



E4134

REPUBLIC OF ZAMBIA  
MINISTRY OF MINES, ENERGY AND WATER DEVELOPMENT

*Water Resources Development Project*

*PEST MANAGEMENT PLAN*

*Final Report*

Department of Water Affairs,  
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February 2013

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## Table of Contents

1	List of Tables .....	iii
2	Acronyms .....	iv
3	Background .....	1
3.1	Project Description .....	1
3.2	Purpose of Pest Management Plan .....	3
3.3	Principles and Objectives of the PMP .....	3
3.4	Context for the WRDP PMP .....	3
4	Pesticide Use .....	4
4.1	General Considerations.....	4
4.2	Pesticides used by Various Institutions and Agricultural Projects in Zambia .....	4

# 1 LIST OF TABLES

Table 1: Pesticides recommended and used in Agricultural Projects and by Different Institutions

Table 2: Pesticides Phased out, Banned or Restricted

Table 3: Crops Grown in Ecological Zones

Table 4: Pest and Recommended Control Methods for Maize

Table 5: Pest and Recommended Control Methods for Cassava

Table 6: Pest and Recommended Control Methods for Ground Nuts

Table 7: Pest and Recommended Control Methods for Common Beans

Table 8: Pest and Recommended Control Methods for Cotton

Table 9: Pest and Recommended Control Methods for Sweet Potatoes

Table 10: Pest and Recommended Control Methods for Soya beans

Table 11: Pest and Recommended Control Methods for Sunflower

Table 12: Pest and Recommended Control Methods for Tobacco

Table 13: Pest and Recommended Control Methods for Millet

Table 14: Pest and Recommended Control Methods for Sorghum

Table 15: Pest and Recommended Control Methods for Cowpeas

Table 16: Pest and Recommended Control Methods for Cabbage

Table 17: Pest and Recommended Control Methods for Rape

Table 18: Pest and Recommended Control Methods for Tomatoes and egg Plant

Table 19: Pest and Recommended Control Methods for Onion

Table 20: Pest and Recommended Control Methods for Okra

Table 21: Pest and Recommended Control Methods for Paprika and Chilli

Table 22: Pest and Recommended Control Methods for Carrot

Table 23: Pest and Recommended Control Methods for Bananas

Table 24: Pest and Recommended Control Methods for Mango

Table 25: Pest and Recommended Control Methods for Coffee

Table 26: Pest and Recommended Control Methods for Citrus

Table 27: Pest and Recommended Control Methods for Irish Potatoes

Table 28: Pest and Recommended Control Methods for Jatropa

Table 29: Pest and Recommended Control Methods for Cashew

Table 30: Pest and Recommended Control Methods for Huss Avocado

Table 31: Pest and Recommended Control Methods for Mushrooms

Table 32: Pest and Recommended Control Methods for Bees

Table 33: Pest and Recommended Control Methods for Beef Cattle

Table 34: Pest and Recommended Control Methods for Dairy Cattle

Table 35: Pest and Recommended Control Methods for Poultry

Table 36: Pest and Recommended Control Methods for Tilapia

Table 37: Pest and Recommended Control Methods for Organically Grown Tomato

Table 38: Pest and Recommended Control Methods for Organically Grown Onion

## 2 ACRONYMS

AFB	American Foul Brood
BBT	Banana Bunchy Top Virus
BCMV	Bean Common Mosaic Virus
BT	Bacillus Thuringiensis
CBB	Cassava Bacterial Bright
CBD	Coffee berry disease
CMV	Cassava mosaic Virus
ECZ	Environmental Council of Zambia
EFB	European Foul Brood
ESMF	Environmental and Social Management Framework
FAO	Food Agriculture Organisation of the United Nations
GLS	Grey Leaf Spot
GRZ	Government of the Republic of Zambia
IDA	International Development Association
IFOAM	International Federation of Organic Agriculture Movements
IPM	Integrated Pest Management
MMEWD	Ministry of Mines, Energy and Water Development
MSV	Maize Steak Virus
OP 4.09	Operational Policy of World Bank on Pest Management
PMP	Pest Management Plan
POP	Persistent Organic Pollutants
WHO	World Health Organisation
WRDP	Water Resources Development Project
ZARI	Zambia Agricultural Research Institute
ZNFU	Zambia National Farmers Union

### 3 Background

The Government of the Republic of Zambia (GRZ) through the Ministry of Mines, Energy and Water Development (MMEWD) is preparing the Water Resources Development Project with the support from the International Development Association (IDA) of the World Bank.

The Project development objective is to support the implementation of an integrated framework for development and management of water resources in Zambia. The Project Beneficiaries are targeted rural communities who will benefit from improved small scale water resources infrastructure. Benefits will also accrue in key river basins to water users and improvements aggregated as the national level through allocation of water and rights. Construction/rehabilitation of some 100 small dams is estimated to have 1,000,000 direct and indirect beneficiaries over the next decade. It is estimated that direct investments in rehabilitation and multi-purpose upgrading of a dam affects some 10,000 beneficiaries. The PDO Level Results Indicators are:

- (a) Improved accuracy of hydrological forecasts;
- (b) Water storage established in rural communities;
- (c) Water resources infrastructure investments under preparation; and,
- (d) Water permits monitored for compliance.

#### 3.1 Project Description

The WRDP will be implemented under the following three components:

##### **Component A: Water Resources Management (IDA contribution US\$8m)**

The objective of this component is to enhance capacity at the national and regional level to address the challenges of water resources management in Zambia. The component will provide support to: (a) building capacity to manage the hydro-meteorological and groundwater monitoring networks; (b) strengthening the hydro-meteorological and groundwater information management systems and functions ; (c) integrating spatial and remotely sensed data into decision making; (d) preparation of consolidated basin-level water resources development plans and strategic assessments, including groundwater; and, (e) implementing a series of comprehensive water allocation, licensing, revenue and compliance monitoring measures. These activities will be supported through the provision of: i) consultants services and technical assistance; ii) goods and equipment, including hydro-climatic and water quality equipment, bulk meters, computers, vehicles and office equipment; iii) works to establish

hydro-meteorological stations; and, iv) carrying out of training and capacity building activities to the sector.

### **Component B: Water Resources Development** (IDA contribution US\$30m)

The objective of this component is to address the infrastructure deficit through support to: (a) development and rehabilitation of small scale water resources infrastructure, such as small dams, weirs, gabions, and other small civil works intended to retain water, reduce erosion, enhance recharge and ensure productive application; (b) updating and climate screening the 1995 Dam Development Master Plan to identify a series of priority investments for further preparation; (c) preparation of studies in support of a proposed pipeline of future medium and large scale water resource investments; (d) supporting environmental and social assessments for future potential water resource investments; and, (e) measures approved under the groundwater development program. This will be supported through the provision of: i) consulting services and technical assistance for the detailed design of water resources infrastructure, along with the preparation of environmental and social safeguards instruments; ii) works required for construction of infrastructure; iii) goods needed to support implementation and, iv) operating expenses associated with workshops, training, community mobilization and capacity enhancement initiatives.

### **Component C: Institutional Support** (IDA contribution US\$12m)

The objective of this component is to strengthen the institutional capacity for water resources management and development, including both surface and ground water. The component will provide support to: (a) operationalizing the provisions of the Water Resources Management Act; (b) strengthening the institutional capacity to develop strategies and studies to ensure the sustainable and equitable development of water resources; (c) increasing the capacity for negotiations, monitoring and compliance with international waters instruments; (d) enhancing inter-agency coordination; and (e) overall project management, including fiduciary responsibilities, financial and technical audits, and safeguard management. These activities will be supported through the provision of: i) consultants services and technical assistance; ii) goods and equipment, including computers, vehicles and office equipment; iii) training and capacity building activities; and, iv) incremental operating costs to support the National Water Management Authority and departments within the Ministry associated with institutional transition.

The Water Resources Development Project is classified as an environmental assessment (EA) category B – partial assessment. The project triggers the following environmental and legal safeguards policies: OP/BP 4.01 (Environmental Assessment), OP/BP 4.09 (Pest Management), OP/BP 4.11 (Physical Cultural Resources), OP/BP 4.37 (Dam Safety), and OP/BP 7.50 (Projects on International Waterways). An Environmental and Social Management Framework which provides a common framework to screen all potential investments in order to assess any potentially negative environmental or social issues has been prepared for the project. This PMP is being prepared alongside the ESMF as one of the safeguards instruments for the project.

### **3.2 Purpose of Pest Management Plan**

The project is preparing this Pest Management Plan (PMP) to meet the requirements of OP/BP 4.09 which has been triggered.

The purpose of this Pest Management Plan is to provide guidance for the management of major crops that are grown under project area in the three ecological zones. Each major crop is considered for the pest management practices that are used to control the pests affecting it. The PMP will contribute to improved pest management, personal safety and environmental sustainability. A preferred solution is to use Integrated Pest Management (IPM) techniques and encourage their use in the whole of the sector concerned.

Under Pest Management OP4.09, the Bank uses various means to assess pest management in the country and support IPM and the safe use of agricultural pesticides. In Bank-financed agriculture operations, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The Bank may finance the purchase of pesticides when their use is justified under an IPM approach.

### **3.3 Principles and Objectives of the PMP**

As the WRDP has triggered the Pest Management Safeguard Policy, OP 4.09, the Government of the Republic of Zambia, is required to prepare a Pest Management Plan for the Project. The objective for preparing the PMP is to minimize potential adverse impacts on human health and the environment and to advance ecologically based integrated pest management (IPM).

### **3.4 Context for the WRDP PMP**

The WRDP will not procure any pesticides or agro-chemicals, but given that it will be financing small dams less than 10 meters high, it is possible that the Government and or communities might use pesticides within their existing production systems. The project would promote use of integrated pest management and the safe use, storage, and disposal of agro-chemicals as appropriate. This PMP is prepared for purposes of providing guidance on pesticide use to project beneficiaries as/when such need arises during project implementation.



## 4 PESTICIDE USE

### 4.1 General Considerations

A variety of pesticides are available on the market, however, some pesticides are not supposed to be accessed because they are either classified Ia (***Extremely hazardous***) and Ib (***Highly hazardous***), phased out or restricted on the WHO listing. This plan lists all the pesticides being used in Zambia indicating those that are either phased out, restricted or banned. Further, pesticide application per crop per pest is also listed under section 3.

### 4.2 Pesticides used by Various Institutions and Agricultural Projects in Zambia

Various institutions and agricultural project beneficiaries use a variety of pesticides as reflected in the table (1) below. The catalogue below details a wide range of crops grown in Zambia and the corresponding pesticide/agrochemical used as these crops are integral to the farming systems and pest management regime in the country. The catalogue also includes the hazard classification by World Health Organization (WHO).

