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Community Markets for Conservation
For

The COMACO Landscape Management Project

P144254

Draft Pest Management Plan (PMP)

August 2014

ACRONYMS AND ABBREVIATIONS

ADSP	Agricultural Development Support Program
ARPF	Abbreviated Resettlement Policy Framework
CCP	Community Conservation Plan
CDM	Clean Development Mechanism
CLMP	COMACO Landscape Management Plan
COMACO	Community Markets for Conservation
CSA	Climate Smart Agriculture
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMA	Environmental Management Act
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EU	European Union
ESMF	Environment and Social Management Framework
FLRCoL	Food Legumes Regional Centre of Leadership
FOREX	Foreign Exchange
GART	Golden Valley Agricultural Research Trust
IDA	International Development Agency
IPM	Integrated Pest Management
LC	Lethal Concentration
LD	Lethal Dose
MAL	Ministry Of Agriculture and Livestock
MSc	Master of Science
MSDS	Material Safety Data Sheet
NAIS	National Agricultural Information Services
NGOs	Non-Governmental Organisations
NISIR	National Institute for Scientific Research
NPE	National Policy on Environment
OP	Operational Policy
PAN	Pesticide Action Network
PhD	Doctor of Philosophy
PIC	Prior Informed Consent
POP	Persistent Organic Pollutants
PPE	Personal Protective Equipment
PMP	Pest Management Plan
PDO	Project Development Objective
RAP	Resettlement Action Plan
RCoL	Regional Centre of Leadership
REDD+	Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
R&D	Research and Development
SADC	Southern Africa Development Community
SALM	Sustainable Agricultural Land Management (Integrated Crop Management) / Afforestation, Reforestation and Re-vegetation

SAN	Sustainable Agriculture Network
SCCI	Seed Control and Certification Institute
TA	Technical Assistance
UNZA	University of Zambia
VCS	Verified Carbon Standard
WB	World Bank
WHO	World Health Organisation
ZARI	Zambia Agriculture Research Institute
ZEMA	Zambia Environmental Management Agency
ZNBC	Zambia National Broadcasting Corporation

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1. INTRODUCTION

This Pest Management Plan (PMP) has been prepared in compliance with the provisions of the World Bank Operational Policy 4.09 triggered by some activities proposed under the COMACO Landscape Management Project(CLMP). Relevant activities under the CLMP program include those to do with technology generation and dissemination covering agricultural land management, as well as afforestation and reforestation of forests. These activities together with Conservation Farming (CF)activities are all vulnerable to pest attack and involve the management of pests in one way or another. In view of the above there is need for effective management of pests in a manner that does not pose health and safety risks to the farmer, users of products, the public and the enviornment – water, soils and biodiversity inclusive of which this PMP addresses.

The report which was prepared through a literature review and interviews with experts and other stakeholders (Appendix 10) is made up of an Introductory Chapter, a review of common pests which may be relevant to the CLMP program, a review of applicable pest management options and finally, a management plan presenting recommendations on pest management under the CLMP project.

Key study limitations included inability to conduct widespread field consultations with farmers and observations due to time limitations and logistical problems encountered. Limited availability of literature on the subject in the local context was another limitation faced but within that framework necessary issues are addressed.

1.1 The CLMP Program

The COMACO Landscape Management Project will increase smallholder farmer crop yield from sustainable Climate Smart Agriculture (CSA), increase farmer income and welfare, reduce uncontrolled forest loss and degradation and increase net forest cover in the project areas within the Luangwa Valley supported by revenues from a significant increase in bio-carbon sequestration. COMACO implements an array of interventions, e.g., fallowing, minimum tillage, no burning and planting of *Gliricidia sepium*; use of increased market incentives and livelihood alternatives; and increased community land use planning and leadership roles in the reduction of forest loss and degradation to sustain a net increase in forest cover in the Luangwa Valley. These activities are part of integrated landscape management strategy to conserve biodiversity, improve food production per unit area of cropland and to minimize climate change. This is achieved with carefully designed, ecologically sensitive mosaic of production and conservation functions. The project will expand the activities being currently implemented by COMACO with a view to achieve overall climate mitigation and adaptability.

As a bio-carbon project, COMACO and its partners intend to pioneer a unique approach to landscape-wide carbon asset management that combines several approved Clean Development Mechanism (CDM) and Verified Carbon Standard (VCS) methodologies under an umbrella of grouped projects, equivalent to CDM Programme of Activities to monitor, verify, and monetize carbon increments in the most biologically and economically important carbon pools across the managed landscape. Conceptually, the project represents a bridge to a comprehensive landscape management methodology, yet to be developed, that would eventually achieve the same economic purpose of capturing for trade incremental carbon in a more economically efficient manner.

COMACO will be the lead implementing organization for this project with increased collaboration with the Government of the Republic of Zambia (GRZ) through the Department of Forestry in the Ministry of Lands, Natural Resources and Environmental Protection (MLNREP) and the Ministry of Agriculture and Livestock (MAL).

Being a predominantly farmer-based program, it is a requirement under the GRZ's Environmental Management Act of 2011, as illustrated in the Environmental Impact Assessment Regulations of 1997, that an Environmental and Social Management Framework (ESMF) and an Abbreviated Resettlement Policy

Framework (ARPF), are prepared. Similarly, for the project under the World Bank financing, it complies with the Safeguards Operational Policy (O.P) 4.01 on Environmental Assessment and OP4.12 on Involuntary Resettlement respectively. This document will be submitted to the Zambia Environmental Management Agency (ZEMA) for clearance through issuance of a "No Objection" and also for World Bank review and issue of no objection and disclosure both in country and at the World Bank's InfoShop, in accordance with Bank Disclosure policy.

1.1.1 Project Components

The COMACO Landscape Management Project (CLMP) will be implemented in areas where COMACO operates and is expected to cover an area of approximately 1.7 million hectare Project success over the next ten years will lay the foundation for expansion of these sustainable land-use practices and innovations to surrounding areas, which will be applicable to over eight million hectares.

The project comprises an array of specific interventions as part of an integrated landscape management strategy that will conserve biodiversity, improve food production per unit area of cropland, and increase farmer resilience to climate change. Operational objectives and interventions for each project component are as follows:

The COMACO Landscape Management project includes two main components under each operational objective and intervention: (1) Sustainable Agricultural Land Management (Integrated Crop Management) / Afforestation, Reforestation and Re-vegetation (SALM) and (2) Reduced Emissions from Deforestation and Degradation (Avoided Unplanned Deforestation) (REDD+):

Component 1: SALM

Component 1 will ensure a) an increase in food production and farm-gate income per unit area by expanding legume-based agroforestry systems with demonstrated improvements in sustainable crop yields, and b) the shift from expansive to intensive farming practices, coupled with the new availability of fuel sources, will help to alleviate the pressure on forests by decreasing the need for agricultural and charcoal-production encroachment as compared to the baseline of traditional small-holder agriculture methods called 'slash and burn' ("*chitemene*"). More specifically, the activities will include:

- Biosequestration of fast-growing agroforestry systems of nitrogen-fixing species (*gliricidia sepium*) with demonstrated higher sustainable crop yields
- Residue retention and cessation of post-harvest crop-residue burning
- No-till agricultural practices
- Composting
- Non-burning of designated woodland sites used as apiaries
- Establishment of firebreaks to protect forest products harvests

Supply side support for the COMACO market-based incentive system will come in the form of inputs, training, and extension delivered through COMACO's hundreds of lead farmers to small-holders from COMACO's technical specialists, and drawing on technical capacity and experience of COMACO partners and advisors.

Component 2: REDD+

Component 2 will protect and expand areas under natural forest cover on traditional land by prioritizing conservation agriculture practices, alternative livelihoods, and traditional governance frameworks through the following activities:

In cooperation with traditional leaders and local government authorities (including District Forestry and Agriculture officials, and ZAWA), COMACO is piloting approaches to land-use zoning and community-based participatory forest management planning for COMACO farmers. These activities layout a potential model for traditional authorities to zone customary land and use market-based incentives to

implement a conservation vision for sustainable agricultural and land use practices in consultation with community members, COMACO cooperative leaders, and local government.
The Project will build on existing pilot initiatives that have resulted in a burgeoning honey market and potentially large wild mushroom market with added premium pricing when producers demonstrate commitment to forest protection.

- Fast-growing coppicing leguminous trees (*Gliricidia sepium* and potentially *Faidherbia albida*) in agroforestry systems represent a significant increases in firewood alternatives from renewable sources as well as increases in materials suitable for tradable carbon production can also make household energy supply sustainable through:
- the establishment of firewood woodlots and border plantings;
- reducing destructive charcoal production in natural forests; and
- introducing (in a parallel COMACO CDM project) the use of clean and efficient wood-stoves for COMACO farmers and associated communities to replace open fire cooking and switch charcoal users to superior wood stoves. This could eventually lead to a regional market for surplus sustainably produced firewood.

Small holder farmers will gain increased premium prices for their farm commodities when their community effectively implements a community-regulated and enforced land use zoning plan or establishes community conservation areas that exclude land use practices destructive to forests, as part of broader Community Conservation Plans (CCPs).

1.2 Pests and Crop Productivity

The term 'pest' in crop production refers to an external biological agent, which competes with and interferes with the proper growth and development of a target crop. Examples include weeds, insects and disease pathogens such as viruses and bacteria. Damage to the crop may arise from competition for available nutrients, water, light or space or may manifest by way of harm where a particular pest subsists and feeds on the plant or transmits disease pathogens. Pests can thus either directly harm the plant or may pave way for secondary infestation by disease or other pests. Arising from this damage, the crop may not be able to realise its full productive potential or may even die. Interviews with the Zambia Agricultural Research Institute (ZARI) field staff showed that crop damage can be as high as 100% if for example the bean stem maggot is not controlled (Muimui, 2012, pers com). The 2012invasion of army worms in Chongwe District and other parts of the country were also reported to have wiped out some maize fields (ZNBC TV documentary, 15 December 2012). Pest management is thus vital for sustained agricultural productivity because without proper pest management, a farmer's effort can be of no benefit.

1.3 Purpose and Objectives of the PMP

This Pest Management Plan (PMP) has been prepared as a supplement to the Environmental and Social Management Framework (ESMF). It is meant to be used as a guide to pest management in the *Gliricidia sepium* coppice and maize intercropping technology development and dissemination activities of the CLMP program. The Plan has been prepared in compliance with the WB's Operational Policy 4.09, the Pesticides and Toxic Substances Regulations (Statutory Instrument no. 20 of 1994 under the EMA (CAP 204 of the Laws of Zambia), the Plant Pests and Diseases Regulation Act (CAP 231 of the Laws of Zambia).Specific objectives of the PMP are:

- To review the relationship between pests and crop productivity and agro forestry;
- To identify common pests likely to affect implementation of the CLMP program on *Gliricidia sepium* coppice and maize intercropping technology generation and dissemination;

- To explore alternative ways of managing pests and recommend environmentally friendly and socially acceptable approaches to pest management in the CLMP program; and
- To identify issues of concern in pesticide use and recommend measures for enhanced public and occupational health and safety.

However, it should be noted that COMACO endeavours to ensure that farmers practice climate smart agriculture with no chemicals applied to the plants or soil. Thus, farmers are encouraged to adopt various cultural practices in the control of pests and diseases. The cultural practices include intercropping, crop rotation, and alley cropping as well as the use of organic pesticides.

This policy will only be triggered in the event that farmers on their own decide to use chemicals in their fields to control pests and disease attack.

