaya, I. K. (1983). A note on copper and coffee plants in Kilimanjaro Region. In TARO Coffee Research Programme Annual Report 1983, pp 75-7, Moshi, Tanzania: Lyamungu Agricultural Research Institute

Lodenius, M., Ak’habuhaya, J. L. and Rusibamayila, C. (1996). Pesticides and metals in lake Jipe, N. Tanzania. Environmentalica 9 (1995):33-38

Madata, C.S. and Kabungo, D. A. (2001). Common diseases and insect pests of Phaseolus beans in the southern highlands of Tanzania and their control/management practices (Unpublished)

Mallya, G. A. (1999). The historical perspective of the larger grain borer, *Prostephanus truncuntus* (Horn) in Tanzania. In proceedings of the workshop on "farmer coping strategies for post harvest problems with particular emphasis on the larger grain borer, August, Plant Protection Division, Dar es Salaam, Tanzania, p13-19

MANREC [Ministry of Agriculture, Natural Resources, Environment and Cooperatives] (2002). Annual production figures.

Masaba, D. M. (1991). The role of saprophytic surface microflora in the development of coffee berry disease (*Colletotrichum kahawae*) in Kenya. PhD thesis, University of London

Masaba, D. M., King'ori P. N. & Opilo, V. L. (1993). Effectiveness of new fungicides against coffee berry disease (*Colletotrichum coffeanum*) in Kenya. Kenya Coffee, 58(678): 1517-24

Mbapila, C. J. (2000). Projects under the rice research programme. Paper presented at the Rice Research Workshop at Kilimanjaro Agricultural Training Centre (KATC) Moshi, September 2000.

Mbwaga, A. M., Pande, S., de Milliano, W. A. J. and Karunakar, R. I.(1993). Diseases and parasitic weeds of sorghum in Tanzania: Occurrence and incidence, 1986-1990. Crop Protection vol 12, 183-187

Mbwaga, A. M., Pande, S., de Milliano, W. A. J. and Karunakar, R. I. (1993). Diseases and parasitic weeds of pearl millet in Tanzania: Occurrence and incidence from 1986 to 1990. Phytophylatica 25:271-273

Moshi, A., Anandajayasekeram, P., Kaliba, A., Martella, D., Mwangi, W. & Shao, F. (1997). Economic impact of maize research in Tanzania. SACCAR

Mwanjabe, P. S. and Leirs H. (1997). An early warning system for IPM-based rodent control in smallholder farming systems in Tanzania. Belg. J. Zool. Vol 127 (1) 49-58

Mushobozi, WL, Grzywacz D, Musebe, R. Kimani M. and Wilson K. (2005). New approaches to improve the livelihoods of poor farmers and pastrolists in Tanzania through monitoring and control of African armyworm, *Spodoptera exempta*. Aspects of Applied Biology, 75:37-45.

Mwatawala, MW, De Meyer M, Makundi RH, and Maerere AP (2006). Seasonality and host utilization of the invasive fruit fly, *Bactrocera invadens* (Dipt.; Tephritidae) in Tanzania. J. Appl. Entomology, 130(9-10): 530-537.

Notely, F. B. (1948). The Leucoptera leaf miner of coffee on Kilimanjaro. I- *Leucoptera coffeela*, Guer. Bull.Entomol. Res. 39: 399-416

Notely, F. B. (1956). The Leucoptera leaf miner of coffee on Kilimanjaro. II- *Leucoptera coffeina* Washb. Bull.Entomol. Res. 46: 899-912

Nyaki, A.S. & Quinones, M. (2000). Project preparation mission April-June 2000 working document on soil fertility recapitalization. Consultancy report for SOFRAIP, Ministry of agriculture and Co-operatives Government of Tanzania

Nyakunga, Y. B., Riwa, W. and Bell, A. (undated). Integrated stored product protection for farmholders: A synoptic compilation of measures to control the LGB and associated storage pests in maize and dried cassava. GTZ publication

Nyambo B. (2001). Integrated Pest Management Plan for SOFRAIP, 9th May to 9th June 2001

Nyambo B. and Youdeowei A. (2007). PAN-UK ASP: IPM Research project. Project report submitted March 2007. Pesticide Action Network –UK 2007

Nyambo B. and Youdeowei A. (2007). PAN-UK ASP: IPM Research project. Phase I background country papers. February 2007. Pesticide Action Network –UK 2007

Nyambo, B. T. & Kimani, M. (1998). Role of information in IPM farmer field schools: Experiences in Kenya. Proceedings of the Integrated Pest Management Communications Workshop: Eastern/Southern Africa, March1-6, 1998, Nairobi-Kenya