**Table 1: Pesticides recommended and used in Agricultural Projects and by different Institutions** <sup>1 2 3 4 5 6</sup>

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	Ethiophen	Ethiophenc	II	Cabbage	Aphids	

<sup>1</sup> Crop Protection Handbook 2009 MEISTER PRO

<sup>2</sup> THE WHO RECOMMENDED CLASSIFICATION OF PESTICIDES BY HAZARD *and* GUIDELINES TO CLASSIFICATION 2009

<sup>3</sup> Major crop Diseases Manual of Zambia

<sup>4</sup> Zambia Seed Technology Handbook

<sup>5</sup> Agricultural Field insect Pest of Zambia and Their Management

<sup>6</sup> 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
			carb	arb				
		5	Methomyl	Methomex 90SP	Ib	Pearl Millet, sorghum,	Bollworm	
		6	Pirimicarb	Primor	II	Cotton, Cabbage, Rape, Okra, Pumpkin	Sucking, Aphids, Turnip Mosaic Virus,	
3	Cyfluthrin organochlorine	7	Endosulfan	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 environmental persistent, Endosulfan has been Nominated by the EU for a global ban

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops	Main insects Controlled	Official Use status	
								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,	II	Cabb	Whitefly, Black beetles, Cutworm,	

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
				s,	Chlorpyrifos,		age, Tomato, Rice, Soybean, Cowpeas, Irish Potato, mushroom	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, tilapi	Tomato moth, parasites	Banned or restricted in other countries

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
							a fish		
		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
		23		Quinalpos	kinalux	II	Cowpeas	Bean Fly	
		24		Malathion	Malathion	III	Tomato Soybean	Tomato moth, Epilachna beetle	

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
							an		
		25		Mercaptotion, Malathion		III	Soybean, mushroom,	Aphids, <i>Phorid fly</i> ( <i>Megaselia</i> ) <i>Sciarid fly</i> ( <i>Lycoriella</i> ), 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	

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
							n		
		30		Terbufos	Hunter	Ia	Groundnut	Groundnut Thrips	Banned or restricted in other countries
		31		Triazophos	Hostathion	Ib	Cotton	Sucking	
		32		Trichlorophos	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	
8	Pyrethroid	35		Alpha cypermethrin	Fastac	II	Cotton, Cabbage, Rape,	Bollworms, Diamond back moth, Aphids, Bugrada bugs, Thrips, Red Cotton Bugs, White fly, Leaf Eating Beetles, Bollworm, Armoured Cricket, Pod moth, Tsetse fly	



Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
							Tomato, Onion, Okra, Hot Pepper, Pumpkins, Pearl Millet, Soybean, Cowpeas, Cattle		
		36		Cypermethrin	Cyrux, Ripcord,	II	Cotton, Cabb	Bollworms, Diamond back moth, white fly, Tomato Moth, Spotted stem borer, African Pink Stem Borer,	

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
							age, Rape, Tomato, Rice, Soybean, Cowpeas, mushroom	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		Fenvalerat	Fenkil	II	Cotto	Bollworms, flies. <i>Phorid fly</i> (	

Insecticide									
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops		Main insects Controlled	Official Use status
				e			n, mushroom	Megaselia) <i>Sciarid fly</i> (Lycoriella) 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, Pumpkin	Bollworms, Diamond back moth, Harlequin bugs, Aphids, Bugrada bugs, Leaf Eating beetles	

Insecticide								
Group #	Chemical Group	Item #	Insecticide Name	Trade Name	WHO Classification	Crops	Main insects Controlled	Official Use status
							pkins , paprika	
9	Tetranortriterpenoid/Insect growth regulator	45		Azadractin	neem extract	IV	Cabbage, Rape, poultry	Diamond back moth , Aphids,, mites, ticks lice

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
1	Aryloxyphenoxypionates	1	Fluazifop-p	Fulsilade Supper	III	Cotton	Butyl grass	
		2	Propaquizafop	Agil-100EC	Unlikely to present acute hazard in normal use	Cotton	Annual/Perennial (A/P)	

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
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	Bipyridylum	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	

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
5	Chloro-carbonic acid	8	Dalapon	Gramevin 85% w.p	Unlikely to present acute hazard in normal use	Tree crops, Lucerne	Most annual and perennial grasses	
				Dalapon 80% w.p.				
6	Dinitroaniline	9	Trifluralin	Treflan E.C (478g/l)	Unlikely to present acute hazard in normal use.	Cotton, Groundnuts, Soybeans, Sunflower, Some vegetables	Most annual grasses and some broadleaf weeds	
		10	Pendimethalin	Prowl	III	Cotton	Annual Grasses	
7	Glycines	11	Glyphosate	Glyphosate 60 Cypat	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),	III	Maize, Wheat, Sorghum	Most Broadleaf weeds	Highly suspected to be an endocrine

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
				Weedkiller D (48% 2, 4-D ester), 2, 4-D Amine (72%), Shellamine (72% 2, 4-D Amine)				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 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.	Unlikely to present acute hazard in normal use	Maize, Sorghum	Most germinating broadleaf and grass weeds	
				Gesaprim 50% w.p.				

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
				19Gesaprim 10% granules				
		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	sorghum	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
					in normal use			
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 annual 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			
Fungicides								
Group #	Chemical Group	Item #	Fungicide Name	Trade Name	WHO Classification	Crops	Main insects Controlled	Official Use status

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds 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	

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
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	Dimethyl dithiocarbamate	10	Thiram	Thiram 80 WP	III	Cabbage	Black rot	
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	
10	Inorganic	12	Copper Ox chloride	Copper Ox chloride	II			

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds Controlled	Official Use status
							Scab	
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	Alternaria	
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,	

Herbicides								
Group #	Chemical Group	Item #	Chemical Name	Trade Name	WHO Classification	Crops	Main Weeds 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	Triphenyltin	19	Triphenyltin Acetate	Brestan,	II	Soybeans	Red leaf blotch	

**Table 2: Pesticides Phased out, Banned, or Restricted**

BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA									
	Chemical Group	INSECTICIDES							
Group #		Item #	Insecticide Name	Trade Name	Oral LD <sub>50</sub> 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

BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA

Chemical Group		INSECTICIDES							
Group #		Item #	Insecticide Name	Trade Name	Oral LD <sub>50</sub> mg/kg	WHO Classification	Crops	Main insects Controlled	Official Use status
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	Banned or restricted in other countries. Possible alternatives are Malathion,

BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA

Chemical Group		INSECTICIDES							
Group #		Item #	Insecticide Name	Trade Name	Oral LD <sub>50</sub> mg/kg	WHO Classification	Crops	Main insects Controlled	Official Use status
								beetle, Spotted stem borer, Groundnut Caterpillar leaf minor	Chlorophypos , Dimethoate, Fenitrothion, Diazinon Azamethiphos ;
		5	Phorate	Umet	2-4	Ia	Groundnut	Groundnut Thrips	Banned or restricted in 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

BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA									
Chemical Group		INSECTICIDES							
Group #		Item #	Insecticide Name	Trade Name	Oral LD <sub>50</sub> mg/kg	WHO Classification	Crops	Main insects Controlled	Official Use status
									for use

BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA								
Herbicides								
	Chemical Group	Chemical Name	Trade Name	Oral LD <sub>50</sub> 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



BANNED , RESTRICTED OR NO LONGER IN USE PESTICIDES THAT ARE STILL IN RECOMMENDATION IN ZAMBIA								
								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

**Table 3: Crops grown in Ecological Zones**

Ecological	Province	Major crops		
		Staples	Cash Crop	Fruit and Vegetables
Zone1 (300 to 900 metres above seas level)	Southern,(Gwembe) Eastern (Luangwa) Central (Lunsemfwa ) Southern part of Western Provinces,	Sorghum Rice Maize Millet Beans Cassava Pumpkins	Cotton Rice	Tomatoes Brassicas Cabbage and Rape Mangoes
Zone 2 (900 to 1300 metres above sea level)	Plateau areas of Eastern, Lusaka, Southern, Western (Flood Plains)	Sorghum Rice Maize Millet Beans Cassava Sweet potato Pumpkins	Coffee Groundnuts Sunflower Wheat Cotton Cassava Carrots Tobacco	Water melons Onions Brassicas (cabbage, Rape) Irish Potatoes Tomatoes Mangoes
Zone 3 (1100 to 1700 metres above seas level)	Northern, Luapula, North-Western, Copperbelt (part of Serenje and Mkushi)	Rice Maize Millet Beans Cassava Sweet potato Pumpkins	Cassava Maize Groundnuts Beans Coffee Sweet Potato Paprika	Pineapples Citrus fruits Onions Brassicas (cabbage, Rape) Irish Potato Tomato Mangoes

The pest control tables below include pest control measures for crops that have a high economic value in Zambian agriculture and are most likely to be considered by WRDP beneficiaries as well as pest control measures for livestock, fisheries and honey production sub sectors.

**Table 4: Pests and Recommended Control Methods for Maize**

Anticipated Pests		Recommended Management Measures
Insects	Stalk borers, Busseola fusca ,Chilo partellus ,Sesamia calamistis	Cultural control <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Time of planting and destruction of crop residues</li> <li>• Intercropping               <ul style="list-style-type: none"> <li>• Biological control</li> </ul> </li> </ul> Chemical control Apply recommended insecticides
	Leaf hoppers transmitting MSV	Cultural control <ul style="list-style-type: none"> <li>• Timely planting to avoid the diseases</li> <li>• Plant recommended tolerant varieties</li> </ul>
	Termites Macrotermes spp Microtermes spp	Cultural control <ul style="list-style-type: none"> <li>• Early harvesting after maturity</li> <li>• Cleaning and burning of crop residue</li> <li>• Crop rotation with less susceptible crops like cotton , millet and sorghum</li> </ul> Chemical control Permethrin, Confidor, Coopex T.C Dursban
	Storage pests Weevil ( <i>Sitophilus</i> spp.) Larger grain borer ( <i>Prostephums</i> <i>truncates</i> )	Cultural control <ul style="list-style-type: none"> <li>• Dehusk and thresh after a harvest</li> <li>• Ensure grain in properly dried, cleaned before storage</li> </ul> Chemical control Dust with recommended insecticide
Diseases	Grey leaf spot GLS	Cultural control <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Deep plough of crop residues</li> <li>• Breeding of resistant varieties</li> <li>• Clean seeds</li> </ul>
	Maize streak virus MSV trans mitted by <i>Cicadulina</i> spp	
	Cob rots caused by	

Anticipated Pests		Recommended Management Measures
	<i>Fasarium</i> and <i>Diplodia spp</i>	<ul style="list-style-type: none"> <li>• Cultural practices, e.g. timely sowing, field hygiene (feeding crop residues to livestock)</li> <li>• Stubble tillage and removal of crop residues</li> <li>• Timely planting of recommended varieties</li> </ul>
	Leaf bright caused by heminthosporium turcium	
	Rusts caused by Puccinia sorghi and P.polysora	

**Cassava** (*Manihot esculenta* Grantz.)

Cassava has the second highest hectarage in the country to that of maize, smaller holder growers are adapting cassava because it is less demanding in inputs and management practices. It's also relatively drought tolerant that makes it provide more food security.

**Table 5: Pest and Control Methods for Cassava**

Anticipated Pests		Recommended Management Measures
Insects	Cassava mealy bug	<p>Biological control</p> <ul style="list-style-type: none"> <li>• with a parasitic wasp <i>Apoanagyrus lopezi</i></li> <li>• Use clean cutting for planting</li> <li>• Treat cuttings with hot water or dip cuttings for planting in dimethoate</li> <li>• <b>Use resistant or tolerant varieties</b> which are released or recommended by the Root and Tuber Improvement Programme at Research Stations.</li> <li>• <b>Plant cassava early in the rainy season</b> to allow the crop to establish well before the dry season, because a strong plant is more likely to withstand pest invasion <b>Avoid burning cassava plantations</b> at harvest for the burning indiscriminately kills insects including</li> </ul>

Anticipated Pests		Recommended Management Measures
		the natural enemies that have been released to attack the pest.
	Cassava green mite <i>Mononychellus tanajoa</i> sensu lato	Biological control phytoseiid <i>Typhlodromalus aripo</i> Cultural control <ul style="list-style-type: none"> <li>Resistant varieties</li> <li>Early planting</li> <li>Use of tar /petroleum and summer oils</li> </ul> Chemical control Dicofol and Endosulfan
Diseases	Cassava mosaic Virus (CMV) trans mitted by whitefly	Cultural control <ul style="list-style-type: none"> <li>Use disease free cuttings</li> <li>Heat treatment of cuttings before planting</li> <li>Burning of diseased plant residues</li> <li>Use of resistant varieties</li> </ul>
	Cassava bacterial bright(CBB)	

**Table 6: Pest and Control Methods for Groundnuts**

Anticipated Pests		Recommended Management Measures
Insects	Groundnut leaf minor ( <i>Stomopteryx nertaria</i> )	Cultural control <ul style="list-style-type: none"> <li>Intercrop with millet, sorghum</li> <li>Crop rotation</li> </ul> Chemical control Monocrotophos
	Brown leaf beetle , <i>Oothecca mutabilis</i>	Cultural control <ul style="list-style-type: none"> <li>Crop rotation</li> <li>intercropping</li> </ul> Chemical control Chlorpyrifos, or Cypermethrin
	Groundnut Hopper, <i>Hilda patruelis</i> (Stal)	Chemical control Hunter and Umet when necessary
	Groundnut Aphids <i>Aphis</i>	Cultural control