2. Common Pests in Gliricidia Sepium and Maize Cropping System

Gliricidia sepium is the target agro forestry in this project as well as maize *(Zea mays*) food crop. Both *Gliricidia sepium* and maize are vulnerable to several pest and disease attacks. However, growing *Gliricidia sepium* brings a lot of advantages to the farmers which are listed below:

- ***Soil improvement****:* Capable of fixing atmospheric nitrogen, and can be used to improve soil fertility. Used as a green manure, *G. sepium* increases soil organic matter and helps to recycle soil nutrients because it produces much leaf litter. It also improves soil aeration and reduces soil temperature. It is a drought-resistant and valuable water-conserving species, because in the dry season it sheds most of its leaves, hence reducing water loss through transpiration;
- ***Erosion control:*** Hedgerows in alley cropping control soil erosion;
- ***Alley-cropping****:* Hedgerows in alley cropping slow weed growth and have been shown to reduce the incidence of disease in groundnut crops;
- ***Apiculture****:* The flowers attract honeybees (*Apis* spp.), hence it is an important species for honey production;
- ***Fodder:*** Leaves are rich in protein and highly digestible for ruminants like goats and cattle, as they are low in fibre and tannin. There is evidence of improved animal production (both milk and meat) in large and small ruminants when *Gliricidia* is used as a supplement to fodder. However, non-ruminants fed on *Gliricidia sepium* have shown clear signs of poisoning;
- ***Shade and shelter:*** Often grown as shade for tea, coffee and cocoa. It is also used as a nurse tree for shade-loving species. Its fine, feathery foliage gives a light shade;
- ***Fuel****:* Good for firewood production. The wood burns slowly without sparking and with little smoke;
- ***Timber:*** Very durable and termite resistant; used for railway sleepers, farm implements, furniture, house construction and as mother posts in live-fence establishment;
- ***Poison****:* The leaves, seeds or powdered bark are poisonous when mixed with cooked rice or maize and fermented. It has been used as a poison for pests like rats and mice;
- ***Reclamation:*** Can be planted to reclaim denuded land or land infested with *Imperata cylindrica* (Cogon grass); and
- ***Boundary/barrier/support****:* Can be used for live fencing around cattle pastures and for delineating boundaries. Its fast growth, ease of propagation, nitrogen fixing ability and light canopy makes it ideal as live support for black pepper, vanilla and yam.

The discussion below highlights common pests and diseases that could affect production of the *Gliricidia sepium*, maize and other relevant crops in Zambia.

2.1 Insects

American bollworm: ***(Helliothis armigera)*** larvae feed on bud, flowers and bolls of cotton, on tomato, on bud and pods of beans and peas, on the milky-ripe grain of maize cobs, sorghum and wheat. Also sunflower and groundnuts may be severely attacked. The larvae bore into and feed on the inner parts of the fruits or plant, often with the hind part of the body exposed.

Aphids*(Aphididae sp.)* are small, soft bodied, more or less pear shaped polyphagus insects. They live in colonies on different parts of the plant, mostly on young shooters and leaves. They pierce and suck the plants and also produce a sugary extract which encourages the development of "sooty mould." The aphid *Aphis craccivora* attacks *Gliricidia sepium*. They also transmit viruses.

Army –worm *(Spodoptera sp.)*Feed on plants of numerous families including, groundnuts, maize, beans, sorghum, wheat, tobacco, tomato, rice and okra. The older stages of the caterpillar devours the leaves of their hosts completely or leave only the midrib, while young caterpillars scrape off the tissue on one side of the leaves so that they dry up.

Beetles Feed on various parts of many crops. They cause damage to the leaves and they can also destroy the flowers so that fruit and seed setting are affected. For example, lady birds *(epilachnasp.)* may skeletonise the leaves of maize, wheat and cucurbits, and may cause them to shrivel dry up. Blister beetles, or pollen *beetles (Mylabris sp.),* black with red orange or yellow transverse bands, feed on the flowers of crops such as groundnuts, cowpea, beans, pasture legumes and okra, and are able to completely destroy the fruit and prevent seed setting.

Bugs *(Heteroptera sp.)* are very destructive pests which may cause great damage to many crops and are found sucking on leaves, stems, petioles, flowers and buds causing whole plants to wilt, dry up and eventually die. The grains and seeds of cereals, especially rice, wheat, sorghum and sunflower, are important sources of food for a number of bug species.

Cutworms *(Agritos sp.)* may cause considerable damage in nurseries and newly planted fields by cutting the roots and lower stems of seedlings. During the day they remain hidden in the soil, near their host.

Grass hoppers *(Acridoidea)* Chews the leaves of plants and will attack a wide range of crops. They can also be transmitters of virus.

Leaf hoppers *(Cicadellidae jassidae)* generally live in scattered colonies on the underside of leaves where they suck the sap, and damage the plants through their feeding and toxic salivary. They are probably more damaging as vectors of virus diseases. Their main hosts are maize, cotton, rice and groundnuts.

Stem- or Stalk borers *(Busseola fusca, Sesamia, Calamistris, Chilo partellus)* Feed as young larvae on the leaves while the older larvae bore into stems and inflorescences, and cause so called dead heart effect. Stalk borers are severe pests on maize, sorghum and wheat.

2.2 Diseases

Crops targeted under the program are susceptible to many diseases caused by fungi, bacteria, viruses, micro plasma and nematodes. These organisms survive and propagate in various ways and may survive on plant residue, in soil, in alternate host and in or on the seed of plants. Key diseases of the target crops are as listed below:

Damping off (*Pythium sp., Rhizoctania sp*) are soils inhabiting fungi affecting near the soil line and thereby killing vary young seedlings before or just after emergence.

Leaf blight on sorghum, maize, wheat and rice caused by *Helminthopsorium sp.,* develops long pale brown spots on leaves which may spread and kill the leaves. The ears and stems may also be infected.

Leaf spots are caused by many different pathogens and appear on many crops sometimes very severely. In general these lesions first appear on the older and lower leaves and then move upwards. They usually start as small, mostly brown, round spots which increase in number and size causing withering and premature defoliation.

Loose smut (*Ustilago nuda*) is a seed borne disease of wheat and other cereals where the infection is carried inside the seed. When infected seed is planted, the mycelium of the pathogen keeps pace with the growing point of the host plant and at flowering the ear is almost completely replaced by a mass of dark brown spores. These spores are dispersed by the wind and may infect the ovary of florets on neighbouring plants. The germinating spores penetrate the ovary wall and complete the infection cycle.Control is by use of systemic fungicides capable of penetrating the seed and controlling the internal infection, or resistant varieties and certified seed.

Mosaic virus Cause a mottling of light green areas and dark green patches of affected leaves. The leaves develop irregularly. The leaf edges are usually curled downwards and sometimes become very narrow. Fruits may have odd shapes and yield is reduced. The disease may be seed borne and attacks a wide range of host plants.

Powdery mildew (*Odium sp., Erysiphe sp*) Symptoms are first seen as white powdery pustules on either upper or lower leaf surfaces, soon covering the whole leaf which turns necrotic. Powdery mildew is very destructive during the dry season, particularly on tobacco, wheat, peas, cucurbits and okra.

Rust (*Uromyces sp., Puccinia sp.)*causes yellowish, orange, red or brown, slightly raised pustules, appearing on the leaf surfaces. Rusts are particularly important pathogens of members of the G*raminae* familyi.e., cereals and pasture grasses, but also many other crops, such as beans, peas, tobacco, sunflower, eggplant and sweet potatoes may be attacked, sometimes severely. They have complex life cycles frequently involving alternate hosts.

Wilt Can be caused either by fungal (e.g.,*Fusarium spp., Verticillium spp.),*or bacterial organisms (e.g.,*Xanthomonas spp., Pseudomonas spp., Erwinia spp.).*Infected plants appear generally unhealthy, chlorotic, and wilt. The initial symptoms are a yellowing of the foliage and a gradual wilting and withering, and ultimately the plant becomes permanently wilted and dies. Wilts cause very serious losses in cotton, tobacco, potatoes, groundnut, sunflower, maize, cucumber, eggplant, cassava, etc., particularly under wet conditions.

Common rust (*Puccinia sorgi*) is a fungus which produces small powdery pustules on the leaves of maize and other plants. Alternative host is *Oxalis*sp. Other diseases of significant effect on maize include Southern rust (*Puccinia polysora*), which is a fungus producing small pustules, lighter in colour than *Puccinia polysora*). Others are **Leaf blight (***Helminthosporium turcicum***),** a fungal disease producing slightly oval small spots on the leaves, later increasing in size as well as **Stalk rot (***Diplodia maydis***)** a fungus causing browning of the pith of internodes which are easily broken,. The cobs may also be affected. One viral disease of significant importance to maize is **Maize streak virus** which **i**s transmitted by leaf hoppers and causes yellow streaks along the veins and stunted growth.

Cercosporidium gliricidiasis causes small, light brown, rounded spots with dark borders in *Gliricidia sepium*trees. Other diseases include ***Sirosporium gliricidiae***, which is associated with poor-growing trees, on which attacks can often result in moderate defoliation; ***Cladosporium sp***., which causes scab, ***Sphaceloma spp.,*** which is manifested as brown lesions on the petioles and stems.

2.3 Seed borne Diseases

Pathogens carried on or in seeds has an opportunity for early infection of the crop and act as a centre from which a disease can spread. Infected seed can be the means of introducing the disease into areas previously free, if special measures are not taken to control the importation.

Table1 presents a list of some important seed borne organisms. The list is not exhaustive.

Table 1: Some important seed borne organisms of relevance to Zambia

Crop	Organism	Disease
maize	*Fusarium spp*	Cob rot
	Diplodia spp	Cob rot
	Erwinia stewartii	Bacterial leaf blight
	Scleropthora microspora	Downy mildew
sorghum	*Spacelotheca spp*	Smut
	Claviceps microcephala	Ergot
	Claviceps purpureum	Ergot
	Fusarium moniliform	Seed rot
groundnuts	*Aspegillus spp*	Seed rot
	Fusarium spp	Seed rot
Common beans	*Colletotrihum Lindermuthianum*	Anthracnose
	Pseudomonas phaseseolicola	Halo blight
	Xanthomonus phaseoli	Common blight
	Bean common mosaic virus	
Soya beans	*Peronospora manshuria*	Downy mildew
	Sclerotinia sclerotorium	Stem rot
	Phomoosis sp	Seed rot leaf and stem blight
	Colletotrichum sp	
Pea	*Ascochyta pisi*	Leaf spot
	Mycosphaerella pisi	Leaf spot

2.4 Weeds

Apart from insects and diseases, weeds are quite a significant pest which can significantly reduce crop yield if not properly managed. Weeds compete with crops for nutrients, water, and light and impair the efficiency of field machinery. Yield losses due to weed competition occur mainly during the initial stages of growth and early weed control gives the greatest increase in the yield.

3. Pest Management

Ensuring sustained crop production requires effective and timely control of pests which can cause crop damage or interfere with its growth either directly e.g.,insects or indirectly by pathogens which spread diseases. Only then will the crop grow well to realise its full yielding potential. There are four common approaches to pest control namely physical or mechanical, chemical control, biological control and integrated encompassing a range of interventions.

3.1 Physical and Mechanical Pest Control

This option entails use of physical or mechanical means to destroy or control the target pest. This option includes examples such as:

- Weeding using hands or a hoe;
- Weeding using a harrow;
- Handpicking of pests e.g., removal of caterpillars or grasshoppers by hand;
- Scaring away or trapping of birds;
- Burning of crop residue;
- Trapping of pests e.g., use of rodents or bird traps; and
- Putting up physical barriers e.g. a wire mesh or net to prevent pests from attacking the crop.

The advantages associated with physical and mechanical pest control are:

- Reduced risk of harm to Non Target Plant Species due to high precision in the selection of target pest species provided the workers are well trained and committed;
- Reduced risk of harm to Fauna species due to high precision in the selection of target species provided the workers are well trained and committed;
- Reduced pollution risks (soil, water and air) in that the activity does not involve the discharge of polluting substances nor are residuals pollutants expected;
- Immediate results as the pest factor is immediately removed leaving the crop free and without interference to its growth;
- Reduced cost of monitoring compared to chemical or biological control methods;
- Lesser demand on expertise as activities such as hand pulling/picking, burning and digging/uprooting can be done by anyone with minimal training provided they are physically fit;
- Less demand on sophisticated equipment as simple tools which can easily be used compared to chemical or biological means which may require relatively sophisticated equipment and technology transfer; and
- Employment creation as more people will be required to implement a physical/mechanical pest control program compared to use of chemicals and or biological means.