Nyambo, B. T. (1985). Cotton insect resistance studies in the Western Cotton Growing areas of Tanzania. Insect Sci. Applic. Vol 6(3); 379-384

Nyambo, B. T. (1989). Use of scouting in the control of *Heliothis armigera* in the Western cotton growing areas of Tanzania. Crop Protect. 8: 310-17

Nyambo, B. T. (1993). The management of coffee leaf miner, *Leucoptera* spp (Lyonetiidae, Lepidoptera) in Northern Tanzania: Past, present and future possibilities. Report submitted to the Commissioner of Research, Ministry of Agriculture and Livestock Development, 1993 (Unpublished)

Nyambo, B. T. (2001). Towards preparation of an integrated pest management plan for SOFRAIP: Report on current Government regulations, pesticide use, integrated pest management and pesticide environmental and health impact assessment, 21st February to 23 March 2001. Consultancy report for SOFRAIP, Ministry of Agriculture and Food Security.

Nyambo, B. T., Kimani, M., Mutiso, A. K., Gikonyo, F. G. W., Karuma, J., and Kamau, E. M. (1997). Finalisation of a pilot project for the implementation of farmer participatory integrated pest management in vegetable/cash crops in small holder production systems in Kenya: participatory internal evaluation of the impact of IPM/FFS training on farmers' practices, February-April 1997. CAB/IIBC Kenya Station .

Nyambo, B. T., Masaba, D. M. and Hakiza, G. J. (1996). Integrated pest management of coffee for small-scale farmers in East Africa: needs and limitations**.** Integrated Pest Management Reviews, 1, 125-132

Nyambo, B.T., Kimani, M., Mutiso, A.K., Gikonyo, F.G.W., Karuma, J., and Kamau, E.M. (1997). Finalization of a pilot project for the implementation of farmers participatory Integrated Pest Management in vegetable/cash crops in smallholder production systems in Kenya: participatory internal evaluation of the impact of IPM/FSS training on farmers' practices, February – April 1997. CAB/IIBC Kenya station.

Paasivirta, J.; Palm, H.; Paukku, R.; Ak'habuhaya, J. L. and Lodenius, M. (1988). Chlorinated insecticide residues in Tanzanian environment, Tanzadrin**.** Chemosphere, vol 17 (10): 2055-62

Participatory Agricultural Development and Empowerment Project (2002): Integrated pest management plan. MAFS. Dar es Salaam

Paul, W. D.; Mwangi, J. and Mwaiko, W. (2000). Participatory work with IPM-farmer groups in Northern Tanzania: workbook Tanzania-German Project for Integrated Pest Management (IPM), Northern Zone, Arusha Tanzania

Paul, W.D., Mwangi, J. and Mwaiko, W. (2000). Participatory work with IPM-Farmers groups in Northern Tanzania: workbook Tanzania-German Project for Integrated Pest Management (IPM), Northern Zone, Arusha, Tanzania.

Peat, J. E. and Brown, K. J. (1961). A record of cotton breeding for the Lake Province of Tanganyika. Emp. J. Exp. Agric. 29: 114

Population Census. (2002). General report of Population and Housing census. Central Census office and National Bureau of Statistics, President's Office (Planning and Privatization).

Reed, W. (1968). The Tanzania Cotton Growing Handbook. The Lint and Seed Marketing Board & Ministry of Agriculture and Cooperatives of Tanzania.

Riwa WH, Kitanda LW and Mkalanga HS (2005). Report on sensitization training on input supply,PPA 1997 and IPM to district functionaries under PADEP May-August 2005. MOAFSC-PHS

Riwa, WH (2007). Tanzania In PAN-UK ASP: IPM Research project. Phase I background country papers page 106-143 (Nyambo B. and Youdeowei A. edit) February 2007. Pesticide Action Network UK 2007

Sakala A., Otieno, W. and Hamilton J. (2008). Provisions for biosecurity in the United Republic of Tanzania: Evaluation of capacity at border posts and initiation of plant pest surveillance Mission report 1-29 February 2008. FAO PROJECT UNJP/URT/129/UNJ:Strengthenin National Disaster Preparedness and Response Capacity .FAO /MOAFSC report

Shao, F. & Quinones, M. (2000). Project preparation mission April-May, 2000. Working document on agricultural intensification (Agronomy). Consultancy report for SOFRAIP, Ministry of Agriculture and Co-operatives Government of Tanzania

Sijaona, M. E. R. & Anthony, J. K. (1998). Ufahamu utitiri (Thrips) wa mikorosho. Kituo cha Utafiti, Naliendele, Mtwara, Tanzania, No. 1, November, 1998

Sijaona, M. E.R. & Barnabas, B. (1998). Ufahamu ubwiri unga wa mikorosho. Kituo cha Utafiti, Naliendele, Mtwara, Tanzania, No. 4, Desemba, 1998

Stockholm Convention on Persistent Organic Pollutants. UNIDO, GEF. GF/URT/02/006. Draft. Vice Presidents Office, Division of Environment, February 2005.