Anticipated Pests	Recommended Management Measures
	<p>craccivora (Koch) transmit rosette</p> <ul style="list-style-type: none"> <li>• Early planting</li> <li>• Close spacing</li> </ul> <p>Chemical control Demeton-SO Methyl, Pirimicarb</p>
	<p>Jassids</p> <p>Cultural control</p> <ul style="list-style-type: none"> <li>• Plant resistance</li> <li>• Early planting</li> </ul> <p>Chemical control Monocrotophos, Thiodan, Carbaryl</p>
	<p>Groundnut Thrips</p> <p>Cultural control Early planting</p> <p>Chemical control Cypermethrin, Triazophos, Monocrotophos, Diazinon, Umet and Hunter</p>
	<p>Termites</p> <p>Cultural control</p> <ul style="list-style-type: none"> <li>• Early harvesting after maturity</li> <li>• Cleaning and burning of crop residue</li> <li>• Crop rotation with less susceptible crops like cotton , millet and sorghum</li> </ul> <p>Chemical control with Permethrin, Confidor, Coopex T.C Dursban</p>
Disease	<p>Early leaf spot Cercospora arachidicola</p> <p>Late leaf spot Phaeoisariopsis personata</p> <p>Rusts Puccunia</p> <p>Cultural control</p> <ul style="list-style-type: none"> <li>• Burning and burying of infested crop</li> <li>• Four year crop rotation</li> <li>• Resistant cultivars</li> <li>• Crop rotation</li> <li>• Timing of planting</li> <li>• Intercropping with cereals</li> </ul>
	<p>Arachnids</p> <p>Yellow molds (Aspergillus flavavus)</p> <p>Cultural control</p> <ul style="list-style-type: none"> <li>• Lifting groundnuts in time</li> <li>• Rapid wind row drying to 12%</li> <li>• Storing in dry and free from infested</li> </ul>

Anticipated Pests		Recommended Management Measures
		place <ul style="list-style-type: none"> <li>• Treat seed with benlate prior to planting</li> </ul>
	Rosette	Cultural control <ul style="list-style-type: none"> <li>• Early planting with</li> <li>• optimum plant population</li> </ul> Chemical control of vector with Menazon
Weeds	All weeds	Early removal of all weeds Chemical control of weeds with Trifluran

**Table 7: Pest and Control Methods for Common Beans**

Anticipated Pests		Recommended Management Measures
Insects	Bean Stem maggot <i>Ophiomyia spp</i>	Cultural control <ul style="list-style-type: none"> <li>• Observe recommended time of planting               <ul style="list-style-type: none"> <li>• Crop rotation</li> </ul> </li> <li>• Apply mulch               <ul style="list-style-type: none"> <li>• Resistant varieties</li> </ul> </li> <li>• Apply manure/fertilisers</li> <li>• Practice hilling/earthing up when weeding</li> </ul> Chemical control Seed treatment with Endosulfan
	Leaf beetle	Cultural and sanitary measures <ul style="list-style-type: none"> <li>• Practice good crop rotation</li> <li>• Observe recommended time of planting</li> </ul> Chemical control Fastac
	Aphids	Cultural and sanitary measures <ul style="list-style-type: none"> <li>• Promote build up of indigenous natural enemies</li> </ul>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Observe recommended time of planting</li> <li>• Apply wood ash in case of a heavy attack</li> <li>• Carry our regular crop inspection to detect early</li> </ul> Attacks Chemical control Apply recommended insecticide when necessary
Diseases	Bean Common Mosaic Virus (BCMV)	Cultural control Clean free seed Early planting to avoid peak of vector Aphid Removal and destruction of infested plants Chemical control with dimethoate or other aphicides
	Common Bacterial Blight(CBB)	Cultural control Clean free seed Crop rotation and burning of infested crop debris Chemical control Copper-oxychloride
	Anthracnose Colletotrichum lindermuthianum	Cultural control <ul style="list-style-type: none"> <li>• Crop rotation</li> </ul>
	Angular leaf spot Phaeoisariopsis griseola	<ul style="list-style-type: none"> <li>• Planting disease free seed</li> <li>• Removing and destroying infested crop debris</li> </ul>
	Ascochyta bright <i>Phoma exigua</i>	
	Scab Elsinoe phaseoli	Chemical control
	Rust Uromyces appendiculatus	Benlate or Dithane M-45
Root Rots Phythium Fusarium	Seed treatment with Captasan	

**Table 8: Pest and Control Methods for Cotton**

Anticipated Pests		Recommended Management Measures
Insects	American bollworm (Helicoverpa)	Cultural control



Anticipated Pests	Recommended Management Measures
Armigera)	<ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Scout fields twice per week to monitor pest populations</li> <li>• Use economic thresholds to determine need for treatment</li> <li>• Destroy stalks promptly after harvest to reduce overwintering insect populations,</li> </ul> <p>Biological control parasitoid (<i>Trichogramma</i>)</p> <p>Chemical control Cypermethrin, Fenvalerate, Labda-Cyhalothrin</p>
Red bollworm (Dipropsis Castanea)	<p>Cultural control</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Scout fields twice per week to monitor pest populations</li> <li>• Use economic thresholds to determine need for treatment</li> <li>• Destroy stalks promptly after harvest to reduce overwintering insect populations</li> </ul> <p>Biological control parasitoid (<i>Trichogramma</i> spp)</p> <p>Chemical control with Cypermethrin, Fenvalerate, Labda-Cyhalothrin</p>
Aphid ( <i>Aphis gossypii</i> )	<p>Biological control with natural enemies including Lady bird beetle, Assassin bug Lacewing, Hover fly</p> <p>Chemical control Acetamiprid Curacron, Pirimicarb, Monocrotophos, Dimethioate</p>

Anticipated Pests		Recommended Management Measures
	Jassids Empoasca spp	<p>Cultural control</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Scout fields twice per week to monitor pest populations</li> <li>• Use economic thresholds to determine need for treatment</li> <li>• Destroy stalks promptly after harvest to reduce overwintering insect populations</li> <li>• Resistant varieties</li> </ul> <p>Chemical control with Acetamiprid Curacron, Pirimicarb, Monocrotophos, Dimethoate</p>
	Cotton Stainers	<p>Cultural control</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Scout fields twice per week to monitor pest populations</li> <li>• Use economic thresholds to determine need for treatment</li> <li>• Destroy stalks promptly after harvest to reduce overwintering insect populations</li> </ul> <p>Chemical control with Acetamiprid Curacron, Pirimicarb</p>
Diseases	Verticillium wilt Fusarium wilt/Nematode complex Boll rots Xanthomonas Campestris pv malvacearum Alternaria leaf spot Alternaria macrospore or alternaria tenius Grey Mildew Ramularia areola	<p>Diseases associated with cotton are neither very common nor of great economic significance .Monitor for their presence</p>
Weeds	All weeds	<p>Critical to control in the first 8weeks as plant grows slowly. Hand weeding,</p>

Anticipated Pests		Recommended Management Measures
		mechanical weeding and possibly herbicides for larger fields.

### Sweet potatoes (*Ipomaea batatas* (L))

**Table 9: Pest and Control Methods for Sweet Potatoes**

Anticipated Pests		Recommended Management Measures
Insects	Sweet potato weevil	Cultural control <ul style="list-style-type: none"> <li>• Early planting and harvesting,</li> <li>• Use insect free planting material, re-ridging about 30days after planting</li> <li>• Tubers to be stored should not be damaged either through weevils or harvesting ,</li> </ul>
Diseases	Mosaic virus	Cultural control <ul style="list-style-type: none"> <li>• Avoid using diseased plant cuttings</li> <li>• Host plant resistance</li> </ul>
Weeds	All weeds	Mechanical control

### Soybean (*Glycine max* (L.) Merr)

**Table 10: Pest and Control Methods for Soyabeans**

Anticipated Pests		Recommended Management Measures
Insects	Cutworm ( <i>Agrotis Segetum</i> )	Cultural control <ul style="list-style-type: none"> <li>• Ploughing under of vegetation in late summer -3 to 6 weeks before planting,</li> <li>• Destruction of weed host plants,</li> </ul> Chemical control Poisoned baits, seed treatment with Carbaryl, Thiodan, Chlorpyrifos, Trichlorphon

Anticipated Pests		Recommended Management Measures
	Groundnut Caterpillar leaf minor ( <i>Stomopteryx Nertaria</i> )	Cultural control Intercropping with millet and sorghum, Chemical control Monocrotophos
	Epilachna beetle ( <i>Epilachna spp</i> )	Cultural control Deep ploughing at least 15cms, All foliage should be ploughed under Chemical control Spray with, Carbaryl, Malathion, Monocrotophos, Thiodan, Chlorban
	Brown Leaf Beetle ( <i>Ootheca mutabilis</i> )	Chemical control Chlorpyrifos, Cypermethrin
	Aphids ( <i>Aphis fabae</i> )	Cultural control Early planting, Good seed density, Chemical control Dimethoate, Mercaptothion, Gamma BHC
	Amoured Cricket ( <i>Aconthrplus speiser</i> )	Cultural control <ul style="list-style-type: none"> <li>• Early field preparation to expose egg pore to predators &amp; heat, Early Planting,</li> <li>• clean weeded field to reduce food source for cricket,</li> <li>• intercropping with bistled millet</li> </ul> Chemical control (Sandy soil field be surrounded by 20X25cm trench, sprinkle with Sevin during grain setting and filling stages of the crop, Treat crop with Sevin and Fastac during grain filling)
	Termites	Chemical control Dursban
Disease	Red leaf blotch Pyrenchaeta glycines	Chemical control Brestan,
	Bacteria blight ( <i>Pseudomonas</i> )	Cultural control

Anticipated Pests	Recommended Management Measures
glycines)	<ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Ploughing back crop residues</li> </ul>
White mould soybeans <i>Sclerotinia sclerotiorum</i>	<p>Cultural Control and Sanitary Methods</p> <ul style="list-style-type: none"> <li>• Crop rotation with maize, sorghum</li> <li>• In heavily infested fields a 3 to 4 year rotation with a non –host crop</li> <li>• Burying crop debris bearing sclerotia at a depth of 15 -25 cm with a mouldboard plough</li> <li>• Minimize soil movements during cultivation around soybean stem may decrease disease incidence</li> <li>• Host Plant Resistance</li> </ul>
Downy Mildew ( <i>Peronospora Manshurica</i> )	<p>Cultural control</p> <ul style="list-style-type: none"> <li>• Plant disease free seed</li> <li>• Plough under all crop residue immediately after harvest</li> <li>• Crop rotation</li> </ul> <p>Chemical control</p> <p>Apply foliar fungicide when weather conditions favour disease development</p> <p>Treat seed with appropriate fungicide</p>
Purple seed stain ( <i>Cercospora kikuchii</i> )	<p>Cultural Control and Sanitary Methods</p> <p>Cultural control</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Use clean seed</li> <li>• Plough under all crop residue</li> <li>• Harvest Soya beans promptly at maturity</li> </ul> <p>Chemical control</p> <p>Apply foliar fungicide starting at early pod set</p> <p>Treat seed with appropriate fungicide</p>
Soybean Rust <i>Phakopsora pachyrhizi</i>	<p>Cultural Control and Sanitary Methods</p> <ul style="list-style-type: none"> <li>• Destruction of weed hosts</li> <li>• Growing early maturing varieties</li> </ul> <p>Chemical control</p>

Anticipated Pests		Recommended Management Measures
		Folicur 250EW, Folicur C 300, and Ortiva
Weeds	All Weeds	Cultural control proper row Spacing, timely planting, optimum plant population per row, crop rotation, good quality seed Between row weeding) Chemical control, Dual/Lasso, Dual+Sencor, Trifluralin, Fluorodifan, Nitralin, Alachlor

**Sunflower** (*Helianthus annuus* L.)

**Table 11: Pest and Control Methods for Sunflower**

Anticipated Pests		Recommended Management Measures
Insects	Cutworms <i>Agrotis segetum</i>	Cultural control ploughing under of vegetation Chemical control poisoned baits using Dipterex and Thiodan Spray treatment of seeding Carbaryl, Thiodan, Chlorpyrifos and Trichlorphon
	Termites <i>Macrotermes</i> spp <i>Microtermes</i> spp	Cultural control <ul style="list-style-type: none"> <li>• Early harvesting after maturity</li> <li>• Cleaning and burning of crop residue</li> <li>• Crop rotation with less susceptible crops like cotton , millet and sorghum</li> </ul> Chemical control Permethrin, Confidor, Coopex T.C Dursban
	Sunflower moth	Biological control by predators

Anticipated Pests		Recommended Management Measures
Diseases	Leaf blotch <i>Septoria helianthii</i>	Cultural Control <ul style="list-style-type: none"> <li>• Cultivar resistance</li> <li>• Proper crop rotation</li> <li>• Controlling volunteer sunflower throughout the rotation</li> </ul>
	Leaf spot <i>Alternaria helianthii</i>	
	Stem rot <i>Erwinia aroideae</i>	
	Angular leaf spot <i>Pseudomonas Spp</i>	
	Powdery mildew <i>Erysiphe cichoracerum</i>	
	Charcoal rot <i>Sclerotium bacticola</i>	
	Dry rot <i>Sclerotium rolfsii</i>	
Weeds	All weeds	Mechanical control Chemical control Prometryne, E.P.T.C, Trifluralin