Key disadvantages of physical and mechanical pest control include:

- It is labour Intensive as it requires a lot of people to accomplish and make any meaningful impact;
- Increased Occupational Health and Safety Risks e.g., injury from snake bites, pricks and injury from use of sharp tools;
- It's slow and takes long to accomplish thereby making the method less efficient and best suited for targeting control in small areas;
- Weeding requires repeated action to eliminate or stabilise populations below injury level);
- Very difficult if not impossible to directly address disease infestation; and
- May in itself contribute to more infestation for instance hand or mechanical weeding done when the grass seed has matured enhances infestation dispersal. .

3.2 Chemical Pest Control

The chemical control option involves use of herbicides for weed control, insecticides for insect control or fungicides for disease control. These chemicals may be applied using aerial spray, tractor drawn boom spray or by knapsack sprayer targeting foliage or soil depending on nature of chemical action, level of infestation, age of the plant and size of the target area to be controlled. Tables 2-4 list pesticides identified to be in use when the ADSP Pest Management Plan was prepared in 2011 while tables 5 and 6 provides a list of banned pesticides still in use.

Amongst the key advantages of chemical control include:

- Ability to control large areas with ease as pesticide application can be done covering a large area with ease within a short period of time;
- Effective control potential due to high potent formulations readily available on the market thereby making pest control programs effective;
- Relatively less labour intensive as pesticide applications require less labour per unit area controlled compared to physical or manual control. This makes it easy to implement on a large scale with less labour; and
- Quick manifestation of control results in comparison to biological control thereby allowing for quick restoration of plant growth and productivity.

The key disadvantage of the chemical approach to pest control is pollution and health considerations together with uncertainty on the chemical's effect on valued non target plant and animal species. Other disadvantages include:

- Increased Occupational health and Safety Risks e.g. chemical poisoning if not properly handled;
- Soil and water contamination thereby limiting the use to which the available water and land can effectively be put to;
- Long term residual effects as some chemicals have potential to remain potent in the environment for a long time thereby limiting other land use activities;
- Public Health concerns equally count among the disadvantages of pesticide use as many pesticides have been discovered to have carcinogenic effects apart from causing reproductive and growth problems as these chemicals are taken up by humans through the food chain; and
- Chemical resistance can also be triggered where chemicals are continuously used for specific target species thereby rendering the chemical ineffective in the long run.

However, it should be noted that COMACO will in no way encourage farmers to use chemical pesticides to control the influx of pests, but will instead encourage the use of organic pesticides in order to control pests.

Table 2: Insecticides recommended and used by different stakeholders[1][2][3][4][5][6]

Insecticide								
Group #	**Chemical Group**	**Item #**	**Insecticide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
1	Avermectin	1	Abamectin	Dynamec	IV	Tomato, Cotton	Red Spider Mite,	
2	Carbamate	2	Carbaryl,	Carbaryl, Sevin Carbax,	II	Tomato, Rice, Pearl Millet, Soybean	Tomato moth, Green Stink Bug, Spotted stem borer, African Pink Stem Borer, Epilachna beetle, Bollworm, Spotted stem borer, Cutworm, Epilachna beetle, Armoured Cricket	
		3	Carbofuran	Furadan	Ib, II	Cowpeas, Carrots	Black Beetle, sorghum Stem Fly, Sweet Potato weevils, nematodes	Banned or restricted in other countries
		4	Ethiophencarb	Ethiophencarb	II	Cabbage	Aphids	
		5	Methomyl,	Methomex 90SP	Ib	Pearl Millet, sorghum,	Bollworm	
		6	Pirimicarb	Primor	II	Cotton, Cabbage, Rape, Okra, Pumpkin	Sucking, Aphids, Turnip Mosaic Virus,	
3	Cyclodiene organochlorine	7	Endosulphan	Endosulfan, Thiodan, Thiokill	II	Cotton, Rice, Millet, Peas, Soybean, Maize	Bollworms, Sucking, Spotted stem borer, African Pink Stem Borer, Bollworm, Spotted stem borer, Pod moth, Epilachna beetle, Cutworm,	Use should be discouraged because it has human and environmental health hazards. Already banned in 56 countries because of its high toxicity and

[1]Crop Protection Handbook 2009 MEISTER PRO
[2]The WHO Recommended Classification of Pesticides by Hazard *and* Guidelines to Classification 2009
[3]Major crop Diseases Manual of Zambia
[4]Zambia Seed Technology Handbook
[5]Agricultural Field insect Pest of Zambia and Their Management
[6]Improved Vegetable production Practices for Smallholder Farmer in Zambia

Insecticide								
Group #	**Chemical Group**	**Item #**	**Insecticide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
								environmental persistent, Endosulfan has been Nominated by the EU for a global ban under the Stockholm Convent.
		8	Lindane	Gamma BHC	II	Soybeans	Aphids	
4	Neonicotinoid	9	Acetamiprid	Spear, Acetam	II	Cotton, Paprika	Sucking	
		10	Imidacloprid	Confidor imidagold	II	Hot Pepper, Maize	White fly Termites	
		11	Thiamethoxam	Renova	IV	Coffee	Antestia bug	
5	Organophosphate	12	Acephate	Orthene	III	Irish Potatoes, Tobacco	Cutworm, Budworm, Aphids,	
		13	azamethiphos			Tilapia fish	parasites	
		14	Chlorpyrifos-methyl	Chlorban	III	Soybean	Epilachna beetle	
		15	Chlorpyrifos,	Dursban, Chlorpyrifos,	II	Cabbage, Tomato, Rice, Soybean , Cowpeas, Irish Potato, mushroom	Whitefly, Black beetles, Cutworm, Brown Leaf Beetle, Termites	
		16	Demeton- S-Methyl	Metasystox	Ib	Rice	Aphids	Believed to be obsolete or discontinued for use
		17	Diazonon	Diazinon	II	Cowpeas	Coreid Bug	
		18	Dichlorvos,	Vapona 50EC	Ib	Tomato, tilapia fish	Tomato moth, parasites	Banned or restricted in other countries
		19	Dicofol,	Dicofol	III	Tomato, mushroom	Red Spider Mite, mites	
		20	Dimethoate	Rogor, Nugor	II	Cotton , Soybean	Sucking, Aphids	
		21	Fenitrothion	Shumba	II	Cowpeas	Coreid Bug	
		22	Fenthion	Lebaycid 50EC	II	Cabbage, Pumpkins, Cowpeas	Leaf Minor, Melon Fly, Bean Fly	Believed to be obsolete or discontinued for use

Insecticide								
Group #	**Chemical Group**	**Item #**	**Insecticide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
		23	Quinalpos	kinalux	II	Cowpeas	Bean Fly	
		24	Malathion	Malathion	III	Tomato Soybean	Tomato moth, Epilachna beetle	
		25	Mercaptothion, Malathion		III	Soybean, mushroom,	Aphids, *Phorid fly (* Megaselia) *Sciarid fly (*Lycoriella, mites	
		26	Monocrotophos	Phoskil, Monocrotopo, Monocron, Azodrin	Ib	Cotton, Cabbage, Tomato, Rice, Soybean	Sucking, White Fly, Cabbage flea Beetle, Spotted stem borer, African Pink Stem Borer, Epilachna beetle, Spotted stem borer, Groundnut Caterpillar leaf minor	Banned or restricted in other countries. Possible alternatives are Malathion, Chlorophypos, Dimethoate, Fenitrothion, Diazinon Azamethiphos;
		27	methamidophos	Metamidofos Monitor	Ib	Paprika	Aphids	Banned or restricted in other countries
		28	Phorate	Umet	Ia	Groundnut	Groundnut Thrips	Banned or restricted in other countries
		29	Profenofos	Curacron	II	Cotton	Sucking	
		30	Terbufos	Hunter	Ia	Groundnut	Groundnut Thrips	Banned or restricted in other countries
		31	Triazophos	Hostathion	Ib	Cotton	Sucking	
		32	Trichlorphon	Dipterex, Granules	II	Soybean Coffee, Tilapia fish	Cutworm , Antestia bug, parasites of fish	
6	Organotin	33	Cyhexatin	cyhexatin	II	Tomato,	Tomato Russet mites	
7	Organosulfite	34	Propargite,	Propargite 30 WP	III	Tomato	Red Spider Mite	

Insecticide								
Group #	**Chemical Group**	**Item #**	**Insecticide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
8	Pyrethroid	35	Alpha cypermethrin	Fastac	II	Cotton, Cabbage, Rape, Tomato, Onion, Okra, Hot Pepper, Pumpkins, Pearl Millet, Soybean , Cowpeas, Cattle	Bollworms, Diamond back moth, Aphids, Bugrada bugs, Thrips, Red Cotton Bugs, White fly, Leaf Eating Beetles, Bollworm, Armoured Cricket, Pod moth, Tsetse fly	
		36	Cypermethrin	Cyrux, Ripcord,	II	Cotton, Cabbage, Rape, Tomato, Rice, Soybean, Cowpeas, mushroom	Bollworms, Diamond back moth, white fly, Tomato Moth, Spotted stem borer, African Pink Stem Borer, Bollworm, Spotted stem borer, Brown Leaf Beetle, Sweet Potato weevils, Coreid Bug, termites	
		37	Deltamethrin	Decis, Decitab	II	Cotton, Cabbage, Tomato, Rice, Pearl Millet, cattle	Bollworms, White fly, Bollworm, Spotted stem borer, tsetse fly	
		38	Fenvalerate	Fenkil	II	Cotton, mushroom	Bollworms, flies. *Phorid fly (* Megaselia) *Sciarid fly (*Lycoriellal termites	
		39	Permethrin,	Actellic, Insect Killer,	II	Rice, Cowpeas, mushroom	Black Beetle, Sweet Potato weevils, termites	
		40	Tralomethrin,	Scout	II	Pearl Millet	Bollworm	
		41	Apistan			Bees	mites	
		42	Amitraz			Bees	mites	
		43	Bayvarol,			Bees	mites	
		44	Lambda-Cyhalothrin	Karate, Kafu	II	Cotton, Cabbage, Rape, Tomato, Pumpkins, paprika	Bollworms, Diamond back moth, Harlequin bugs, Aphids, Bugrada bugs, Leaf Eating beetles	
9	Tetranortriterpenoid/Insect growth	45	Azadractin	neem extract	IV	Cabbage, Rape, poultry	Diamond back moth , Aphids,, mites, ticks lice	

Insecticide								
Group #	**Chemical Group**	**Item #**	**Insecticide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
	regulator							

Source: ADSP Pest Management Plan

Table 3: Herbicides recommended and used by different stakeholders

Herbicides								
Group #	**Chemical Group**	**Item #**	**Chemical Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main Weeds Controlled**	**Official Use status**
1	Aryloxyphenoxy propionates	1	Fluazifop-p	Fulsilade Supper	III	Cotton	Butyl grass	
		2	Propaquizafop	Agil-100EC	Unlikely to present acute hazard in normal use	Cotton	Annual/Perenial (A/P)	
2	Benzoic acid	3	Chlorthal or D.C.P.A	Dathal 75% w.p.	Unlikely to present acute hazard in normal use	Many Vegetables and Lucerne	Many germinating grasses and some broadleaf weeds	
3	Bipyridylium	4	Paraquat	Gramoxone (200g/l)	II	Potatoes, Cotton	All Types	Among the dirty dozen. Currently under intensive controversial discussion due to its toxicity to animals and its serious and irreversible effect if absorbed
4	Chloroacetamide	5	Acetochlor	Acetochlor 900	III	Cotton	Annual Grasses	
		6	Alachlor	Lasso 480g/l	III	Maize, Soya, Groundnuts	Most annual grasses and some broad leaves	
		7	Metolachlor	Dual magnum	III	Cotton	Annual broadleaf	
5	Chloro-carbonic acid	8	Dalapon	Gramevin 85% w.p Dalapon 80% w.p.	Unlikely to present acute hazard in normal use	Tree crops, Lucerne	Most annual and perennial grasses	
6	Dinitroanaline	9	Trifluralin	Treflan E.C (478g/l)	Unlikely to present acute hazard in normal use.	Cotton, Groundnuts, Soybeans, Sunflower,	Most annual grasses and some broadleaf weeds	