Swynnerton, R. J. M., Bennet, A. L. B & Stent, H. B. (1948). *ALL about 'KNCU' coffee* Moshi, Tanganyika: Moshi native Coffee Board

TPRI (2007). List of pesticides registered in Tanzania, November 2007. TPRI Webpage

United Republic of Tanzania, (2005). National Implementation Plan (NIP) for the

United Republic of Tanzania, (2006). Agriculture Sector Review: Performance, Issues and Options. Main report volume1.

URT (2001). Agricultural Sector Development Strategy October 2001.

URT (2005). The Environmental Impact Assessment and Audit Regulations, 2005-G.N. No. 349 of 2005

URT (2007a). Environmental Act 2005, Chapter 191. Supplimentary No 30. Subsidiary Legislation G.N. No 193, August 2007. ISSN 0856-034X.

URT (2007b). Suppliment No 42. Subsidiary Legislation. The Environmental Management Act (CAP 191) (Soil Quality Standards) Regulations, 2007. ISSN 0856-034X

Van Huis, A. and Meerman, F. (1998). Challenges to develop and implement IPM in Sub-Saharan Africa. Proceeding of the Integrated Pest Management Communication workshop, Eastern/Southern Africa, March 1-6, 1998, Nairobi – Kenya.

Varela AM, Seif A and Nyambo B. (2005). A guide to IPM in mango production in Kenya. ICIPE Science Press. ISBN: 92 9064 176 2

ANNEXES

Annex 1 Terms of References

Terms of Reference For the award of a Short Term Consultant Appointment
To Review the Government of Tanzania's Integrated Pest Management Plan (IPMP) Prepared under the Agriculture Sector Development Program (ASDP, P085752)

Background: The Government of Tanzania (GoT) has asked the World Bank for support for a broad package of complimentary programs comprised of the following three operations;

- **Accelerated Food Security Project (AFSP)** – a new operation.
- Additional Financing for the **Agricultural Sector Development Program (ASDP)** – an ongoing operation.
- Additional Financing for the **Tanzania Social Action Fund II (TASAF II)** – an ongoing operation.

The activities funded under these three operations will lead to the increased use of agricultural pesticides, inter alia, in the sector. To ensure these issues are managed using an integrated management approach and that this approach is mainstreamed more broadly and nationally across the sector, and also for compliance with the World Banks own Operational Policy OP4.09 on Pest Management and the GoT own requirements, the GoT is required to have in place an effective and sustainable Integrated Pest Management Plan (IPMP) beyond the lifetime of these operations.

The GoT would like to adopt and mainstream the current IPMP prepared under the ASDP in August 2004, for use generally in Tanzania, and particularly also to cover the use of agricultural pesticides in each of the three operations listed above. The World Bank agrees with this approach, but now requires;

4. A review of the overall comprehensiveness of the original IPMP to ensure it captures all of the activities being funded in each of the three operations thereby ensuring continuing compliance with OP4.09 and the GoT's own requirements.
5. A review of the GoT's performance in implementing the original IPMP in the ASDP which has been effective since 2006.
6. That we determine any gaps in the institutional and regulatory framework within the GoT to effectively implement the IPMP and develop a tangible plan to address these gaps in these operations.

The objective being that the GoT prepares, adopts, maintains and effectively implements and monitor's one IPMP throughout the Agriculture Sector during and well beyond the life of these operations.

Therefore, the World Bank seeks the services of a Short Term Consultant to undertake the tasks and services required and detailed in this Terms of Reference.

Task 1: To review the existing IPMP, documentation for AFSP, ASDP and TASAF, such as the respective Project Appraisal Documents and draft Project Papers, Mid Term Review (MTR) and Joint Implementation Review (JIR) aide memoire's, OP4.09, relevant laws and regulations of Tanzania and other supporting Bank and GoT documents to ensure fuller understanding of the program details and of the sector.

Task 2: To undertake a detailed review of the existing IPMP prepared for the ASDP to determine (i) whether it fully covers the activities being funded under the existing operations (i.e ASDP and TASAF), (ii) whether in its present forms it fully covers the any new activities being proposed for funding under the additional financing for the ASDP and TASAF II, and for the new operation, the AFSP, and (iii) whether it is fully compliant with the requirements of OP4.09 on Pest Management, and GoT's own regulatory and institutional framework for Pest Management, and with relevant international best practice.