**Tobacco** (*Nicotiana tabacum* L)

**Table 12: Pest and Control Methods for Tobacco**

Anticipated Pests		Recommended Management Measures
Insects	Cutworms <i>Agrotis segetum</i>	Cultural control Including ploughing under of vegetation Chemical control Poisoned baits using Dipterex and Thiodan Spray treatment of seeding Carbaryl, Thiodan, Chlorpyrifos and Trichlorphon
	Ants	Chemical control Acephate, Azodrin
	Leaf minor	Chemical control
	Leaf eaters grasshoppers, lace worm, lesser army worm and	Acephate, Azodrin, Orthene

Anticipated Pests		Recommended Management Measures
	semi looper	
Diseases	Frog eye	Chemical control Benomyl
	Alternaria	Destruction of stalks, nematode control Correct fertilization Chemical control Anilazine
	Wild fire	Chemical control
	Angular leaf spot	Copper oxychloride
	Rhizoctonia solani	Crop rotation
	Fusarium solani	Chemical control Baytan
Weeds	All weeds	Hand and mechanical control Chemical control Nitralin, Tillam, Dual
Nematodes	Root knot nematodes	Chemical Control Ethylene debromide, Ethoprop (Mo-cap)

### Finger Millet (*Eseusine coracana*)

**Table 13: Pest and Control Methods for Finger Millet**

Anticipated Pests		Recommended Management Measures
Insects	Stalk borer, <i>Busseola fusca</i> , <i>Chilo partellus</i> , <i>Sesamia calamistis</i>	<ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Time of planting and destruction of crop residues</li> <li>• Intercropping <ul style="list-style-type: none"> <li>• Biological control</li> </ul> </li> <li>• Apply recommended insecticides</li> </ul>
	African armyworm <i>spodoptera exempa</i>	<ul style="list-style-type: none"> <li>• Biological control with <i>Bacillus thuringiensis</i> BT</li> <li>• Monitor their incidence on regular basis during vegetative growth</li> <li>• Minimal till and plough the field to</li> </ul>



Anticipated Pests		Recommended Management Measures
		<p>expose existing larva and pupa to sunlight</p> <ul style="list-style-type: none"> <li>Remove weeds like Amaranthus spp as they harbour developing larvae</li> </ul> <p>Chemical control Fastac</p>

**Sorghum** (*Sorghum bicolor* L.)

**Table 14: Pest and Control Methods for Sorghum**

Anticipated Pests		Recommended Management Measures
insects	Stem borer, Bollworm (herecoverpa) armoured crickets	Regular monitoring Prophylactic sprays
Diseases	Downy mildew anthracnose ergot	Field sanitation
Weeds	All weeds	<ul style="list-style-type: none"> <li>Plant after cleaning the field from first flush of weeds</li> <li>Keep fields from weeds at seed production</li> <li>Cultivate at knee high stage to control late weeds</li> <li>Use recommended herbicides</li> </ul>
Birds	Quelea quelea spp	<ul style="list-style-type: none"> <li>Scaring</li> <li>Bird trapping</li> <li>Avoid planting in areas of high risk</li> <li>Farmers to scout potential breeding sites and destroy nests</li> <li>Spot spraying, targeting roosting sites (carried out</li> </ul>

**Cowpeas** (*Vigna unguiculata* L.)

**Table 15: Pest and Control Methods for Cowpeas**

Anticipated Pests		Recommended Management Measures
Insect	Pod moth ( <i>Maruca Testulalis</i> )	Cultural Control Intercropping with Sorghum and Maize, Chemical control Endosulphan, Fastac
	Sweet Potato weevils ( <i>Cylas Formicarius</i> / <i>Cylas Puncticollis</i> )	Biological control <i>Pheidole Megacephala</i> Cultural control <ul style="list-style-type: none"> <li>• Destruction of infected crops materials, and crop residues,</li> <li>• Crop rotation,</li> <li>• Mulching,</li> <li>• Sanitation,</li> <li>• Re-ridging 30 days after planting fill cracks in the field,</li> </ul> Chemical control Treat vines with Carbofuran, Cypermethrin, or Permethrin at planting time
	Brown Leaf Beetle ( <i>Ootheca mutabilis</i> )	Chemical control chloropyrifos, Cypermethrin
	Coreid Bug ( <i>Mictis Profana</i> )	Chemical control Diazonon, Fenitrothion, Cypermethrin
	Bean Fly ( <i>Ophiomyia Phaseoli</i> )	Cultural control <ul style="list-style-type: none"> <li>• Avoid successive, over cropping the crop,</li> <li>• crop residues should be removed,</li> <li>• Remove Volunteer plants,</li> <li>• Use certified seed,</li> <li>• Ridge crop after emergence,</li> <li>• Crop rotation,</li> <li>• Treat seed with Gaucho before sowing)</li> </ul> Chemical control Spray Kinalux and Fenthion

Anticipated Pests		Recommended Management Measures
Weeds	All weeds	Cultural control Early weeding of the field Chemical control Trifluralin, Dual

**Cabbage** (*Brassicas Oleracea* var. *capitata*)

**Table 16: Pest and Control Methods for cabbage**

Anticipated Pests		Recommended Management Measures
Insects	Diamond back moth ( <i>Plutella Xylostella</i> )	Biological control with ( <i>apenteles plutellae</i> , <i>bacillus thuringiensis</i> , Botanical extracts Cultural Control <ul style="list-style-type: none"> <li>• Hand picking egg masses</li> <li>• Isolation of new crop from old crop,</li> <li>• Destruction of old brassica crop,</li> <li>• Over head irrigation,</li> </ul> Intercropping with tomatoes,) Chemical control with ( <i>Cypermethrin</i> , <i>Alfamethrin</i> , <i>Lambdacyhalothin</i> )
	Aphids ( <i>Brevicoryne Brassicae</i> )	Biological control with parasitic wasps ( <i>braconids</i> ) <ul style="list-style-type: none"> <li>• Isolation of new crop from old crop</li> <li>• Destruction of old brassica crop</li> <li>• Over head irrigation</li> <li>• Adequate fertilization</li> </ul> Chemical control <i>Primicarb</i> , <i>Neem</i> <i>Ethiophencarb</i> seed treatment with systemic insecticide
	White Fly ( <i>Bemisia Tabaci</i> )	Cultural Control Plant hygiene, Control weeds near the crop field

Anticipated Pests	Recommended Management Measures
	Chemical control Phoskill, Chlorpyrifos, Cypermethrin, Deltamethrin
Cabbage Flea Beetles <i>(Phyllotreta spp)</i>	Cultural control Keep down weeds in and around the field, Chemical control Phoskil
Leaf Minor <i>Liriomyza spp</i>	Chemical Control Fenthion
Harlequin bugs (Burgrada Hilaris)	<b>Cultural Control</b> (Regular Irrigation) <b>Chemical Control</b> (Lambdacyhalothin, Alfamethrin,
Oriental Cabbage Worm <i>(Hellula undalis)</i>	If control is required, it's as in <b>Diamond            back moth</b>
Diseases	Black rot (xanthomonas Campestris)  Cultural Control <ul style="list-style-type: none"> <li>• Resistant varieties</li> <li>• Crop rotation,</li> <li>• Isolation</li> <li>• Hot water treatment of fruits and seeds</li> <li>• Improved drainage</li> <li>• Mulching</li> <li>• Removal of brassica plant residues</li> </ul> Chemical Control Use Thiram treated seed, Mancozeb,
Soft Rot	Cultural Control Improve drainage in the field, Remove infected plants
Leaf Spot and Head browning of Cabbage <i>Alternaria            brassicicola</i>	Cultural Control and Sanitary Methods <ul style="list-style-type: none"> <li>• Crop debris management e.g. through crop rotation and deep tillage</li> <li>• Use of clean seed.</li> </ul>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Proper weed control</li> </ul> Chemical Control Chloro-thalonil, Copper based fungicides
	Downy Mildew <i>Peronospora parasitica</i>	Cultural Control Avoid crowding plants Chemical Control Chloro-thalonil , Ridomil, Prime metalaxyl

**Rape (brassica napus)**

Table 17: Pest and Control Methods for Rape

Anticipated Pests		Recommended Management Measures
Insects	Diamond back moth ( <i>Plutella xylostella</i> )	Biological control with <i>apanteles plutellae</i> , <i>bacillus thuringiensis</i> Cultural Control <ul style="list-style-type: none"> <li>• Isolation of new crop from old crop,</li> <li>• Hand picking egg masses</li> <li>• Destruction of old brassica crop,</li> <li>• Over head irrigation,</li> <li>• Intercropping with tomatoes</li> </ul> Chemical control with cypermethrin, neem extract Fastac Karate, Bt.,
	Mealy Cabbage Aphids ( <i>Brevicoryne Brassicale</i> )	Biological control with parasitic wasps (braconids), Cultural Control <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Isolation of new crop from old crop,</li> <li>• Destruction of old brassica crop,</li> <li>• Over head irrigation</li> <li>• Adequate fertilization</li> </ul> Chemical control with Primicarb, neem extract, Fastac, Karate,

Anticipated Pests		Recommended Management Measures
	Buganda bugs ( <i>Baroda</i> )	Cultural Control Avoid water stress <b>Chemical Control</b> ( karate, Fastac)
Diseases	Black rot	Cultural Control <ul style="list-style-type: none"> <li>• Resistant cultivars,</li> <li>• Improved drainage</li> <li>• Removal of infected plants</li> </ul>
	Turnip Mosaic Virus	Cultural Control <ul style="list-style-type: none"> <li>• Isolate new crop from old crop,</li> <li>• remove infected plants</li> </ul> Chemical Control Pirimor
	Downy Mildew	Cultural Control Improve drainage Chemical Control Daconil

**Tomatoes** (*Lycopersicum esculentum* mill) and **Egg plants** (*Solanum melongena*)

**Table 18: Pest and Control Methods for Tomatoes and Egg Plant**

Anticipated Pests		Recommended Management Measures
Insects	Red spider mite <i>Tetranychus ssp</i>	Biological Cultural Control <ul style="list-style-type: none"> <li>• Predacious mites</li> <li>• Isolate new crop from old crop,</li> <li>• Control host weeds,</li> <li>• Overhead irrigation,</li> <li>• Destruction of old, solanaceae crop residues,</li> <li>• Use of barriers,</li> <li>• Adequate fertilization</li> </ul> Chemical Control Propargite, Dicofol, Abamectin

Anticipated Pests	Recommended Management Measures
	<p>African bollworm (<i>Helicoverpa armigera</i>)</p> <p>Chemical control</p> <ul style="list-style-type: none"> <li>• Adult and Caterpillar Scouting is important to detect infestations</li> <li>• Hand picking of eggs and larvae can be an effective method if infestations are not too severe.</li> <li>• infested crop residues are carefully destroyed to prevent pest transfers</li> </ul> <p>Chemical control Alfamethrin, Lambdacyhalothrin, Cypermethrin</p>
	<p>Tomato Russet mites</p> <p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Isolate nursery from old crop</li> <li>• Attend to nursery before old infested crop</li> <li>• Ripping out and burning of crop residue</li> </ul> <p>Chemical control Dicofol, Carbox, Cyhexatin,</p>
	<p>Tomato Moth (<i>Lacanobia Oleracea</i>)</p> <p>Chemical control Dichlofos, Carbaryl, Cypermethrin, Malathion, Cyrux</p>
	<p>White Fly (<i>Bemisia Tabaci</i>)</p> <p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Plant hygiene, Control weeds near the crop field growing</li> <li>• African marigolds has been reported to discourage whitefly, Neem extract</li> </ul> <p>Chemical control Phoskill, Chlorpyrifos, Cypermethrin, Deltamethrin</p>
	<p>Green Stink Bug (<i>Nezara Viridula</i>)</p> <p>Cultural control Early planting</p> <p>Chemical control Carbaryl</p>