Herbicides								
Group #	**Chemical Group**	**Item #**	**Chemical Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main Weeds Controlled**	**Official Use status**
						Some vegetables		
		10	Pendimethalin	Prowl	III	Cotton	Annual Grasses	
7	Glycines	11	Glyphosate	Glyphosate360 Cycat	Unlikely to present acute hazard in normal use	Cotton	All Types	
8	Oxyacetamide	12	Flufenacet	Tiara	III	Cotton	Annual Grasses	
9	Phenoxy-carboxylic acid	13	2, 4-D	Weedkiller D (70% 2, 4-D ester), Weedkiller D (48% 2, 4-D ester), 2, 4-D Amine (72%), Shellamine (72% 2, 4-D Omine)	III	Maize, Wheat , Sorghum	Most Broadleaf weeds	Highly suspected to be an endocrine disruptor
10	Thiocarbamate	14	Butylate	Suttan 720 g/l	Unlikely to present acute hazard in normal use	Maize	Most grasses and some broadleaf weeds. At least partial control of nutsedge	
		15	E.P.T.C	Eptam 6E (720g/l)	II	Potatoes, and some vegetables	Germinating grass and broadleaf weeds. Some control of nutsedge	
11	Triazine	16	Atrazine	Atrazine 80% w.p. Gesaprim 80% w.p. Gesaprim 50% w.p. 19Gesaprim 10% granules	Unlikely to present acute hazard in normal use	Maize, Sorghum	Most germinating broadleaf and grass weeds	

Herbicides								
Group #	**Chemical Group**	**Item #**	**Chemical Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main Weeds Controlled**	**Official Use status**
		17	Atrazine + Cymazine	Brazine , Maize Weed Killer	II	Maize	Most germinating broadleaf and grass weeds	
		18	Ametryn	Ametryn 500SC	III	Cotton	Annual Grasses	
		19	Cyanazine	Bladex 50% W.P.	II	Maize	Most germinating broad leaf and grass weeds	
		20	Prometryne	Gesagard 80% w.p.	Unlikely to present acute hazard in normal use	Cotton, Groundnuts	Most broadleaf weeds and some grasses	
		21	Simazine	Simazine 80% w.p.	Unlikely to present acute hazard in normal use	Maize, Tree crops	Many broadleaf weeds and many annual grasses	
				Gesatop 50% w.p				
		22	Terbutryne	Igram 50%f.w.	Unlikely to present acute hazard in normal use	sorghum	Most annual grasses and some broadleaf weeds	
12	Urea	24	Diuron	Diuron 80% w.p.	Unlikely to present acute hazard in normal use	Tree crops, Cotton	Most annual broadleaf weeds and grasses	
		25	Fluometuron	Cotoran 80% w.p.	Unlikely to present acute hazard in normal use	Cotton	Most annu8al broadleaf weeds and many annual grasses	
				Cotoguard				
				Cottonex				
		26	Linuron	Afalon 50%	Unlikely to present acute hazard in normal use	Potatoes, Onions	Most annual broadleaf weeds and some grasses	

Source: ADSP Pest Management Plan

Table 4: Fungicides recommended and used by different stakeholders

Fungicides								
Group #	**Chemical Group**	**Item #**	**Fungicide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
1	2,6-dinitroaniline	1	Flumetralin	Prime	Unlikely to present acute hazard in normal use	Tomato	Late blight	
2	Acylalanine	2	Metalaxyl	Ridomil	III	Cabbage	Downy Mildew	
3	Alkylenebis(dithiocarbamate)	3	Mancozeb,	Dithane M-45,	III	Tomato, Pumpkin, Carrot, Cabbage, Onion	Late blight, Anthracnose, Carrot leaf bright, Black rot, Purple Blotch, Mildews, Anthracnose	Evaluated by EPA as being carcinogenic
4	Azole	4	Difenoconazole,	Score250EC	III	Tomato	Late blight	
		5	Hexaconazole	Anvil	III	Okra, Pumpkins	Powdery Mildew	
		6	Tebuconazole	Folicur	II, III	Soyabeans	Soybean Rust	
5	Benzimidazole	7	Benomyl	Benlate	III	Tomato, Onion, Okra, Carrot, Mango, paprika	Tomato powdery mildew, Late blight, Purple Blotch, Powdery Mildew, Carrot leaf bright, Mango Anthracnose	
6	Benzimidazole	8	Carbendazim	Arrest, Assure, Carbendazim	III	Jatropha	Jatropha wilt	
7	Dicarboximide	9	Iprodione	Roval Flo	III	Citrus	Leaf Spot of Rough Lemon	
8	Dimethy ldithiocarbamate	10	Thiram	Thiram 80 WP	III	Cabbage	Black rot	

Fungicides								
Group #	**Chemical Group**	**Item #**	**Fungicide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
9	Inorganic	11	Copper Hydroxide	Funaguran OH	II	Cabbage, Tomato, Bananas, Mango, Coffee, Citrus, Paprika	Downy Mildew, Leaf Spot and Head browning of Cabbage, Late Blight, Bacterial Spot on foliage and Tomato fruit, *Sigatoka* Disease of banana, Bacterial Black Spot of Mango, Coffee Berry Disease, Coffee leaf rust disease, *Cercospora* leaf and fruit spot of citrus, Orange Scab	
10	Inorganic	12	Copper Ox chloride	Copper Ox chloride	II			
11	Methoxyacrylate	13	Azoxystrobin	Ortiva	III	Soybeans	Soybean Rust	
12	N-trihalomethylthio	14	Captan	Captan	Unlikely to present acute hazard in normal use	Mango, seed treat for beans , Maize	Mango Anthracnose,	
13	Triazine	15	Anilazine	Anilazine	II	Tobacco	Alternalia	
14	Chloronitrile	16	Chlorothalonil	Bravo 500, Encor Daconil	III	Cabbage, Rape Tomato, Onion, Okra, Carrot	Downy Mildew, Leaf Spot and Head browning of Cabbage , Late Blight, Purple Blotch, Powdery Mildew, Carrot leaf bright,	

Fungicides								
Group #	**Chemical Group**	**Item #**	**Fungicide Name**	**Trade Name**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
15	Sulphur	17	Sulphur	Dusting Sulphur	Unlikely to present acute hazard in normal use	Tomato	Tomato powdery mildew	
16	Triazole	18	Triadimenol	Baytan	III	Coffee	Coffee Leaf Rust	
17	Triphyenyltin	19	Triphenyltin Acetate	Brestan,	II	Soybeans	Red leaf blotch	

Source: ADSP Pest Management Plan

Table 5:Insecticides phased out, banned, or restricted

Banned, restricted or no longer in use pesticides that are still recommended in Zambia									
	Chemical Group	**INSECTICIDES**							
Group #		**Item #**	**Insecticide Name**	**Trade Name**	**Oral LD_{50} mg/kg**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
1	Carbamate	1	Carbofuran	Furadan	14.4	Ib, II	Sorghum, Cowpeas, Carrots	Black Beetle, sorghum Stem Fly, Sweet Potato weevils, nematodes	Banned or restricted in other countries
2	Carbamate	2	Methomyl,	Methomex 90SP	17	Ib	Sorghum,	Bollworm	Banned or restricted in other countries
3	Organophosphate	3	Dichlorvos,	Vapona 50EC	56 -108	Ib	Tomato	Tomato moth,	Banned or restricted in other countries
		4	Methamidophos	Metamidofos Monitor	30	Ib	Paprika	Aphids	Banned or restricted in other countries
		5	Monocrotophos	Phoskil, Monocrotopos, Monocron, Azodrin	14	Ib	Cotton, Cabbage, Tomato, Rice, Soybean	Sucking, White Fly, Cabbage flea Beetle, Spotted stem borer, African Pink Stem Borer, Epilachna beetle, Spotted stem borer, Groundnut Caterpillar leaf minor	Banned or restricted in other countries. Possible alternatives are Malathion, Chlorophypos , Dimethoate, Fenitrothion, Diazinon Azamethiphos ;
		5	Phorate	Umet	2-4	Ia	Groundnut	Groundnut Thrips	Banned or restricted in

Banned, restricted or no longer in use pesticides that are still recommended in Zambia									
	Chemical Group	**INSECTICIDES**							
Group #		**Item #**	**Insecticide Name**	**Trade Name**	**Oral LD_{50} mg/kg**	**WHO Classification**	**Crops**	**Main insects Controlled**	**Official Use status**
									other countries
		6	Terbufos	Hunter	1.6	Ia	Groundnut	Groundnut Thrips	Banned or restricted in other countries
		7	Triazophos	Hostathion	82	Ib	Cotton	Sucking	Banned in Zambia
		8	Demeton- S-Methyl	Metasystox	30	Ib	Rice	Aphids	Believed to be obsolete or discontinued for use

Table 6:Banned, restricted or no longer in use pesticides that are still being recommended in Zambia

	Banned, restricted or no longer in use pesticides that are still recommended in Zambia							
	Herbicides							
	Chemical Group	**Chemical Name**	**Trade Name**	**Oral $LD_{50\ mg}$ /kg**	**WHO Classification**	**Crops**	**Main Weeds Controlled**	
1	Bipyridylium	Paraquat	Gramoxone (200g/l)	150	II	Potatoes, Cotton	All Types	Among the dirty dozen. Currently under intensive controversial discussion due to its toxicity to animals and its serious and irreversible effect if absorbed
2	Dinitroaniline	Nitralin	Plaza in 75% w.p.	2000+	III	Cotton, Groundnuts , Soya	Most annual grasses and some broadleaf weeds	Believed to be obsolete or discontinued for use as pesticide

Source: ADSP Pest Management Plan

The above list of pesticides is a compilation of all products recommended for and are used in Zambia per responses of interviewed stakeholders during the ADSP Pest Management Plan 2011 study and current handbooks for crop management. Comparatively this list has a number of pesticides that are phased out, banned and or restricted in other countries as noted in the official use status of the tables and Appendix 9.

3.3 Biological Pest Control

The biological control option involves use of animals, insects, bacteria or viral agents which can either be predators (e.g., predatory bugs and spiders), parasites (e.g., some type of wasps) or pathogens (e.g., types of bacteria, fungi, viruses, nematodes) to feed on or attack the target pest species with the aim of killing or suppressing their growth and development. For example, Lady beetles feed on aphids. In most cases, control is achieved when the population level of the introduced biological agent has reached its peak to overwhelm the target pest species being controlled.

The advantages of biological control include:

- Cheap to run once established as there are no incremental costs and invasive control remain effective over time; and
- Pollution free as the control method does not present pollution risks to the environment even though the potential of the agent mutating to attack and contaminate other species cannot be ruled out.

Amongst the key disadvantages are:

- High capital investment in breeding the biological control agent to critical population levels for effective control;
- Risk of the control agent attacking the non- target plant or animal species;
- The need for long term monitoring of after effects is another disadvantage as the behaviour and characteristics of a given biological control agent can change over time and become invasive thereby affective beneficial plant and animal species; and
- Delayed manifestation of results as biological control takes long to reach equilibrium and may not be ideal where results are needed in a short period of time

3.4 Integrated Approach to Pest Control

The Integrated Pest Management (IPM) option involves the systematic application of more than one option .for enhanced effectiveness and is based on the principle of ecosystem management to create a conducive environment for the crop and less so for the pest. The approach is effective in that a healthy crop will have better resilience and ability to withstand pest attack or competition than a weak plant. Consequently, apart from proper and well measured integration of the physical/mechanical, chemical and biological it also embraces cultural practices aimed at manipulating environmental conditions such as proper provision of nutrients and water, crop rotation, intercropping, strip/alley cropping, use of natural pest repellents, use of resistant varieties, use of natural/plant based pesticides as opposed synthetic ones etc. This option is noted to be more effective than any single method because of the combined effect of the various control methods incorporated. It also focuses on pest specific interventions thereby limiting harm to non-target species, the environment and human life in general.

The main disadvantage of this option is that it is more expensive than any single option due to incremental activities required. It also requires the based on a full understanding of each target pest's life cycle in order to identify the best point of intervention and as such takes long to effectively develop. However, the approach can cost be effective if well planned with constant monitoring of crop fields thereby allowing for selection of the best option or combination of options capitalising on more environmentally friendly and effective low cost interventions.