Task 3: Based on the findings from Task 2, to assist the GoT in revising and updating the existing IPMP to ensure it fully covers all the activities being financed under the existing and new operations, and to ensure full compliance with the World Bank's OP4.09 and the GoT's own requirements and with relevant international best practice.

Task 4: The revised and updated IPMP should include a monitoring plan for its implementation with the required levels of detail including adequate budget to ensure the monitoring plan is implementable. The monitoring plan should also include tangible monitoring indicators (both output and outcome based), and details for who (institution and position, how (methodology for use of indicators, reports to be generated, reporting lines etc,) and when (time, duration and frequency) monitoring of the revised IPMP would be undertaken.

Task 5: To review and analyze the GoT's own performance in implementing the existing IPMP since the ASDP became effective in July 2006 and thereby determining the lessons to be learned from this experience.

Task 6: Develop a detailed and comprehensive capacity building plan (to be a stand alone document) to be implemented contemporaneously with the implementation of the revised and updated IPMP in these operations going forward, to address: (i) any capacity gaps be they institutional and/or regulatory framework that has in the past prevented or is likely to prevent in the future, effective implementation of the revised and updated IPMP, and (ii) lessons learned from the implementation of the existing IPMP to date.

Task 7: The Capacity Building plan required under Task 6 above must include the required budget details to ensure adequate funding of this plan as part of the broader budget within the IPMP, which will then be included in the COSTAB of the additional financing for the ASDP. The capacity building plan must provide sufficient levels of detail by identifying specific actions to be taken with details of who (institutions, positions), how (methodology. e.g. long and short term training, TA, specify equipment/required technology, information systems, etc) and when (timing, frequency, duration, etc) they should be done, and with corresponding details for monitoring implementation of this capacity building plan including output and outcome based monitoring indicators, with details of who, how and when monitoring would be done across the three operations. See task 4 for additional details on the monitoring plan.

Task 8: To provide detailed inputs into the relevant annexes of the Project Papers for the each of the three operations.

Timing and Duration of this Assignment: Given that this program package is scheduled for delivery to the Board in May 2009, the consultant is required to be contracted by end of February 2009 and to start work soon thereafter. This work will require a visit to Tanzania to hold discussions with the relevant officials at both national and sub-national levels, the World Bank team preparing these operations and to undertake site visits and inspections as required. The duration and time for this assignment is 14man days (7days for in-country visit and another 7days for report writing).

The Consultant would be expected to complete this assignment by end of March 2009 provided the contract is in place by end of February 2009.

Qualifications of the Consultant: The selected consultant will have academic qualifications in entomology or similar fields at the post graduate level, with both breadth and in-depth knowledge of the issues in Tanzania and/or other countries with similar agro-ecological zones and challenges, acquired from at least 10years of relevant experience working in these types of countries on pest management issues. Experience working on World Bank funded operations would be a significant added advantage.

Deliverables:

3. Revised and Updated IPMP including Monitoring Plan for its implementation (IPMP).
4. Stand alone Capacity Building Plan document including monitoring plan for its implementation.

Annex 2 Institutions and persons consulted: 17th-30th March 2008

MOAFSC
- Dr. Nicodemus P. Sicilima, Director Crop Development
- Mrs Sophia E. Kaduma, Deputry Permanent Secretary
- Dr. Rose Anne Mohamed, Principal Agricultural Officer PHS
- Mr Fabian C. Mkondo PHS
- Mr. William H. Riwa, IPM Coordinator PHS
- Ms Rebecca J. Mawishe, PHS
- Dorah J. Amuli, PHS
- Mwaiko William, PHS
- Dr. F. Katagila, Acting Ass. Director, PHS
- Mr. Beatus A. Malema, Acting Ass Director Crop Promotion Services
- Mr. G. Kirenga, Director, Crop Promotion Services

World Bank Tanzania
- Zainab Semgalawe, Senior Rural Development Specialist
- Jane Kibassa, Environmental Specialist
- Madhur Gautam, Lead Economist Agriculture & Rural Development, Sustainable Development African Region (Task Team Leader)
- Sergiy Zorya, Agriculture & Rural Development Africa Region
- Hermann Pfeiffer, FAO
- Tekola Dejene

NEMC
- Ignace A.J.Mchallo. Director, EIA
- Dr. Robert Ntakamulenga, Environmental Engineer, Director

Africa Stockpiles Programme
- Mr. Samwel S. Musangi, Project Manager, ASP Tanzania