Anticipated Pests		Recommended Management Measures
Diseases	Early Bright Alternaria Solani	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Use clean seed</li> <li>• Hot water treatment of seeds</li> <li>• Destroy solanaceous weeds</li> <li>• Stack plants before the first flowers appear</li> <li>• Crop rotation should not be planted in areas where susceptible crops such as potato, pepper, eggplant</li> <li>• Avoid sprinkler irrigation</li> <li>• Destroy old crop residues, stake tomato in the rainy season</li> </ul> <p>Chemical Control Dithane, Benomly, Copper Oxychloride Prime Difenaconazole, Chlorothalonil</p>
	Late bright phytophthora infestans	
	Fusarium Wilt of Tomatoes F. oxysporum	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Use disease free – seed</li> <li>• In the field , remove or destroy tomato debris by deep ploughing after harvest</li> <li>• One year rotation</li> </ul> <p>Chemical Control apply an appropriate fungicide on a 7- 10 day schedule</p>
	Leaf Spot of Tomatoes <i>Septoria lycopersici</i>	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Burning plant remains, removing old foliage up to first flowers</li> <li>• Crop rotation</li> <li>• Raising seedlings in fumigated soil</li> </ul> <p>Chemical Control apply an appropriate fungicide</p>
	Bacterial Spot on foliage and Tomato fruit <i>Xanthomonas Campestris pv.</i>	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Production of disease free- free transplants , elimination of</li> </ul>



Anticipated Pests		Recommended Management Measures
	<i>vesicatoria</i>	<p>any potential for volunteers by disking fields periodically</p> <p>Chemical Control</p> <p>Seed treatment with appropriate chemicals Copper oxychloride and Funguran- OH</p>
	Tomato powdery mildew <i>Leveillula taurica</i>	<p>Cultural Control and Sanitary methods</p> <p>Proper irrigation</p> <p>Chemical Control</p> <p>Appropriate systemic fungicide such as Sulphur or benomyl</p>
	Tomato Mosaic Virus	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Avoid proximity to older crops or other host of virus</li> <li>• Decontaminate implements and hands which may be exposed</li> </ul> <p>to crop</p> <ul style="list-style-type: none"> <li>• Use of virus free seed</li> <li>• Cultivation of plants in sterilized compost in plastic bags</li> <li>• Application of strict hygiene can often reduce and sometimes</li> </ul> <p>prevent infection</p> <p>Chemical Control</p> <p>Seed treatment</p> <p>Soaking seed for 20 min in 10% (w/v) tri-sodium phosphate solution</p> <p>Treat harvested seed with hydrochloric acid</p>
Nematodes	Root knot nematodes	<p>Follow rotation and include Tagetes spp</p> <p>Use resistant cultivars</p> <p>Apply compost or any livestock manure</p>

**Onion** (*Allium cepa*. L)

**Table19: Pest and Control Methods for Onion**

Anticipated Pests		Recommended Management Measures
Insects	Thrips <i>Thrips tabaci</i>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Crop rotation ,</li> <li>• Sowing soon after rainy season,</li> <li>• Regular irrigation,</li> <li>• Mulching,,</li> <li>• isolate new crop from the old crop</li> </ul> <p>Chemical Control</p> <p>Karate, Fastac, Dimethoate , drench plants with Imadocroprid before transplanting</p>
Diseases	Purple Blotch <i>Alternaria porri</i>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Crop rotation ,</li> <li>• Tolerant cultivars,</li> <li>• Increased spacing between plants.</li> <li>• Higher doze of nitrogen and phosphate increases number of leaves and decrease amount of disease ,drip irrigation</li> </ul> <p>Chemical control</p> <p>Mancozeb, Benomyl, Chlorothalonil</p>
	Black mould of Onion <i>Aspergillus niger</i>	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Post- harvest black rot can be controlled if produce is stored and transported below 15<sup>0</sup> C or under very low humidity</li> <li>• Reduce the amount of physical damage to the storage organs</li> <li>• Onions with red scales tend to be more resistant than those with white scales</li> </ul> <p>Chemical Control</p>

Anticipated Pests		Recommended Management Measures
		Treat of seed with broad spectrum fungicide
Weeds	All Weeds	Cultural Control inter-row cultivation Chemical control Eradicate, and Dachal

**Okra** (*Albermoschus esculentus*)

**Table 20: Pest and Control Methods for Okra**

Anticipated Pests		Recommended Management Measures
Insects	African bollworm	Chemical control Fastac
	Aphids ,	Cultural Control <ul style="list-style-type: none"> <li>• Isolation of new crop from old crop,</li> <li>• Destruction of old Okra after harvest</li> </ul> Chemical control Primicarb
	Red Cotton Bugs	Cultural Control Isolation of new crop from old crop Chemical control Fastac
Diseases	Verticillium wilt of Okra <i>Verticillium dahliae</i>	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Use Verticullium – free planting stock</li> <li>• Rotation with grain crops</li> <li>• Thermal treatment of seed</li> <li>• Ploughing land immediately after harvest of a wilt- susceptible crop</li> </ul> Chemical control

Anticipated Pests		Recommended Management Measures
		Soil fumigation with a appropriate fungicide
	Powdery Mildew	Cultural Control Scouting Chemical Control Benomyl, Chlorothalonil, Hexaconazole
	Flower Rot	Cultural Control Avoid dump conditions
Nematodes	Meloidogymne spp	Cultural control <ul style="list-style-type: none"> <li>• Decomposed Manure,</li> <li>• Crop rotation,</li> <li>• Certified seed</li> </ul>

Paprika, Chilli (*Capsicum spp*)

**Table 21: Pest and Control Methods for Paprika and Chilli**

Anticipated Pests		Recommended Management Measures
Insects	Aphids	Cultural and biological control with parasitic wasps (braconids) <ul style="list-style-type: none"> <li>• Isolation of new crop from old crop</li> <li>• Destruction of old brassica crop</li> <li>• Over head irrigation</li> <li>• Adequate fertilization</li> </ul> Chemical control use Spear, Chlorophypos
	Whiteflies	Chemical Control Fastac, Imadocroprid
	Bollworm	Scouting to determine pest levels Chemical control Karate
Diseases	Fusarium Wilt	Cultural Control <ul style="list-style-type: none"> <li>• Crop Hygiene,</li> <li>• Remove infested plants, 3year crop rotation</li> <li>• Prevent mechanical damage to crop</li> </ul>

Anticipated Pests		Recommended Management Measures
	Early and Late blight	Copper oxychloride, Benomyl, Bravo

**Carrot** (*Daucus carota*. L)

**Table 22: Pest and Control Methods for Carrot**

Anticipated Pests		Recommended Management Measures
Diseases	Carrot leaf bright <i>Alternaria dauci</i>	Cultural Control <ul style="list-style-type: none"> <li>• A sufficiently long rotation between two successive crops ,</li> <li>• Using disinfected seed</li> <li>• Host plant resistance</li> </ul> Chemical control Dithane M-45, Benomyl, Chlorothalonil
	<i>Cercospora</i> spp	
Weeds	All weeds	Weed free by hand weeding at all times
Nematodes	Nematodes	Cultural Control <ul style="list-style-type: none"> <li>• Avoid growing carrots on land previously grown to nematodes susceptible crops such as tomato, Okra, celery</li> <li>• Apply kraal manure or compost to suppress nematodes</li> <li>• Maintain adequate plant nutrition</li> </ul> Chemical Control Furadan at planting

**Bananas** (*Musa acuminata*)

**Table 23: Pest and Control Methods for Banana**

Anticipated Pests		Recommended Management Measures
Insects	Citrus Red Scale <i>Aonidiella aurantii</i>	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Bury or burn all infested plant parts</li> <li>• Maintain a clean environment around the trees</li> </ul> Biological control

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Use parasites <i>Aphytis Spps</i></li> <li>• And <i>Comperiella bifaciata</i></li> </ul>
Diseases	Banana Bunchy Top (BBT) Virus	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Select original planting materials very carefully</li> <li>• Inspect nurseries and mature plantations regularly</li> <li>• Dig out the plants making sure no buds are left to start the Diseases off again. Dig out all the plants in a mat and cut them into small bits</li> <li>• If plantation is more than 50% infested destroy the lot rather than try to keep up with replants</li> <li>• Keep plantation weed free as much as possible</li> </ul> <p>Chemical Control</p> <p>Control aphid which is vector with appropriate aphicides</p>
	Sigatoka Disease of banana <i>Pseudocercospora musae</i>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Removal and destruction of badly spotted leaves (trash) from banana plantations to reduce inoculums.</li> <li>• Heavily diseased leaves can be buried within the plantation or piled on top of one another to prevent the effective discharge of ascospores from most leaves</li> <li>• Host plant resistance</li> </ul> <p>Chemical Control</p> <p>Copper oxychloride or Funguran-OH (copper</p>

Anticipated Pests		Recommended Management Measures
		hydroxide
	Cigar End Tip Rot of Banana <i>Verticillium theobrome</i>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Frequent removal of dead flowers followed by bagging bunches with perforated polyethylene sleeves.</li> <li>• Bracts and dead flower parts accumulate in the fruit bags and should be removed a few weeks after bagging</li> <li>• Field sanitation is helpful in reducing the disease inoculum pressure and subsequent cigar –end rot</li> </ul> <p>Chemical Control</p> <p>Appropriate fungicide spray may be necessary during some peak cigar- end rot seasons</p>

### Mango (*Mangifera indica*)

**Table 24: Pest and Control Methods for Mango**

Anticipated Pests		Recommended Management Measures
Insects	Fruit fly <i>Bactroera invadeus</i> <i>Ceratitidis cosyra</i>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Control of fruit fly involves the use of protein bait spray and sex attractants</li> <li>• Collection and destruction of all infested fruits</li> <li>• Avoid planting varieties that serve as continuous hosts</li> </ul> <p>Chemical control</p> <p>Dimethoate plus protein hydrolysate as a bait</p>
	Citrus red Scale <i>Aonidiella aurantii</i>	<p>Cultural control and sanitary methods</p> <p>Bury or burn all infested plant parts and maintain a clean environment around the</p>

Anticipated Pests		Recommended Management Measures
		<p>trees</p> <p>Biological control</p> <p>Use parasites <i>Aphytis Spps</i></p> <p>And <i>Comperiella bifaciata</i></p>
Diseases	<p>Mango Anthracnose</p> <p><i>Colletotrichum mangiferae</i></p>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Prune dead branches and twigs and remove them from the Orchard. Remove dead leaves as well.</li> <li>• Monitor for disease weekly</li> </ul> <p>Chemical Control</p> <ul style="list-style-type: none"> <li>• Many systemic and non systemic fungicides control anthracnose but timing and frequency of application are critical</li> <li>• Post harvest treatment of shipment involve immersion of fruit in hot water (52- 55<sup>0</sup>C for five min) and fungicides</li> <li>• Bi-monthly application of copper sprays or Captan. Benomyl plus a crop oil combination will give good result</li> </ul>
	<p>Bacterial Black Spot of Mango</p> <p><i>Xanthomonas Campestris pv. Mangiferae-indica</i></p>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Orchard sanitation by way of removal of infested materials</li> <li>• Wind breaks reduce disease</li> </ul> <p>Chemical Control</p> <p>Seedling treatment as preventive measures with appropriate chemicals. Copper oxychloride or Funguran</p>
	<p>Leaf and Fruit Spot of Mango</p> <p><i>Collectotrichum gloesporioides</i></p>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Post harvest treatment of shipment involve immersion of fruit in hot water (52- 55<sup>0</sup>C for five min) and fungicides</li> <li>• Host plant resistance</li> </ul>



Anticipated Pests		Recommended Management Measures
		Chemical Control Many systemic and non systemic fungicides control anthracnose but timing and frequency of application are critical such as Copper Hydroxide, Benomyl

**Coffee** (coffee Arabica) <sup>7</sup>

**Table 25: Pest and Control Methods for Coffee**

Anticipated Pests		Recommended Management Measures
Insects	Leaf miner	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Sanitation and crop hygiene</li> <li>• Shade management</li> <li>• Mulching</li> <li>• Pruning</li> <li>• Crop scouting</li> </ul> Chemical Control Aldicarb, Thiamethoxam
	Antestia bug,	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Shade management by reducing size</li> <li>• Pruning and desuckering</li> <li>• Scouting</li> <li>• Preserve natural enemies (parasitic wasps, Tachind flies)</li> </ul> Chemical Control Chlorpyrifos Methomyl Thiamethoxam , Trichlorfon
	Ants	Chemical Control Chlorpyrifos
	Giant looper	Chemical Control