One major challenge in implementing the IPM approach to pest management is lack of knowledge about IPM, its practice and full benefits amongst the majority of farmers and service providers of the agricultural extension service inclusive. It should however be appreciated that aspects of IPM are unconsciously implemented as these constitute part of the traditional way of farming e.g. intercropping

and crop rotations as well as shifting cultivation and fallowing. However, the practice is not applied to its full whether on the part of the commercial or subsistence farmers. Similarly at research level the practice does not receive the attention it deserves.

It is however hoped that with COMACO's introduction of *Gliricidia* among its farmers, this in itself will work as a form of 'integrated pest management', IPM, which will enable farmers maintain a cheap but healthy method of controlling pests during crop production.

3.5 Status Review of Pest Management in Zambia

Pests continue to present a major challenge in crop production in Zambia. Consequently pest management is one of the major aspects of crop management in Zambia. Whilst appreciating the benefits of adopting an IPM approach to pest management, knowledge about the full benefits and practice of IPM is generally lacking. It should however be appreciated that aspects of IPM are implemented as these constitute part of the traditional way of farming e.g. intercropping and crop rotations as well as shifting cultivation and fallowing. However, the practice is not applied to its full whether on the part of the commercial or subsistence farmers.

The most widely applied mode of pest control constitutes physical/mechanical mostly by resourced poor small scale farmers and chemical control (mostly by resource rich commercial farmers and moderate resource rich emergent farmers). Biological control is very limited in both cases. Unlike trends in chemical use where more and more farmers are adopting pesticide use including small scale farmers biological control remain static in its application even though aspects of its may be taking place in fields without the conscious knowledge of the farmers. However, trends are slowly changing especially with the promotion of conservation farming which is promoting use of herbicides for enhanced effectiveness.

Interviews with commodity research team members indicated similar trends at ZARI where pest control is mostly limited to physical/mechanical and chemical control with only limited application of IPM. The growing trend in pesticide use however raises concern regarding occupational, public and environmental health.

A survey conducted on some farmers and agro dealers during a project review exercise for the Conservation Agricultural Project implemented under the Conservation Farming Unit of the Zambia National Farmers Union showed that only basic information on pesticide use exists. It was further revealed that much of this information was limited to occupational health and little information was made available concerning public and environmental health such as the fate of herbicides in the soil, potential for surface and ground water contamination and the implications thereof. Information on the long term effects (e.g. mutagenic, carcinogenic and reproductive effects) was also not so much availed together with information on what to do in case of acute effects such as poisoning in direct ingestion cases. Other observations made included the following:

- Material Safety Data Sheets (MSDS) are not readily available. Most agro dealers, especially small scale dealers do not stock them and some do not even know them. Even large dealers too do not make these readily available;
- Information on MSDS is too detailed in some cases and may contain user unfriendly information and does not encourage many users to read. In other cases the information is scanty and does not contain all the important information about the product and its effects yet in other cases the information is contradictory from manufacturer to manufacturer;

- Labels (which should ideally contain vital information from MSDS) on some products are not user friendly – too small to read and language too technical;
- The different formulations of the same product e.g. Atrazine has 25%, 42%, 90% etc, formulations by different manufacturers and this present a challenge to the user since he/she has to deal with one chemical bearing different product formulations whose degree of effects/effectiveness are different due to varying concentrations. This situation becomes more challenging when calibrating sprayers to ensure correct concentration of the chemical sprayed
- Information on herbicide use does not in most cases include the aspect of sprayer calibration yet this information has a strong bearing on correct dosage application;
- The tendency by agro dealers to offer an alternative where the farmer's preferred or known product choice is unavailable presents a challenge to application of the acquired knowledge in that the new product may present knowledge requirements which are not yet possessed by the user thereby increasing the risk of poor handling/management and consequent risks; and
- The hurried manner in which agro dealers provide the information on the use of agro chemicals in general is inadequate to facilitate adequate knowledge for effective use of the product. Practical demonstrations are vital in most cases for effective learning but agro-dealers are not readily available for this purpose.

In view of the above it is desirable that:

- The Zambia Environmental Management Agency (ZEMA) and other players such as the Zambia Agrochemical Association (ZAA) be brought on board in the implementation of the COMACO Landscape program to build capacity and put in place an effective monitoring system that ensure that only registered herbicides are being distributed to farmers and that formulations are maintained in their registered state (without re-formulation) and that farmers acquire appropriate knowledge in the use of pesticides. However, this will only be the case in the event that the farmers adopt chemical use of pesticides. However it is not the intention of COMACO to introduce these pesticides at this point in the programme.
- All dealers should have in possession Material Safety Data Sheets (MSDS) for all chemicals being sold and this information should be explained to buyers. An MSDS is a source of information on likely hazards that may arise from the use of chemicals. Generally, an MSDS should contain information such as:
    - Pesticide Identification (Name of the substance/trade name; preparation/other ingredients;
    - Name, address and telephone of company/supplier;
    - Composition and information on ingredients;
    - Hazards identification;
    - First aid measures;
    - Fire-fighting measures;
    - Spillage, accident release measures;
    - Handling and storage;
    - Exposure controls and personal protection;
    - Physical and chemical properties;
    - Stability and reactivity;
    - Toxicological information;
    - Ecological information;
    - Disposal considerations;
    - Transportation information;
    - National regulations and references; and
    - Other information deemed appropriate.

Further, a simplified sheet should be made available to target farmers in a language easily understood by them. Farmers interviewed and some dealers were unable to confirm availability of MSDSs.

4. Pest Management Plan

Preparation of the Pest Management Plan (PMP) to guide implementation of pest management interventions under the CLMP program will have to satisfy both the national and World Bank requirements.

4.1 World Bank Requirements

World Bank requirements in relation to pest management are elaborated under Operational Policy (OP) 4.09. The policy places emphasis on pest management within the context of environmental management. To that effect it puts preference on the use of biological or integrated approach and less so on synthetic chemical use. Projects qualifying under the program will have to consider this and make informed decisions aided by consideration of other factors during the project's environmental assessment process.

The Bank will only fund projects which do not involve use of pesticides or where use of such is included it should be justified and supported with demonstrated capacity starting at the country level covering the regulatory framework and institutional capacity for monitoring and enforcing safe, effective, and environmentally sound use of pesticides. It will also require demonstrated knowledge of IPM by the beneficiary institution or people implementing a subproject. As noted earlier, IPM approaches use a combination of biological control, physical and mechanical control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest and to some degree limited use of pesticides.

In endorsing use of pesticides, the Bank will require evidence to the effect that the pesticides being used meet the following criteria:

- They must have negligible adverse human health effects;
- They must be shown to be effective against the target species;
- They must have minimal effect on non-target species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies. Pesticides used in public health programs must be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them;
- Their use must take into account the need to prevent the development of resistance in pests; and
- Highly toxic or hazardous pesticides may not be used and these include formulated products that fall in WHO classes IA and IB, or formulations of products in Class II, if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

4.2 Applicable Guidelines for Pest Management in Zambia

Like the World Bank, Zambia does not endorse indiscriminate use of pesticides and to that effect promotes an integrated pest management approach. Although agricultural policies put emphasis on agricultural productivity including promotion of pesticide use to address the low productivity issue, safe use of such chemicals is encouraged. Specifically, two pieces of legislation have direct relevance and give guidance on pest management.

The Plant Pests and Diseases Act, CAP231 provides for prevention of the introduction of pests and diseases into the country and the spread thereof. The Act further provides for designation of certain pests

and disease vectors as requiring destruction. The Act is enforced by the Phyto-sanitary Services Department under the Ministry of Agriculture and Livestock.

The Pesticides and Toxic Substances Regulations (Statutory Instrument no. 20 of 1994): These Regulations enforced by the Zambia Environmental Management Agency (ZEMA) provide for the control of pesticide use through a licensing system. This ensures that only acceptable pesticides are allowed into the country and found on the Zambian market. Further, the Regulations provide guidance on transportation, packaging, use, and final disposal of containers. Appendices 3, 4, 5, 6 and 7 are provisions of the PTS Regulations on toxicity and hazard warning; Transportation, Warehousing and Storage; Protective Clothing and Cleaning Equipment and, Disposal respectively. These requirements all need to be complied with as a matter of statutory requirement.

However, ZEMA's enforcement capacity is inadequate and cases of non-compliance are rampant with dealers selling repackaged pesticides without proper labelling, some labels lacking vital information while the registration process rarely include testing and verification of the efficacy and hazard characteristics of the pesticides under consideration. Of serious concern is the fact that a list of banned or strictly restricted pesticides is non-existence thereby rendering the registration process to be porous. This therefore means that not all pesticides registered and allowed by ZEMA may necessarily be allowable under the COMACO Landscape Management program which does not sponsor pesticides category 1a and 1b of the WHO classification.

At the international level, Zambia is a signatory to both the Stockholm and the Rotterdam Conventions. The Stockholm convention restricts parties from production and use of pesticides classified as Persistent Organic Compounds (POPs). These chemicals are restricted because of their chemical characteristics of not only being toxic but equally persistent with high potential for bio-accumulation. The Rotterdam Convention on the other hand provides for Prior Informed Consent and requires that any country exporting the pesticides listed under the Convention notify the recipient country in writing and get their prior written consent before the chemicals are exported. Appendix 9 is a list of pesticides banned or severely restricted by the United States of America (Environmental Protection Agency (EPA), the European Union (EU), the Stockholm Convention (for POPs) and the Rotterdam Convention (PIC), Pesticide Action Network (PAN) and the Sustainable Agriculture Network (SAN).

4.3 Pest Management Plan

4.3.1 Implementation Plan

The preferred approach to pest management under the COMACO Landscape Management program is IPM. This chapter provides guidance on how best to maximise pest management interventions with minimal negative impacts on the environment and human health using the principles of IPM. The chapter is not meant to provide a detailed prescription of cultural practices required to raise each target crop as such information is very well appreciated by both research teams and farmers. Further, cultural practices differ widely depending on the characteristics of each particular crop species being grown and the agro-ecological and other environmental conditions prevailing at each particular site. Rather, the chapter is meant to bring to the fore vital IPM considerations for incorporation in prevailing cultural practices applicable at each project site. It should be noted that IPM cannot be applied as a cast transplant of interventions and practices, rather it is a set of interventions developed based on a good understanding of prevailing environmental and other conditions at a given field incorporating the most fitting aspects of IPM tools commensurate with resources at the farmer's disposal. This can be achieved by following a stepwise process elaborated below:

Step 1: Monitoring and Pest Identification

The first step in IPM is crop or field monitoring involving observations of the field and immediate surroundings to identify the presence of pests or conditions which may be conducive for pest proliferation within the context of prevailing cultural practices. This exercise should be carried out at every stage of the crop calendar starting at harvest through field preparation up to harvest time again. This exercise may involve walking through each field randomly or following a transect pattern taking note of pest infestation, growth stage and rates of infestation for each pest species in a given crop. The information collected can then be recorded and ranked to give an indication of relative prevalence for each category of pest. Pests recording a higher level of infestation will in this way be prioritised for action while giving not losing site of the need to address the other pests too though prevailing at a relatively lower rate of infestation.

The importance of conducting an all year round monitoring of pests is to ensure collection of adequate information for planning purposes. This is because effective IPM requires timely planning. For example identification of pests prevailing at harvest time and their pattern of growth will help to plan the next crop with a view to controlling the identified weeds in a timely manner. The historical data collected through such monitoring will thus provide vital information in planning the best combination of IPM interventions.

Step 2: Threshold determination and Action Planning

Results of field monitoring conducted should lead to an assessment of whether or not action is needed to address the pest or condition prevailing as well as decision making on when to institute such action. Where a pest is present an assessment of the level of infestation is made and if it reaches a threshold of potential damage appropriate preventive action should be taken against that particular pest or a combination of pests using any or a combination of biological, cultural, physical/mechanical and chemical management tools. In this way, rather than having a fixed scheduled program of e.g., chemical spray, results of monitoring should help decide if or not action should be taken and the nature and level of action to be taken. Similarly, results of environmental conditions monitoring will be used to determine and assess if or not the prevailing conditions favour pest infestation or plant growth based on which action can be taken to manipulate the ecosystem or environmental conditions in favour of the crop.

Step 3: IPM Implementation

The implementation stage will involve application of one or a mix of IPM interventions identified as best suiting under prevailing circumstances. Below are a number of considerations to be borne in the implementation of choice interventions.

Considerations under Physical/Mechanical Control

- Develop and strictly enforce adherence to safety rules and codes of conduct;
- Provide training to all staff on occupational health and safety as well as on ensuring personal protection and safety;
- Provide appropriate safety gear;
- Reduce the harmful characteristics of impact sources by devising less harmful ways of effecting project activities;
- Localise project impacts as much as possible by taking precautions in effecting project activities so as to limit effects on non-target elements of the environment;

- Explore ways and means of enhancing the resilience and regenerative/recovery capacity of impacted elements of the environment deemed useful; and
- Streamline Better Management Practices as an integral part of project implementation.

Considerations under Biological Control

- Use proven host specific biological control agents;
- Conduct specificity tests in the host environment before release;
- Quarantine biological control agents undergoing specificity test;
- Develop and strictly enforce adherence to safety rules and codes of conduct; Provide training to all staff on occupational health and safety as well as on ensuring personal protection and safety; Provide appropriate safety gear; Provide First Aid medical facilities; Recruit qualified First Aid Attendants; and Maintain emergency responsiveness;
- Reduce the harmful characteristics of impact sources by devising less harmful ways of effecting project activities;
- Localise project impacts as much as possible by taking precautions in effecting project activities so as to limit effects on non-target elements of the environment;
- Explore ways and means of enhancing the resilience and regenerative/recovery capacity of impacted elements of the environment deemed useful; and
- Streamline Better Management Practices as an integral part of project implementation.

Considerations under Chemical Control

- Consider both human health and environmental effects of target pesticides before use;
- Sensitise and train workers on pesticide management, calibration of sprayers;
- Develop and enforce protocols for safe use of pesticides;
- Avoid direct spray on water bodies;
- Avoid washing sprayers in natural water bodies;
- Avoid spraying during windy conditions, wear personal protective gear (appropriate respirators), avoid spraying in areas close to settlements and other populated areas, and use wetting agents to minimise dripping;
- Use only recommended pesticides at recommended application rates. Do not overdose;
- Contain any spills and clean up (Appendix 6) to avoid contamination of the environment
- Dispose of chemical containers properly;
- Develop and strictly enforce adherence to safety rules and codes of conduct;
- Provide training to all staff on occupational health and safety as well as on ensuring personal protection and safety;
- Provide appropriate safety gear;
- Reduce the harmful characteristics of impact sources by devising less harmful ways of effecting project activities;
- Localise project impacts as much as possible by taking precautions in effecting project activities so as to limit effects on non-target elements of the environment;
- Explore ways and means of enhancing the resilience and regenerative/recovery capacity of impacted elements of the environment deemed useful;
- Streamline Better Management Practices as an integral part of project implementation;
- Store pesticides under lock and key on impermeable surface that is bundled;
- Wash hands before eating, drinking or using the toilet; and
- Remove clothing immediately if pesticide gets inside, wash thoroughly and put on clean clothing.

Appendix 1 and 8 further elaborates considerations needed in chemical control of pests.

Considerations under Cultural Practices

Following are some of the considerations under cultural practices:

- Timely removal of weeds before they seed to reduce seed-bank build up;
- Cleaning of equipment to eliminate potential sources of infestation;
- Use of clean seed free of pests and diseases;
- Cleaning the field before planting. This can be done e.g. by allowing weeds to germinate before planting after which they can be controlled by a choice of appropriate herbicide or cultivation and planting thereafter;
- Avoid clearing and burning non target plants;
- Control erosion by limiting land clearing and setting up sediment traps along storm ways;
- Develop and strictly enforce adherence to safety rules and codes of conduct;
- Reduce the harmful characteristics of impact sources by devising less harmful ways of effecting project activities;
- Localise project impacts as much as possible by taking precautions in effecting project activities so as to limit effects on non-target elements of the environment;
- Explore ways and means of enhancing the resilience and regenerative/recovery capacity of impacted elements of the environment deemed useful;
- Streamline Better Management Practices as an integral part of project implementation;
- Provide training to all staff on occupational health and safety as well as on ensuring personal protection and safety; and
- Provide appropriate safety gear.

4.3.2 Institutional Roles and Responsibilities

Implementation of the PMP under the CLMP program will require effective participation of key players in a coordinated manner under the leadership of COMACO. Key players in this regard and their roles are presented in the table 7 below.

Table 7: Institutional roles and responsibilities

No.	Institution	Proposed Responsibility
1	Extension staff	Provide training and other forms of knowledge transfer to farmers on the management of pests affecting their fields/crops including practical knowledge on IPM, knowledge on choice, safe use and disposal of pesticides
3	Participating farmers	Control pests in their fields in compliance with the provisions of this PMP and other applicable protocols

4	Pesticide dealers	Ensure that only registered pesticides sold Comply with the provisions of the PTS Regulations on importation, transportation, storage and vending of pesticides Fully understand the pesticides in their custody including pesticide toxicity, health and safety hazards and environmental risks Provide information to farmers and other buyers on safe use and management of pesticides

4.3.3 Training and Capacity Building

A number of capacity building interventions will be required under the program in order to ensure effective implementation of the PMP in an environmentally friendly and socially acceptable manner. The following interventions are hereby proposed:

- Procurement of equipment for pesticide application including Personal protective Equipment (PPE) including chemical proof overalls, aprons, gum boots, chemical proof hand gloves, goggles and respirators, etc. Emergency equipment e.g. for cleaning up spills should also be procured. This equipment would only be provided to Lead farmers and key extension staff in the event that farmers decide to adopt the use of chemicals. However, this will not be encouraged as COMACO's aim is to only introduce *Gliricidia sepium* for intercropping which in itself will act as a pest management plan.
- Training of extension staff in the life cycle management of pesticides covering selection, usage and safe disposal of containers as well as chemical formulation and dosing (dilution of chemicals for use), calibration of equipment, spraying procedures and other factors to consider, handling of sprayers as well as general equipment maintenance. Trainees should be sensitised enough to use only pesticides with authentic and clear labels showing all the necessary information including expiry dates, occupational/public health and safety as well as basic environmental safeguards. This will also help avoid adulteration and sale of expired herbicides.
- Provision of training and sensitisation programs in IPM including demonstrations and preparation of IPM implementation Manuals and Guidelines
- Training/Sensitisationin the use of personal protective equipment, treatment of any pesticide poisoning, interpretation of material safety data sheets and labels on pesticide containers and safe storage of pesticides
- Training in First Aid and Emergency Response with a focus on treatment of chemical poisoning and pesticide spill management
- Sensitisation on weather and other environmental related considerations insecticide application e.g. avoiding spraying when it is about to rain, when it is windy, when it is too hot or when the soil is wet or in ponded areas or areas close to water sources (e.g., rivers, dambos, wells, etc.) and populated areas.

Training will be provided in both formal and informal settings including Field Days as appropriate in meeting the specific training objectives. A training needs assessment would help in setting the training agenda and ensure that the training sessions area relevant and tailored to answer to farmers' pressing information needs. .

Table 8: Capacity Building Implementation Plan for the proposed **PMP**

Activity	**Duration**	**Responsibility**	**Proposed budget (US $)**
Two sessions of training in safe and environmentally friendly pesticide use including: (i) understanding and interpretation of labels and symbols on pesticides, (ii) formulation, dosing and calibration of equipment, (iii) transportation, storage and disposal of pesticides and pesticide containers and (iv) personal safety and hazard understanding for self-health protection	1 year	Extension Department/MAL/Forestry	2800
Three sessions of training, sensitisation and Awareness in IPM and its implementation	3 years	Extension Department	5.000
		Total	7,800

4.3.4 Monitoring and Reporting

Effective implementation of the PMP will require regular monitoring of its implementation for timely corrective actions. Monitoring will cover all aspects of the PMP implementation starting at the field level where aspects listed below will be monitored:

- Implementation of proposed capacity building interventions
- Adoption and Effectiveness of the chosen combination of IPM interventions
- Environmentally friendliness of applied IPM interventions e.g. by monitoring the prevalence/survival of non-target plant and animal species
- Soil and water contamination
- Public and occupational health and safety e.g. Incidences of poisoning or injury

Table 9 is a Plan for monitoring implementation of the PMP.

Table 9: PMP monitoring plan

PMP Activity	What parameter is to be monitored?	Where is the parameter to be monitored?	How is parameter to be monitored/type of monitoring equipment?	When is parameter to be monitored/frequency of measurement or continuous?	Annual Monitoring cost	Responsibility	Start date	End date
Capacity Building Interventions								
Training in IPM	Number of people trained	Training programs and attendance lists	Review of documentation, trainee interview	Annual	Included in project coordination and management costs	Extension Manager		
Monitoring Interventions								
Ground water pollution	Pesticide active ingredient, Chlorides, Nitrogen and phosphates	Borehole, water well or soil in target fields as appropriate	Sampling and lab analysis	Semi-annually effective year after use of project procured agrochemicals	6,000	Consultant/UNZA		
Surface water pollution	Pesticide active ingredient, Chlorides, Nitrogen and phosphates	Runoff receiving water body	Sampling and lab analysis	Semi-annually effective year after use of project procured agrochemicals	6,000	Consultant/UNZA		
Soil contamination	Pesticide active ingredient, Nitrogen and	soil in target fields	Sampling and lab analysis	Semi-annually effective year after use of project procured agrochemicals	4,000	Consultant/UNZA		

	phosphates							
Plant and animal sampling and analysis	Pesticide residue	Plant and animal tissues	Sampling and lab analysis	Annually following target species life cycle	10 000	Consultant/UNZA		
IPM adoption and effectiveness	Adoption rates	Commodity research teams and farmers	Social surveys	Annually effective first year of training and sensitisation	Included in operational costs	Consultant		
Effect of pest control interventions on biodiversity	Prevalence of non-target species	Field and surrounding areas	Species population inventories	Biannually effective	8 000	Consultant/UNZA		
Public and occupational health and safety concerns such as poisoning due to misuse or improper handling of pesticides	Incidences of poisoning or illness associated with pesticide use	Workers and surrounding community	Incidence reports/surveys	Each time incidence is reported	Included in operational costs	Farmers, Extension Officers		

Monitoring results will be used to improve implementation of the PMP through documentation of lessons learnt on the most effective, environmentally friendly and cost effective combination of interventions.

4.3.5 Proposed Budget

Effective implementation of the PMP will require adequate provision of funds to cover planned activities. Table 10 below gives an indicative budget for implementation of the plan. It should however be noted that the adopted IPM approach in practice will entail spreading pest management costs across all aspects of crop management in breeding, seed multiplication, demonstration fields and post harvest management of crop. Therefore only aspects aimed to do with capacity building and monitoring are included here as elaborated in the implementation and monitoring plans in the preceding chapters

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Table 10: Budget --Cost of implementing PMP

No	Activity	participants	Unit cost (USD)	Cost (USD)
1	**Training and Capacity Building Costs**			
1.1	Two sessions training, sensitisation and Awareness in IPM and its implementation for staff and lead farmers from five chiefdoms(mwasemphangwe,zumwanda,chikomeni,magodi and nyampande)	50	160	8,000
1.2	Ongoing training in safe and environmentally friendly pesticide use including: (i) understanding and interpretation of labels and symbols on pesticides, (ii) formulation, dosing and calibration of equipment, (iii) transportation, storage and disposal of pesticides and pesticide containers and (iv) personal safety and hazard understanding for self-health protection	50	100	5,000
	Subtotal			**13,000**
2	**Monitoring and Reporting Costs (if necessary)**			
2.1.	Water sampling and analysis (surface water resources)	6	6,000	36 000
2.2.	Water sampling and analysis (ground water resources)	6	6,000	36 000
2.3	Soil sampling and analysis	6	4,000	24 000
2.4	Plant and animal sampling and analysis	6	10,000	60 000
2.5	Monitoring of sponsored trial biological monitoring programs			48 000
2.6	Monitoring of IPM adoption and implementation			60 000
	Subtotal			**264,000**
	Total Costs			**277,000**

References

1. Environmental Council of Zambia, 2000: The State of Environment in Zambia 2000, Environmental Council of Zambia, Lusaka.
2. Food and Agriculture Organization of the United Nations (FAO), 2005: International Code of Conduct on the Distribution and Use of Pesticides, Revised version, FAO, Rome.
3. Government of the Republic Of Zambia, 2005: National Policy on Environment. Ministry Of Tourism, Environment and Natural Resources, Environmental Policy Development Secretariat, Lusaka.
4. Ministry Of Agriculture and Livestock, 2006: Environmental Management Framework. Agricultural Development Project, Lusaka.
5. Ministry Of Agriculture and Livestock, 2012: The Food Legumes Regional Centre Of Leadership, Draft Project Proposal, Zambia Agriculture Research Institute, Chilanga.
6. Ministry Of Agriculture and Livestock, 2011: Pest Management Plan, Agricultural Development Support Project, Lusaka.