<sup>7</sup> African Organic Farmers Field crop manual

Anticipated Pests		Recommended Management Measures
		Endosulfan Bacillus thuringiensis
	semi-looper	Chemical Control Trichlorfon
	White wax scales	Chemical Control Mineral oil
Diseases	Coffee berry disease (CBD) <i>Collectotrichum kahawae</i>	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Plant recommended resistant/tolerant varieties</li> <li>• Sanitation and crop hygiene</li> <li>• Shade management</li> <li>• Mulching</li> <li>• Pruning</li> <li>• Proper plant nutrition</li> <li>• Stem cleaning</li> </ul> Chemical control Copper oxychloride or Funguran-OH
	Coffee Leaf Rust <i>Hemileia vastatrix</i>	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Resistant varieties</li> <li>• Removal of old unproductive trees</li> <li>• Sanitation and crop hygiene</li> <li>• Shade management</li> <li>• Mulching</li> <li>• Pruning</li> <li>• Clean weeding</li> </ul> Chemical control Copper oxychloride or Funguran-OH or Chlorothalonil, Triadimenol
	Coffee Wilt <i>Fusarium xylarioides</i>	Cultural control and sanitary methods <ul style="list-style-type: none"> <li>• Use of clean seed</li> <li>• Frequent inspection of the crop, along with burning infected materials</li> <li>• Removal of bushes to reduce spread between plantations, gaps of a few</li> </ul>

Anticipated Pests		Recommended Management Measures
		<p>hundred meters should be enough to confine the diseases</p> <ul style="list-style-type: none"> <li>• Grafting of susceptible varieties to a more resistant variety</li> <li>• Host plant resistance</li> </ul>
	Cercospora,	<p>Chemical control</p> <p>Copper oxychloride or Figurant-OH or Chlorothalonil</p>

### Citrus (Citrus spp)

**Table 26: Pest and Control Methods for Citrus**

Anticipated Pests		Recommended Management Measures
Insects	<p>Citrus red Scale <i>Aonidiella aurantii</i></p>	<ul style="list-style-type: none"> <li>• <b>Cultural and Biological control</b> Bury or burn all infested plant parts</li> <li>• maintain a clean environment around the trees</li> <li>• Use parasites <i>Aphytis Spps</i></li> </ul> <p><i>Comperiella bifaciata</i></p> <p>Chemical Control</p> <p>Phoskill, Thiokill, Dimethioate</p>
	<p>False coating Moth <i>Argyroplote leucotreta</i></p>	<ul style="list-style-type: none"> <li>• Orchard hygiene all dropped and rotting fruits as well as stung fruits on trees should be collected at regular intervals</li> <li>• Orchard sanitation is economically worthwhile</li> </ul> <p>Chemical control</p> <p>Cypermethrin, Kinalux, Carbaryl, Deltamethrin, Fenvalerate, Aziphos – methyl</p>
	<p>Citrus Mealy Bug <i>Planococcus citri</i></p>	<p><b>Biological control</b> by fungal diseases in rain season</p> <p>Chemical control</p> <p>Monocrotophos, Endosulfan</p>

Anticipated Pests		Recommended Management Measures
	Orange dog ( <i>Pappilio demodercus</i> )	<ul style="list-style-type: none"> <li>• Regular scouting and hand picking of caterpillars</li> <li>• Apply contact insecticides in case of a severe attack</li> </ul>
	Citrus leaf Minor <i>phyllocnistis citrella</i>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Collection , destruction of fallen leaves and pruning affected leaves</li> <li>• Fertilization and avoidance of drought keeps trees in healthy state improving resistance,</li> <li>• Timed application of BT and bio rational pesticides such insect growth regulators (<i>Buprofezin</i> and <i>Pyriproxyfen</i>)</li> </ul> <p>Chemical Control <i>Monocrotophos</i></p>
Diseases	Cercospora Leaf and Fruit Spot of Citrus <i>Pseudocercospora angolensis</i>	<p>Cultural control and sanitary methods</p> <ul style="list-style-type: none"> <li>• Collection and destruction by burying and /or burning of all fallen fruit and leaves in affected orchards</li> <li>• Planting of windbreaks around the citrus orchards minimize the impact of wind , which is the primary dispersal agent</li> <li>• Judicious pruning of shoots, particularly those which die back, to allow light , free aeration within canopy making environment in the phyllosphere less conducive to reduce disease</li> </ul> <p>Chemical control <i>Copper formulations</i></p>
	Sooty mould of Orange <i>Capnodium citri</i>	<p>Chemical control Insect control of honey dew causing problem with <i>Dimethoate</i></p>
Nematodes	Nematodes	Under crop with of cowpeas

**Irish Potatoes (*Solanum tuberosum*)**

**Table 27: Pest and Control Methods for Irish Potatoes**

Anticipated Pests		Recommended Management Measures
Insects	Aphids	<p>Cultural measures</p> <ul style="list-style-type: none"> <li>• Promote build up of indigenous natural enemies</li> <li>• Apply wood ash in case of a heavy attack</li> <li>• Carry our regular crop inspection to detect early Attacks</li> </ul> <p>Chemical control</p> <p>Apply recommended insecticide when necessary</p>
	Tuber moth	<p>Biological control</p> <p><i>capidosoma</i> parasitic wasp</p> <p>Chemical with Chlorophypos, Acephate</p>
Diseases	Early	Prophylactic sprays
	late bright	Maneb, Mancozeb, Daconil, Copper oxychloride , Fenitinnhysroxides
Nematodes	Root knot nematodes	<p>Chemical Control</p> <p>Ethylene debromide, Ethoprop (Mo-cap)</p>

**JATROPHA (Jatropha Curcas)**

**Table 28: Pest and Control Methods for Jatropha**

Anticipated Pests		Recommended Management Measures
Insects	Scutellera nobilis	<b>Chemical Control:</b> Spray Cypermethrin (Pyrethroid) at a recommended rate
	<p>Inflorescence and capsule-borer</p> <p><i>Pempelia morosalis</i></p>	<p><b>Cultural Control:</b> It has been observed that <i>Pempelia morosalis</i> is parasitized by a dipteran natural enemy to an extent of 85%. Another natural control agent is the spider, <i>Stegodyphus</i> sp. (Eresidae: Arachnida), which snared these bugs in its web.</p> <p>Chemical Control:</p> <p>However, capsule-borer and the bark eating caterpillar can be controlled with a spray of Endosulfan.</p>

Anticipated Pests		Recommended Management Measures
Diseases	Jatropha Wilt Fusarium oxysporum	Cultural Control Avoid contaminated equipment, seedling or soil <b>Chemical Control:</b> Treat the soil with Carbendazim at 1.5-2g/l + Thiram at 1g/l of water or any other fungicides available on the market.
	Powdery mildew <i>Oidium</i> spp	<b>Chemical Control:</b> Powdery mildew can be controlled by spraying fungicides such as Bayleton, Sulphur and Benomyl
	Damping off (Phytophthora, Pythium)	<b>Chemical Control:</b> Treat the seed with Captan 50% at 0.2% before planting. Improve on the drainage of the nursery and aeration.
	Leaf spot (Cercospora jatrophae)	<b>Chemical Control:</b> Spray with copper oxychloride or any other suitable fungicide found on the market.
	Anthraxnose (Colletotrichum gleosporioides)	<b>Chemical Control:</b> Spray with Mancozeb at 0.1%
	Root rot (Macrophomina Phaseolina and Clitocybe tabescens)	<b>Chemical Control:</b> Treat the Soil with fungicide whose active ingredient include copper

## Cashew

**Table 29: Pest and Control for Cashew**

Anticipated Pests		Recommended Management Measures
Insects	Coreid bugs (Pseudotheraptus wayi)	Control Measures <ul style="list-style-type: none"> <li>• <b>B i o l o g i c a l</b> control using the African weaver ant (<i>Oecophilla longinoda</i>). To enhance effectiveness of the bio-control agents, farmers are advised to do the following: <ul style="list-style-type: none"> <li>✓ Apply Hydramethyl to control Brown house ants</li> </ul> </li> </ul>

Anticipated Pests		Recommended Management Measures
		<p>(<i>Pheidole megasephala</i>) when necessary</p> <ul style="list-style-type: none"> <li>✓ Construct artificial aerial bridges to facilitate mobility of weaver ants between trees</li> <li>✓ Plant weaver ant nests in areas where they do not occur naturally</li> </ul> <ul style="list-style-type: none"> <li>• Apply recommended insecticide at recommended dosage in case of severe outbreaks</li> </ul>
	Holopeltis bugs ( <i>Helopeltis anacardi</i> & <i>H. schoutedeni</i> )	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Biological control using, the African weaver ant (<i>Oecophylla longinoda</i>). Same as above</li> <li>• Not intercropping pigeon pea with cashew</li> <li>• Apply recommended insecticide at recommended dosage in case of severe outbreaks</li> </ul>
	Cashew mealybugs ( <i>Pseudococcus longispinus</i> )	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Crop sanitation (removal &amp; proper disposal of affected plant parts)</li> <li>• <b>B i o l o g i c a l</b> control using Biological control using, the African weaver ant (<i>Oecophylla longinoda</i> as above.</li> </ul>
	Thrips ( <i>Selenothrips rubrocinctus</i> )	<p>Control Measures</p> <p>Control should mainly target larvae stage during early stages of flowering</p>
	Stem borers, Weevils, ( <i>Mecocorynus loripes</i> )	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Adults should be collected and destroyed by hand</li> <li>• Mechanical, using a recommended hooks</li> </ul>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• If the tree is severely attacked, cut and dispose properly</li> </ul>
Diseases	Powdery mildew (Oidium anacardii)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Prune to provide good ventilation and aeration within trees making microclimate not conducive to the pathogen multiplication</li> <li>• Scouting</li> <li>• For established plantations, practice selective thinning</li> <li>• Remove off-season young shoots which can be sources of fresh inoculum during the season</li> <li>• Sanitation</li> <li>• Thin densely populated trees and leave them well spaced, to reduce or delay mildew epidemic due to changes in microclimate in the field</li> <li>• Plant recommended tolerant clones e.g. at recommended spacing</li> <li>• Apply recommended fungicides as appropriate</li> </ul>
	Anthraxnose (Colletotrichum gloeosporioides)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• <b>R e m o v e</b> and burning of all infected organs before the start of the cashew season.</li> <li>• Plant recommended tolerant clones at recommended spacing</li> <li>• Apply at recommended pesticide at correct rate and time</li> </ul>
	Dieback (Phonopsis anacardii)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• <b>R e m o v e</b> and burn all infected organs before the start of the cashew season.</li> <li>• Apply at recommended pesticide at</li> </ul>
	Wilt syndrome	<ul style="list-style-type: none"> <li>• Apply at recommended pesticide at</li> </ul>



Anticipated Pests		Recommended Management Measures
		correct rate and time

Huss avocado

**Table 340: Pest and Control Methods for Huss Avocado**

Anticipated Pests		Recommended Management Measures
Insects	Thrips , Scirtothrips perseae	Control Measures The Parasitic Wasps, Predatory Thrips, Predatory Mites, Lacewings, and Pirate Bugs are a natural predators and can help to control populations. For serious infestations, dust with Diatomaceous earth.
	Scales	Control Measures parasitoids were bred from the heart-shaped scale: <i>Metaphycus galbus</i> Annecke, <i>M. helvolus</i> (Compere), <i>M. stanleyi</i> and <i>Tetrastichus</i> sp and the hyperparasitoids, <i>Cheiloneurus cyanonotus</i> Waterston and <i>Marietta javensis</i> (Howard); the predators recorded are <i>Chilocorus angolensis</i> and <i>Hyperaspis</i> sp. Oil emulsion sprays occasionally used for scale control
	Fruit fly	Control Measures pheromone traps, apply the bait larval parasitoid, <i>Opius concolor</i> Szepliget, a pupal parasitoid <i>Trichopria capensis</i> , predatory ants
Diseases	Phytophthora root rot	Control Measures Several controls have been deployed including cultural (field drainage), disease free root stock ,hot water

Anticipated Pests	Recommended Management Measures
	Chemical control Fungicide treatment of seed, drenching the soil with fungicides Ridomil (Metalaaxyl) and Aliete or injecting trees twice a week with fosetyl-aluminium.
Anthracnose	Control Measures Several agronomic measures may be used to manage this disease including field sanitation (disposal fruit mummies and dead twigs) breeding for resistance , tree management i.e. proper pruning and fertilization and Application of fungicides.
Cercospora leaf spot	Chemical control Timely application of copper and /or benomyl
Verticilium Wilt	Cultural control Do not plant trees on land previously planted with susceptible Verticilium wilt trees Do not use plants with history Verticilium wilt Prune dead branches