Appendices

Appendix 1: Precautions for Using Pesticides

Pesticides are poisonous and must be used with caution. **READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER**. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates. Avoid using pesticides where alternative options work. Use the right equipment

Legal Responsibility: The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation: Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage: Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal: Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants: Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect non-pest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields: For some materials, *restricted entry intervals* are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Pre-harvest Intervals: Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements. Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Processed Crops: Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury: Certain chemicals may cause injury to crops (phyto-toxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Environmental Conditions: Apply in the evening and avoid doing so during hot days (to avoid vaporization and the risk of chemical vapor inhalation) as well as reduced efficacy due to rapid degradation of chemical under heat. Rainy days should also be avoided as the pesticide will easily be washed off the crop.

Personal Safety: Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift (avoid spraying when it is windy), and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.

(Adopted from University of California Agriculture and Natural Resources, Integrated Pest Management Program (http://www.ipm.ucdavis.edu/GENERAL/precautions.html, 8 December 2012. The above provisions are in tandem with the provisions contained in the Pesticides and Toxic Substances Regulations under the Environmental Management Act)

Appendix 2: Pesticides Banned under the Stockholm Convention

The following pesticides that are classified as Persistent Organic Pollutants were banned under the Stockholm Convention and belong to the original list of "The Dirty Dozen" and may not be sponsored under the program.

- Aldrin
- Chlordane
- DDT
- Dieldrin
- Endrin
- Heptachlor
- Hexachlorobenzene
- Mirex
- Toxaphene

The following pesticides were added to original list of banned pesticides since August 2009 and may not be sponsored under the program:

- Chlordecone
- Alpha hexachlorocyclohexane
- Beta hexachlorocyclohexane
- Lindane
- Pentachlorobenzene.

Appendix 3: Pesticides Hazard Warning and Toxicity Colour Coding

(Third Schedule of the PTS Regulations)

	Pesticide Toxicity	Colour code	Warning	Additional
(i)	Acute oral LD50	Red	Very dangerous poison	skull and cross bones up to 50 mg/kg
(ii)	Acute dermal LD50	Red	Very dangerous poison	skull and cross bones up to 200mg/kg:
(iii)	Acute inhalation LC 50200mg/m^3/4h	Red	Dangerous poison	skull and cross bones
(iv)	Acute oral LD50 51-500mg//kg	Purple	Dangerous poison Poison	skull and cross bones
(v)	Acute dermal LD50 201-2,000mg/kg	Purple	Poison	skull and cross bones
(vi)	Acute inhalation LD50 201-2000mg/m^3/4h	purple	Poison	skull and cross bones
(vii)	Acute oral LD50 501-5,000mg/kg	Amber		
(viii)	Acute dermal LD50 2,001mg/kg	Amber		
(ix)	Acute inhalation LC50 2,001-20,000mg/m^3/4h	Amber		

	Pesticide Toxicity	Colour code	Warning	Additional
(x)	Acute oral LD50 greater than 20,000mg/kg	Green	Harmful if swallowed	
(xi)	Acute dermal LD50 greater than 20,000mg/kg	Green	Harmful	
(xii)	Acute inhalation LC50 greater than 20,000mg/ m^3	Green	Harmful	
(xiii)	Acute inhalation LC50 greater than 20,000mg/m^3	Green	Harmful	

Pesticides shall be classified according to colour symbol and warning it carries;

Symbol		Warning
Red	I	Very dangerous poison
Purple		Dangerous poison
Amber		Poison
Green		Harmful

Appendix 4: Guidelines for Transportation of Pesticides
(Fourth Schedule of the PTS Regulations)

1. Ensure that the emergency procedure information relating to the pesticide(s) or toxic substances card is in the vehicle.
2. Ensure that all hazard warnings are displayed, not obstructed and that they are kept clean at all times.
3. Follow the route as advised by the transporter or operator.
4. Ensure that the vehicle is not left unattended at any time.
5. Ensure that the vehicle has certificate of fitness.
6. Ensure that the First Aid Equipment is in the vehicle.

Appendix 5: Warehousing and Storage Requirements

(Sixth Schedule of the PTS Regulations)

1. Warehouse conditions
    a. The pesticide and toxic substances warehouse should be located away from homes, highly populated areas, drinking water sources and areas liable to flooding;
    b. The floors in the building should be of concrete with a load bearing capacity sufficient to withstand the weight of the stock, racking and any mechanical handling equipment to be used. Floors should be impervious to liquids free from cracks and smooth to facilitate cleaning;
    c. The building should be designed such that escape in case of emergency should be possible from any enclosed area in at least two directions. Emergency exits should be clearly marked;
    d. The warehouse should have access from at least two sides to facilitate firefighting, regardless of wind direction and also facilitate easy escape from any enclosed area;
    e. Bunding is the physical retention of firefighting water or spillage. All warehouses constructed above;
    f. Ground-level should have special provision for bunding. This can be achieved, for example by constructing ramps across external doorways of existing warehouses;
    g. The building should permit reasonable movement of materials and enough space to allow hygienic working conditions and clear access to fire-fighting equipment;
    h. The walls of the warehouse should be of non-flammable type and all pipings and electrical wiring should be sealed;
    i. The roof of the warehouse should be able to effectively keep out rain, be able to provide both ventilation to allow fumes and heat to escape in case of fire and at the same time provide protective against direct sunlight;
    j. The warehouse should have drains which should not be directly linked to waterways or public sewers. They should instead be linked by a closed system, to an evaporation tank; and
    k. The evaporation tank should be emptied from time to time depending on the accumulation of solid waste. It should be covered during the rainy season to avoid filing by rain water.

2. Storage Conditions

    a. All products should be stored under lock and key with proper warning signs displayed clearly to keep away unauthorised persons. Pesticides and toxic substances must be stored in a separate warehouse, away from any other goods especially foods and stock-feeds;
    b. Before storing any pesticides ensure that they are properly labelled and are of good quality and acceptable condition. If any of the products are not in good condition, do not store them together with other products but take appropriate action;
    c. If pesticides and toxic substances are to be stacked inside the warehouse, stacking heights should not exceed three metres unless the use of racking prevents overloading of the lower tiers;
    d. Persons loading pesticides and toxic substances in the warehouse should pay special attention to "THIS SIDE UP" signs on cartooned packs; and
    e. Pesticides and toxic substances should be stored separately, preferably according to their use in the field e.g., herbicides, insecticides etc. The objective of this is to prevent cross contamination as well as minimise the risk of fire and consequent environmental contamination often presented by mixed storage arrangements.

3. Management Requirements

a. All stocks in the warehouse should be frequently inspected for leakages, caking of powders, pulverisation of granules, sedimentation or gelling of liquids, change in colour due to oxidation, dampness of packages and corrosion or deterioration of containers. All leakages must be treated as being extremely toxic;
b. Spillages should not be cleaned out with water. They must be swept up and kept in a special labelled container awaiting safe disposal. Liquids should first be absorbed by saw dust, earth or any other absorbent before being swept up;
c. Every warehouse must have an emergency spills treatment kit consisting of a PVC apron, neoprene gloves, a gas mask, a brush or broom, a dust pan, an empty clearly labelled container (for collecting wastes) a container of sawdust and a spade; and
d. Always strictly follow the rule "First-in First-out" i.e., new stocks should be moved to the rear.

Appendix 6: Protective Clothing and Cleaning Equipment

(Seventh Schedule of the PTS Regulations)

A. Any person involved in the manufacture and formulation of pesticides or toxic substances must ensure that the following protective clothing is available to the employees:

(i) Acid resistant or chemical resistant overalls or dust coats with buttons to the neck;
(ii) Acid resistant or chemical resistant trousers and coat or suit;
(iii) PVC gloves;
(iv) PVC aprons;
(v) rubber boots;
(vi) Respirator canisters with filters specific for dusts, mists, fumes, gases and vapour; and
(vii) Face shields covering eyes and face.

When self-contained breathing apparatus is to be used, only persons properly trained and experienced in the correct procedure should be allowed to use them.

B. To clean-up spills, the following should be available:

(i) Absorbent material(saw dust, sand, earth or powdered lime);
(ii) Washing detergent;
(iii) Brooms;
(iv) Shovels, spades; and
(v) Funnels.

Appendix 7: Disposal Options

(Eighth Schedule of the PTS Regulations)

Pesticides and toxic substances wastes, those which are expired, spillage and leftover diluted product and packaging material can be disposed of in the following manner:

1. *Product Use By Recycling*

If an alternative use exists the product may be re- used or may be reformulated for the purpose for which it is included to be used.

2. *High Temperature Incineration (High Temperature Thermal Oxidation)*

Should be considered when disposing of most pesticides and toxic substances, but should NOT be used when disposing:-
(a) Inorganic materials; and
(b) Organic products containing heavy metals such as mercury and lead.

3. *Chemical Treatments*

To be used as a disposal technology for a few specific unformulated pesticides and some other toxic substances. The products of decomposition from such treatment should not present toxic or environmental hazard.

4. *Long Term Storage*

Certain compounds cannot be disposed of safely using existing technology. Such compounds include those containing heavy metals and in particular, organo-mercury compounds. The only available option is to contain and store these products safely until a suitably acceptable disposal technology is developed. A full risk analysis should be made for all materials stored to ensure maximum safety over the longest foreseeable period of time.

5. *Landfill (For Incinerator Ash and Slag Only)*

Landfilling is not an acceptable disposal option for pesticides and toxic wastes which can be leached.

Incinerator ash and slag can be disposed of at approved landfill sites.

6. *Waste Solidification/Fixation*

The process involves the mixing of chemical and other waste with building materials such as cement, silicates and polymers, causing the mixtures to solidify into an impervious mass. Waste treated in this way can be disposed of at a landfill. This should be applicable to inorganic wastes. Organic wastes could easily leach into ground water with time, and should therefore not be used in disposing organic pesticides or toxic substances.

7. *Packaging Materials Disposal*

Contaminated packaging material shall be disposed as follows:

(a) *Contaminated Packaging Material*
Cartons, boxes and bags should be cut and rendered non-usable. The waste should be over-packed inplastic bags to minimise the risk of exposure during handling. Disposal of these should be carried out byeither:-

- Burning in a simple incinerator, or on a hot fire in isolated area downwind of the nearest habitation; and
- Burial in an approved landfill.

(b) *Small Packs*
Small packaging shall be drained well to reduce residues to a minimum by triple-rinsing with water or anappropriate solvent such as diesel fuel. The triple rinsed packaging material should be made unusable byshredding or crushing. Combustible packaging material should be incinerated as described in 8 (2a).

Non-combustible crushed containers should be buried in a landfill site.Small packs which cannot be or have not been triple rinsed should be over-packed in strong polyethylenebags or preferably 200 litre steel drums for disposal as toxic wastes.

(c) *Large Containers*
Effort must be made to drain the maximum amount of residue from each container prior to triple rinsingwith water or a suitable solvent and disposed as follows:

(i) *Steel Drums*
Triple - rinsed and drained drums should be crushed, to render them unusable and disposed of by either:

- STEEL SMELTING - This is the preferred option. Where the drums are processed at hightemperature for metal recovery.
- BURIAL-Burial in an approved landfill site at least one metre below ground level.

(ii) *Plastic Drums*
After triple rinsing, plastic drums must be punctured and shredded to avoid any form of reuse and packedfor disposal by burial at approved landfill sites. Large quantities of plastic wastes must not be burnedexcept in approved incinerators with flue-gas scrubbing facilities.