Mushroom

**Table 31: Pest and Control Methods for Mushroom**

Anticipated Pests	Recommended Management Measures
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Anticipated Pests	Recommended Management Measures
Insect larva Phorid fly ( Megaselia) Sciarid fly (Lycoriella) Mycophila, Heteropeza	Cultural Control <ul style="list-style-type: none"> <li>• Clean surroundings.</li> <li>• Screening the mushroom house ventilation system to adult flies out.</li> <li>• Double doors and positive atmospheric pressure within the structure also prevent flies from entering. Since adult fungus flies are drawn to standing pools of water on benches, walks, or floors,</li> <li>• Places where water can collect should be eliminated.</li> </ul> <p><b>Biocontrol</b> is another option for several mushroom pests, the sciarid fly among them. A predatory nematode attacks this fly in its larval form. Therefore, this nematode can be added to the composting substrate to prevent infestation.</p> Chemical Control Dimilin, malathion ,Mercaptation
Termites	Cultural Control Clean surroundings Chemical control Permethrin, cypermethrin, fenvelelate, chloropyrifos
Mites	Chemical control Dicofol, Malathion
Nematodes	Cultural Control <ul style="list-style-type: none"> <li>• Disinfect thoroughly the room before new substrate is placed in them,</li> <li>• Maintain a strict hygienic regime</li> <li>• Dipping shoes in a disinfectant before entering the growing room</li> </ul>
Saprophytic fungi	Cultural Control <ul style="list-style-type: none"> <li>• Clean water</li> </ul>

Anticipated Pests		Recommended Management Measures
	Parasitic fungi	<ul style="list-style-type: none"> <li>• Filtered air</li> <li>• Careful pasteurization</li> <li>• Clean workers</li> <li>• Clean surroundings</li> </ul>
	Bacteria	Cultural Control <ul style="list-style-type: none"> <li>• Clean water</li> <li>• Filtered air</li> <li>• Careful pasteurization</li> <li>• Clean workers</li> <li>• Clean surroundings</li> <li>• Isolate the contaminated spots by digging a slit at at1.5metres and disinfect with a2%formalin</li> </ul>
	Virus	Cultural Control <ul style="list-style-type: none"> <li>• Clean water</li> <li>• Filtered air</li> <li>• Careful pasteurization</li> <li>• Clean workers</li> <li>• Clean surroundings</li> <li>• Cook out a room when virus appear</li> </ul>

### Bees (*Apis merrier*)

Literature on honey production shows that there are no major pest problems associated with this subsector. The dreaded American Foul Brood (AFB) and European Foul Brood (EFB) have not been sited in Zambia Honey industry.

**Table32: Pest and Control Methods for Bees**

Anticipated Pests		Recommended Management Measures
Parasitic bee mites	<i>Varroa mite (Varroasis)</i>	Biological control Method Hive manipulation techniques Chemical control is by far the most popular method of varroa control .Among the commonly-used mite-control agents are organic acids (Formic acid.

Anticipated Pests		Recommended Management Measures
		oxalic acid, Lactic acid ), ethereal oils (Thymol), synthetic pyrethroids (Apistan and Bayvarol,)and amitraz
	Tropilaelaps mite	<p>Biological control Method</p> <p>Hive manipulation techniques</p> <p>manipulate the brood- rearing cycle of their infested colonies in such</p> <p>A way that the mites are deprived of sealed and unsealed brood, their food, for at least three days. During this period, a large proportion of the mite population will starve to death.</p> <p>Chemical control</p> <p>By far the most popular method of varroa control Among the commonly-used mite-control agents are organic acids (Formic acid. oxalic acid, Lactic acid ), ethereal oils (Thymol), synthetic pyrethroids (Apistan and Bayvarol,)and amitraz</p>
	Tracheal mite ( <i>Acarapidosis</i> )	<p>Chemical Control</p> <p>Chemotherapeutic measures are widely adopted for mite control. Best results could be achieved with evaporating substances such as formic acid and ethereal oils.</p>
Insects	Red ants	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Beekeepers have found that the most effective method of controlling ants is to search systematically for the ants' nests in the vicinity of the apiaries and, when found, to destroy them by burning.</li> <li>• Eliminating brush and rotten wood from the apiary and cutting the grass.</li> <li>• Place the hives on stands supported by posts 30-50 cm high and to coat the posts with used engine oil or grease.</li> </ul>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Frequent inspection and renewed application of grease are both necessary and a source of soil pollution.</li> <li>• A more reliable method is to place the hive-stand posts in tin or plastic containers filled with either water or oil.</li> <li>• Regular clean up is required to avoid the formation of bridges of vegetation or earth that can be crossed by ants and liquids need to be replenished frequently.</li> </ul>
	Termites	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Maintain clean surrounding ,</li> <li>• Regular inspections</li> <li>• Treat poles that are being used with used oil.</li> </ul>
	Greater wax moth ( <i>Galleria mellonella</i> )	<p>Biological control</p> <ul style="list-style-type: none"> <li>• Treatment with <i>Bacillus thuringiensis</i>, in a watery suspension, sprayed onto the combs. The effect on the wax-moths larvae persists for several weeks</li> <li>• Preventive measures include ensuring that the colonies are strong and have adequate food stores; adapting the hive space to the strength of the colony; reducing the hive entrance; sealing cracks and crevices in hive walls; protecting the colonies against pesticide poisoning; controlling pests and diseases that might otherwise weaken them; and removing any wax and debris accumulated on the bottom boards of the hives.</li> <li>• Several measures can be taken to</li> </ul>

Anticipated Pests		Recommended Management Measures
		<p>prevent or control wax-moth infestation in stored combs and hive products. Products that are vulnerable to wax moth attack such as empty combs, used hive parts and wax should be properly stored, preferably in tight, moth-proof rooms. As preferably formerly hedged combs are infested they should be stored apart from new ones.</p> <p><b>Fumigation treatment;</b> with radichlorbenzene new combs should be treated less frequently, The application of sulphur, however, is inoffensive. Sulphur powder is wrapped in newspaper and burned in a metal container. Liquid sulphur from sprayers can also be used. All treatments should be repeated at intervals depending on the level of infestation. Regular control is therefore recommended.</p>
	Lesser wax moth ( <i>Achroia grisella</i> )	<p>Control</p> <p>The methods employed in controlling <i>Galleria mellonella</i> are equally effective for the control of <i>Achroia grisella</i></p>
	Smaller hive beetle	<p>Cultural Control</p> <p>The best way to protect against an infestation of the small hive beetle is to keep strong colonies and to remove those that are weak from an apiary. The removed honey combs should be centrifugally extracted one to two days after harvesting the honey.</p> <p>Chemical Control</p> <p>successful control is made possible using a preparation named 'Checkmate'</p>
Microbial	Bacterial diseases	Cultural Control

Anticipated Pests		Recommended Management Measures
diseases	American foulbrood disease (AFB)	<p>Frequent, efficient inspection which search and destroy any attempt to minimize damage to apiaries caused by this serious honey bee disease.</p> <p>The entire honey bee population that is infected by American foulbrood is killed and hive materials belonging to the colony, are disinfected or destroyed by burning.</p> <p><b>Chemotherapeutic methods</b> of controlling AFB involve the administration of antibiotics or sodium sulfathiazole, in various formulations, fed mixed with powdered sugar or sugar syrup</p>
	European foulbrood disease (EFB)	
	<p>Fungal disease</p> <p>Chalkbrood disease (<i>Ascosphaerosis</i>)</p>	<p>Control Measures</p> <p>Stimulate the hygiene behavior of the bees by changing the brood-rearing conditions. In this respect, it is most important to adapt the size of the hive to the strength of the bee colony. In this way the bees have a chance to inspect and</p> <p>Clean the many brood cells the method of stimulating hygiene behaviour, already described under European foulbrood control, is sufficient for chalkbrood control</p>

## Animal Health

Good animal health and productivity on the farm is achieved through the following

1. Preventing entry of disease onto the farm
2. Having an effective herd health/disease management program in place which should include immunization of livestock
3. Use veterinary drugs as prescribed by veterinarians or as specified on the label
4. Training of all people appropriately

## Beef Cattle pest and diseases



**Table 33: Pest and Control Methods for Beef Cattle**

Anticipated Pests		Recommended Management Measures
External parasite	Tsetse fly	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Drive away wild animals from places where cattle are kept</li> <li>• Make fly belts by clearing wide strips by hand</li> <li>• Set up fly traps/baits impregnated with appropriate insecticides (alphacypermethrin, Deltamethrin)</li> </ul>
Tick Diseases	Red Water	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Restrict cattle movements in the affected area</li> <li>• Animals from other countries or areas should be confined or quarantined and examined by a veterinary officer</li> <li>• maintenance of enzootic stability to tick-borne diseases,</li> <li>• Paddocks where infected cattle lived should not be grazed for some time to allow the diseases causing germs to die off</li> <li>• Cattle which has died from diseases to be burned under supervision</li> <li>• Vaccinate or inoculate healthy cattle</li> <li>• use of tick-resistant cattle</li> </ul>
	Heart Water	
	Gall sickness	
	Corridor Disease	
	East Coast Fever	
Non tick borne Diseases	Anthrax	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Remove Cattle from affected areas</li> <li>• Carcasses of Cattle which have died from disease with any blood must be burned under supervision</li> <li>• Early treatment with antibiotics may save the animals life</li> <li>• Vaccinate all cattle annually</li> </ul>
	Quarter Evil or blackleg or	Control Measures

Anticipated Pests		Recommended Management Measures
	black Quarter	<ul style="list-style-type: none"> <li>• Burn carcasses of all dead animals</li> <li>• Move healthy animals to new pastures</li> <li>• Vaccinate all calves yearly for first three years</li> </ul>
	Contagious Bovine Pluro-pneumonia (CBPP)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Prevent Cattle movements</li> <li>• Kill affected animals and burn their carcasses</li> <li>• Vaccinate healthy animals</li> </ul>
	Rinderpest	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Control Cattle movements</li> <li>• Kill affected animals and burn their carcasses</li> <li>• Vaccinate healthy animals</li> </ul>
	Tsetse fly disease Trypanosomosis	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Control of movement of wild animals in places where cattle are kept</li> <li>• Control the tsetse fly with Alpha cypermethrin, deltamethrin</li> <li>• Treat sick animals</li> </ul>
	Foot and Mouth Disease	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Restrict cattle movements</li> <li>• Slaughter infected animals</li> <li>• Vaccinate healthy cattle</li> </ul>
	Lumpy Skin Disease	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Isolate sick animals from healthy ones</li> <li>• Kraal cattle in dry paddocks or kraals</li> <li>• Vaccinate cattle as a preventive measure</li> </ul>
	Foot Rot	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Remove nails and other things which may cause wounds</li> <li>• Avoid wet kraals and paddocks</li> <li>• Treat cattle</li> </ul>

Anticipated Pests		Recommended Management Measures
Internal Parasites	Wire worms	<b>Control Measures</b> <ul style="list-style-type: none"> <li>• Consult local veterinary or livestock production personnel on prevention or control of worms and drugs to use</li> <li>• Dose atleast twice every year</li> <li>• Prevent over stoking the paddock</li> <li>• Adopt rotational grazing</li> <li>• Do not graze cattle in wet dambos where many parasites are often found</li> </ul>
	Liver flukes	
	Bankrupt worms	
	Hook worms	
	Nodular worms	

#### Dairy Cattle Pest and Diseases

**Table 54: Pest and Control Methods for Dairy Cattle**

Anticipated Pests		Recommended Management Measures
External parasites	Tsetse fly	<b>Control Measures</b> <ul style="list-style-type: none"> <li>• Drive away wild animals from places where cattle are kept</li> <li>• Make fly belts by clearing wide strips by hand</li> <li>• Set up fly traps/baits impregnated with appropriate insecticides</li> </ul>
Tick Diseases	Red Water	
	Heart Water	<b>Control Measures</b> <ul style="list-style-type: none"> <li>• Restrict cattle movements in the affected area</li> <li>• Animals from other countries or areas should be confined or quarantined and examined by a veterinary officer</li> <li>• maintenance of enzootic stability to tick-borne diseases,</li> <li>• Paddocks where infected cattle lived should not be grazes for some time to allow the diseases causing germs to die off</li> <li>• Cattle which has died from diseases to be burned under supervision</li> </ul>
	Gall sickness	
	Corridor Disease	
	East Coast Fever	