8. *Export*
Where no "safe disposal" facilities exist in Zambia, export of pesticide and toxic wastes to anothercountry with facilities can be done.

9. *Return To Manufacturer*
Where a manufacturer is willing to accept pesticides or toxic substances wastesor expired obsolete stocks, this will be accepted as a disposal option.

Appendix 8: Instructions for cleaning up spills and leaked pesticides

1. First read the instructions on the product label or material safety data sheet.
2. All unauthorized persons should be kept away from the contaminated area.
3. The store should be ventilated immediately as much as possible.
4. Work in teams of at least two people. All persons involved should wear appropriate protective clothing. Eyewash, water and soap should be kept at hand.
5. In case of leakage: put the leaking drum into another drum, or pump its content into another drum. As a very temporary "first aid" measure, it is often possible to stop leakage by rolling the drum in such a position that the leak is on top.
6. Absorb the leaked product with absorbent material (sand, sawdust, earth, lime or spill-control material), sweep up and pack the material. Lay a ring (small dike) of absorbent material around the contaminated area. Wet the area with a detergent solution (e.g., 10 percent saturated sodium carbonate solution or 5 percent caustic soda solution), scrub the floor and then sweep the solution into the ring of absorbent material. Remove the material after all liquid has been absorbed. Repeat if necessary. Clean equipment with detergent solution.
7. Contaminated soft surfaces of earth, sand or gravel should be excavated, packed and labelled. Contaminated absorbent materials and soil should be regarded as hazardous waste and should be carefully packed and properly labelled for disposal or temporary storage until disposal can take place.

Appendix 9: Banned pesticides under SAN, EPA, EU, POPs, PIC and PAN

(Source: Sustainable Agriculture Network, Prohibited Pesticide List (September 2009, www.sanstandards.org)

Active Ingredient	EPA [2]	European Union [3]	POP [4]	PIC [5]	PAN [6] Dirty Dozen	*SAN Regulatory Status*
1. 1,2-dibromoethane (ethylene dibromide)	X	X		X	X	Prohibited since November 2005
2. 1,2-dichloroethane (ethylene dichloride)	X	X		X		Prohibited since November 2005

1. 39 of the Annex' I List 1 substances, which were included in the July 2008 version of SAN Prohibited Pesticide List are no longer included.
2. U.S. List of "Banned" or "Severely Restricted" Pesticides and U.N. PIC Pesticides
3. Pesticides banned or severely restricted in EU as a consequence of the application of Directive 79/117/EEC, Council Regulation 805/2004/EC and Directive 91/414/EEC
4. Stockholm Convention on Persistent Organic Pollutants
5. Rotterdam Convention on Prior Informed Consent
6. Pesticide Action Network (see attached table below)

Active Ingredient	EPA	European Union	POP	PIC	PAN Dirty Dozen	*SAN Regulatory Status*
3. 2,3,4,5-bis(2-butylene) tetrahydro-2-furaldehyde [repellent-11]	X					Prohibited since November 2005
4. 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) and its salts and esters (dioxin contamination)	X	X		X	X	Prohibited since November 2005
5. 2,4,5-TCP (potassium 2,4,5-trichlorophenate)	X					Prohibited since November 2005
6. acephate		X				Prohibited since November 2005
7. alachlor		X				3-year phase-out (limit June 30, 2011)
8. aldicarb					X	Prohibited since November 2005
9. aldrin	X	X	X	X	X	Prohibited since November 2005
10. alpha HCH (alpha-hexachlorocyclohexane)			X			3-year phase-out **(limit June 30, 2012)**
11. amitraz		X				Prohibited since November 2005
12. arsenic compounds (EPA: arsenic trioxide; calcium, copper, lead and sodium arsenate; sodium arsenite)	X	X				Prohibited since November 2005
13. atrazine		X				Prohibited since November 2005
14. beta HCH (beta-hexachlorocyclohexane)			X			3-year phase-out **(limit June 30, 2012)**
15. binapacryl	X	X		X		Prohibited since November 2005
16. bromoxynil	X					Prohibited since November 2005
17. butylate	X					Prohibited since November 2005
18. cadmium and its compounds	X					Prohibited since November 2005
19. cadusafos (ebufos)		X				3-year phase-out (limit June 30, 2011)
20. captafol	X (granu-lar only)	X		X		Prohibited since November 2005
21. carbaryl		X				3-year phase-out (limit June 30, 2011)
22. carbofuran	X	X				3-year phase-out (limit June 30, 2011) for formulations other than granular ones (already Prohibited since November 2005)
23. carbon tetrachloride	X					Prohibited since November 2005
24. carbosulfan		X				3-year phase-out (limit June 30, 2011)
25. chloranil	X					Prohibited since November 2005
26. chlordane	X	X	X	X	X	Prohibited since November 2005
27. chlordecone (kepone)	X	X	X			Prohibited since

7.

Active Ingredient	EPA	European Union	POP	PIC	PAN Dirty Dozen	*SAN Regulatory Status*
						November 2005
28. chlordimeform	X	X		X	X	Prohibited since November 2005
29. chlorfenapyr		X				Prohibited since November 2005
30. chlorobenzilate	X	X		X	X	Prohibited since November 2005
31. chloromethoxypropyl-mercuric-acetate (CPMA)	X					Prohibited since November 2005
32. chlozolinate		X				Prohibited since November 2005
33. cyhalothrine *(but not lambda isomers of cyhalothrin)*		X				Prohibited since November 2005
34. daminozide (alar)	X					Prohibited since November 2005
35. DBCP	X				X	Prohibited since November 2005
36. DDT	X	X	X	X	X	Prohibited since November 2005
37. dicofol containing less than 78% p,p'-Dicofol or >1 g/kg of DDT and DDT related compounds		X				Prohibited since November 2005
38. dieldrin	X	X	X	X	X	Prohibited since November 2005
39. dimethenamid		X				3-year phase-out (limit June 30, 2011)
40. dinoseb, its acetate and dinoseb salts	X	X		X		Prohibited since November 2005
41. dinoterb		X				Prohibited since November 2005
42. di (phenylmercury) dodecenylsuccinate (PMDS)	X					Prohibited since November 2005
43. DNOC (dinitro-ortho-cresol) and its salts (ammonium, potassium, sodium)	X	X		X	X	Prohibited since November 2005
44. Dustable powder formulations containing a combination of: benomyl ≥ 7%, carbofuran ≥ 10%, thiram ≥ 5% *(PIC: 15%)*		X		X		Prohibited since November 2005
45. endosulfan	X	X				3-year phase-out (limit June 30, 2011)
46. endrin	X	X	X		X	Prohibited since November 2005
47. EPN	X					Prohibited since November 2005
48. ethylene oxide (oxirane)	X	X		X		Prohibited since November 2005
49. ethyl hexyleneglycol	X					Prohibited since November 2005
50. fenthion		X				Prohibited since November 2005
51. fentin acetate		X				Prohibited since November 2005
52. fentin hydroxide		X				Prohibited since November 2005
53. fenvalerate		X				Prohibited since November 2005
54. ferbam		X				Prohibited since November 2005

Active Ingredient	EPA	European Union	POP	PIC	PAN Dirty Dozen	*SAN Regulatory Status*
55. fluoroacetamide	X	X		X		Prohibited since November 2005
56. haloxyfop-R (haloxyfop-P-methyl-ester)		X				3-year phase-out (limit June 30, 2011)
57. HCH mixed isomers (containing less than 99.0% of the gamma isomer)		X		X	X	Prohibited since November 2005
58. heptachlor	X	X	X	X	X	Prohibited since November 2005
59. hexachlorobenzene (HCB)	X	X	X	X	X	Prohibited since November 2005
60. leptophos	X					Prohibited since November 2005
61. lindane (gamma-HCH)	X	X		X	X	Prohibited since November 2005
62. malathion		X				Prohibited since November 2005
63. maleic hydrazide and its salts, other than choline, potassium and sodium salts; choline, potassium and sodium salts; maleic hydrazide containing more than 1 mg/kg of free hydrazine expressed on the basis of the acid equivalent		X				Prohibited since November 2005
64. Mercury and its compounds (including mercuric oxide, mercurous chloride (calomel), phenylmercury acetate (PMA), phenylmercuric oleate (PMO) other inorganic mercury compounds: alkyl mercury, alkoxyalkyl and aryl mercury compounds)	X	X		X		Prohibited since November 2005
65. methamidophos	X (600 g/l (SL) formu-lation and higher)	X		X (600 g/l (SL) formu-lation and higher)		Prohibited since November 2005
66. methyl parathion (parathion methyl)	X	X		X	X	Prohibited since November 2005
67. mevinphos	X					Prohibited since November 2005
68. mirex	X	X	X			Prohibited since November 2005
69. monocrotophos	X	X		X		Prohibited since November 2005
70. monolinuron		X				Prohibited since November 2005
71. monuron		X				Prohibited since November 2005
72. nitrofen	X	X				Prohibited since November 2005
73. nonylphenol ethoxylates		X				3-year phase-out (limit June 30, 2011)
74. OMPA (octamethylpyrophosphoramide)	X					Prohibited since November 2005

Active Ingredient	EPA	European Union	POP	PIC	PAN Dirty Dozen	*SAN Regulatory Status*
75. oxydemeton-methyl		X				3-year phase-out (limit June 30, 2011)
76. paraquat					X	Prohibited since November 2005
77. parathion	X	X		X	X	Prohibited since November 2005
78. pentachlorobenzene			X			3-year phase-out **(limit June 30, 2012)**
79. pentachlorophenol (PCP) and its salts and esters	X	X		X	X	Prohibited since November 2005
80. permethrin		X				Prohibited since November 2005
81. phosalone		X				3-year phase-out (limit June 30, 2011)
82. phosphamidon	X (≥ 1000 g/l (SL) formu-lation)	X		X (≥ 1000 g/l (SL) formu-lation)		Prohibited since November 2005
83. polychlorinated biphenyls PCB (except mono-and dichlorinated)			X			Prohibited since November 2005
84. propham		X				Prohibited since November 2005
85. pyrazophos		X				Prohibited since November 2005
86. pyriminil (vacor)	X					Prohibited since November 2005
87. quintozene		X				Prohibited since November 2005
88. safrole	X					Prohibited since November 2005
89. silvex	X					Prohibited since November 2005
90. simazine		X				Prohibited since November 2005
91. TDE	X					Prohibited since November 2005
92. technazene		X				Prohibited since November 2005
93. terpene polychlorinates (strobane)	X					Prohibited since November 2005
94. thallium sulphate	X	X				Prohibited since November 2005
95. thiodicarb		X				3-year phase-out (limit June 30, 2011)
96. toxaphene (camphechlor)	X	X	X	X	X	Prohibited since November 2005
97. triazophos		X				3-year phase-out (limit June 30, 2011)
98. trichlorfon		X				3-year phase-out (limit June 30, 2011)
99. triorganostannic compounds (tributyltin compounds)	X	X				Prohibited since November 2005
100. vinyl chloride	X					Prohibited since November 2005
101. zineb		X				Prohibited since November 2005

Appendix 10: List of People Interviewed

1. Mr. Moses Mwale, Director, ZARI Chilanga
2. Mr. Wilson Phiri, Procurement Specialist, ZARI Chilanga
3. Mr. Rasphord Simwinga, Accountant, ZARI Chilanga
4. Mr. Kennedy Muimui, Bean Breeder, ZARI Kasama
5. Mr. Chrisantus Mutale, Rice Agronomist, ZARI Mongu
6. Mr. Kannedy Kanenga, Groundnut Breeder, ZARI Chipata
7. Mr. Kabamba Mwansa, Maize Breeder, ZARI Golden Valley
8. Mr. Godfrey Mwila, Plant Genetic Resources, ZARI Chilanga
9. Mr. Lloyd Nbulwe, Sorghum Breeder, ZARI Golden Valley
10. Mr. Laston Milambo, Soybean Breeder, ZARI Chilanga
11. Mr. Davy Simumba, Monitoring and Evaluation Specialist, ZARI Chilanga
12. Mr. Fred Muyano, Zambia Environmental Management Agency