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• use of tick-resistant cattle</li> <li>• Vaccinate or inoculate healthy cattle</li> </ul>
Non tick borne Diseases	Anthrax	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Remove Cattle from affected areas</li> <li>• Carcasses of Cattle which have died from disease with any blood must be burned under supervision</li> <li>• Early treatment with antibiotics may save animal</li> <li>• Vaccinate all cattle annually</li> </ul>
	Quarter Evil or blackleg or black Quarter	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Burn carcasses of all dead animals</li> <li>• Move healthy animals to new pastures</li> <li>• Vaccinate all calves yearly for first three years</li> </ul>
	Contagious Bovine Pluro-pneumonia (CBPP)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Prevent Cattle movements</li> <li>• Kill affected animals and burn their carcasses</li> <li>• Vaccinate healthy animals</li> </ul>
	Rinderpest	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Control Cattle movements</li> <li>• Kill affected animals and burn their carcasses</li> <li>• Vaccinate healthy animals</li> </ul>
	Tsetse fly disease Trypasomosis	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Control of movement of wild animals in places where cattle are kept</li> <li>• Control the tsetse fly with Alpha cypermethrin, Deltamethrin</li> <li>• Treat sick animals</li> </ul>
	Foot and Mouth Disease	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Restrict cattle movements</li> <li>• Slaughter infected animals</li> </ul>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Vaccinate healthy cattle</li> </ul>
	brucellosis	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Vaccinate heifers between ages of 4 and 8 months</li> <li>• Test animals regularly and any positive tested animal to be slaughtered to prevent infections on the rest of herd</li> </ul>
	Bovine Tuberculosis (TB)	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Cleaning and disinfection of cattle premises</li> <li>• Movement control of animals from infected herds or highly risk herds</li> <li>• Control of contact of cattle and wildlife reservoirs</li> <li>• Test and slaughter reduces incidences of infection</li> <li>• Trace back carcasses detected at slaughter</li> </ul>
	Tetanus	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Best controlled by vaccination</li> <li>• Inoculate dam at 6 weeks and again 2 weeks before giving birth</li> </ul>
	Lumpy Skin Disease	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Isolate sick animals from healthy ones</li> <li>• Kraal cattle in dry paddocks or kraals</li> <li>• Vaccinate cattle as a preventive measure</li> </ul>
bacteria	Mastitis	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Proper milking hygiene, good milking techniques (fore-milking, udder washing, tit dipping)</li> <li>• Dipping of teats after milking</li> </ul> <p>Control Measures</p> <ul style="list-style-type: none"> <li>• Treatment of all quarters of all cows at drying off</li> <li>• Prompt treatment of clinical udder</li> </ul>

Anticipated Pests		Recommended Management Measures
		<p>infections during lactation</p> <ul style="list-style-type: none"> <li>• Culling of chronically infected animals</li> <li>• Treat with appropriate antibiotics</li> </ul>
	Milk Fever in Cows	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Treatment is with a calcium injection</li> <li>• Prevention is possible by keeping cow on a low calcium diet while she is dry</li> <li>• A Magnesium supplement will also help to prevent milk fever</li> <li>• Remove calves from affected cows</li> <li>• The cow be partially milked out for 48 hrs after treatment to reduce the calcium drain</li> </ul>
	Foot Rot	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Remove nails and other things which may cause wounds</li> <li>• Always separate animals with foot-rot from those without symptoms</li> <li>• Avoid wet kraals and paddocks</li> <li>• Treat cattle</li> <li>• Zink sulphate, Foot-rot vaccines and portable handling equipment help fight foot-rot</li> </ul>
	Calf scours	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Treatment</li> <li>• Giving a mixture of fluids(electrolytes) early in course of disease</li> <li>• Severe cases may need the veterinarian to give intravenous fluid and a course of antibiotics</li> </ul>
Internal Parasites	Wire worms	<p>Control Measures</p> <ul style="list-style-type: none"> <li>• Consult local veterinary or livestock production personnel on prevention or control of worms and drugs to use</li> <li>• Dose at least twice every year</li> </ul>
	Liver flukes	
	Bankrupt worms	
	Roundworms	
	Lungworms	

Anticipated Pests		Recommended Management Measures
	Hook worms	<ul style="list-style-type: none"> <li>• Prevent over stoking the paddock</li> <li>• Adopt rotational grazing</li> <li>• Do not graze cattle in wet dambos where many parasites are often found</li> <li>• Place more mature cows on contaminated pastures as they are more immune</li> </ul>
	Nodular worms	

## Poultry

**Table 36: Pest and Control Methods for Poultry**

Anticipated Pests		Recommended Management Measures
Virus	Newcastle Disease	Control Measures <ul style="list-style-type: none"> <li>• Hygiene which include measures such as cleaning, disinfection, limiting access to wild birds and other flocks of birds, and personal hygiene of farm staff</li> <li>• Slaughter of infected flocks</li> <li>• Vaccination</li> <li>• Live vaccines</li> <li>• Killed vaccines</li> </ul>
	Avian Encephalomyelitis	Control Measures use of a crude chicken brain-propagated virus for vaccination of breeder replacement flocks
	Fowl pox	Control Measures Vaccination
	Marek's Disease	Control Measures Vaccinate at day old
	Infectious Bronchitis	Control Measures Prevention and control of this disease requires a well coordinated approach, balancing biosecurity / hygienic measures and vaccination.
	Infectious laryngotracheitis	Control Measures Good <u>biosecurity</u> principles such as effective

Anticipated Pests		Recommended Management Measures
		sanitation and quarantine procedures are important control measures. Vaccination with A20 vaccine
	Gumboro Disease (infectious bursal Disease)	Control Measures Vaccinate at 21days
	Duck Virus Hepatitis	Control Measures <ul style="list-style-type: none"> <li>• If accidentally introduced, strict isolation and control of rats are necessary measures to control DHV.</li> <li>• Vaccination</li> <li>• A killed vaccine</li> </ul>
Mycoplasma	Chronic Respiratory Disease	Control Measures <ul style="list-style-type: none"> <li>• controlling predisposing factors and attending to hygiene</li> <li>• separating birds in older age groups from young birds</li> <li>• Isolating affected groups.</li> <li>• Vaccinate pullets.</li> </ul>
Bacteria	Fowl Cholera	Control Measures <ul style="list-style-type: none"> <li>• Avoid contact with wild birds, or other domestic birds</li> <li>• Hygiene usage of uncontaminated feed, water</li> <li>• Vaccination</li> </ul>
	Salmonellosis	Control Measures <ul style="list-style-type: none"> <li>• Good rodent control program in place, as rodents often are carriers of the bacteria.</li> <li>• Spraying and / or eggs or fumigation with formaldehyde</li> <li>• Treatment For young birds only if allowed by local legislation. In many countries, destruction is obligatory. Antibody positive breeders are</li> </ul>



Anticipated Pests	Recommended Management Measures
	destroyed.
	<p data-bbox="505 312 683 344">Fowl typhoid</p> <p data-bbox="773 312 1008 344">Control Measures</p> <p data-bbox="773 365 919 396">Prevention</p> <ul data-bbox="821 417 1292 711" style="list-style-type: none"> <li>• Control vectors</li> <li>• Test breeders for positive serum</li> <li>• Destroy positive breeders</li> <li>• Pellet feeds</li> <li>• Use chlorine in the water</li> <li>• Vaccines from non pathogenic <i>S. gallinarum</i> are available</li> </ul> <p data-bbox="773 732 919 764">Treatment</p> <p data-bbox="773 785 1170 816">Neomycin or sulfaquinoxaline.</p>
	<p data-bbox="505 831 667 863">Colibacillosis</p> <p data-bbox="773 831 1179 863">Treatment &amp; Control Measures</p> <p data-bbox="773 884 919 915">Prevention</p> <ul data-bbox="821 936 1373 1272" style="list-style-type: none"> <li>• Use mycoplasma-free stock to prevent interaction with <i>E. coli</i>.</li> <li>• Pellet feed to kill bacteria.</li> <li>• Chlorinate water (3 to 5 ppm) and nipple drinkers use to reduce transmission in water.</li> <li>• An inactivated vaccine is available for breeders and layers.</li> </ul> <p data-bbox="773 1293 919 1325">Treatment</p> <p data-bbox="773 1346 1349 1608">Chlortetracycline (CTC) (400 g / t), Oxytetracycline (OTC), Quinolones (Flumequine), and SULFADIMETHOXINE Ormetoprim or Trimethoprim, can be used. Gentamicin can be given by subcutaneous injection at 1 day-of-age.</p> <p data-bbox="773 1629 1365 1745">Chlorox<sup>®</sup> in water at 2 to 4 oz / gal or quinolone for 1-3 weeks in water for 3-5 days to treat clinical signs.</p>
<p data-bbox="505 1814 643 1887">Infectious sinusitis</p> <p data-bbox="773 1814 1008 1845">Control Measures</p> <p data-bbox="773 1866 919 1898">Prevention</p>	

Anticipated Pests		Recommended Management Measures
		<p>Depopulate infected stock, hatch clean stock only, vaccination of pullets for MG with live or killed vaccine to prevent the disease.</p> <p>Treatment</p> <p>Drugs, which can be used, include tylosin, LS 50® at (2 g/gal), quinolones and spiramycin*.</p>
Ectoparasites	Lice	<p>Control Measures</p> <p><u>Hanging medicinal plants in poultry sheds</u></p> <p>A bouquet of Nirgundi/Sephali (Vitex negundo), Tulsi (Ocimum sanctum) or lemon grass (Cymbopogon citrates) is hung in the poultry house: the smell of the plant drives ectoparasites away.</p>
	Mites	<p><u>Applying plant extracts on the skin of birds</u></p> <p>Rubbing of fresh and dry tobacco leaves on the skin of the bird is helpful in killing lice.</p> <p><u>Bedding in Brooding Pen</u></p> <p>One handful of lemon grass (Cymbopogon citrates) is put in the nest before the hen starts to lay eggs; it remains in the nest throughout the brooding period.</p> <p><u>Dipping in Neem Water</u></p>
	ticks	<p>Fresh leaves of neem are boiled for 15-20 minutes; the solution is kept overnight and the leaves taken out. The solution is used for dipping the birds, the separated leaves are ground properly to make the paste, which is then applied on the affected parts of the bird.</p> <p><u>Fumigation of Poultry Housing</u></p> <p>Burn dry leaves of Diospyros ebenum (ebony), tobacco or powdered bark of Citrus acida (lime) and let the smoke go into the poultry house.</p>

Anticipated Pests		Recommended Management Measures
		All surfaces of the basket, coop, or hut are sprayed with appropriate insecticides, to be done only when house is empty. Parasites on poultry be treated with naphthalene
Endoparasites	Nematodes	Control Measures Deworming with a polyvalent poultry dewormer
	Blackhead (Histomoniasis)	Control Measures Prevention of blackhead in turkeys by management is twofold: 1) Prevention of exposure by quarantine or isolation, especially avoiding any contact with chickens or game birds, and 2) use of migration barriers to Prevent commingling of infected birds with uninfected birds. 3)Also, farm owners should be aware of the hobbies of their workers and discourage the keeping of backyard chickens, Treatment Dimetridazol (0.015%), Carbasone (0.025%), Ipronidazole (0.00625%), Nitarstone (0.01875%) or Furazolidone (0.011%), are effective drugs, though not licensed in Western Europe.
	Round worms	Control Measure
	Hair worms	<u>Apple Cider Vinegar (ACV)</u> , Diatom ( <u>Diatomacious Earth</u> ). given regularly to help eliminate or reduce worms Chemical Wormers: <u>Flubenvet</u>

Anticipated Pests		Recommended Management Measures
		Solubenol
	Avian malaria	<p>Control Measures</p> <p>Prevention</p> <p>Control flies with Carbamate granules distributed by large scale aerial or treatment of grounds.</p> <p>Eliminate carriers by spraying repellent within the houses to discourage entrance of flies.</p> <p>Clopidol fed continuously at 0.0125–0.0250% also reduce some infection.</p> <p>Treatment</p> <p>Clopidol, Phrimethamine (1 ppm) and sulfadimethoxine (10 ppm) are effective treatments.</p>
	Protozoa: coccidiosis	<p>Treatment &amp; Control Measures</p> <p>The use of virulent vaccines by eye drop at 1 day or in the drinking water or sprayed on the feed during the bird's first week is a system of controlled exposure.</p> <p>After 3 complete life cycles (3 weeks), the bird is usually solidly immune to the parasite. If the litter is too moist a second round of infection may cause severe diarrhoea and paleness. If this occurs, birds should be given a curative treatment and/or vitamins and minerals in the water.</p> <p>Vaccination is only tolerated for pullets and broilers which have at least 8 weeks of rearing.</p> <p>Attenuated vaccines are also available, both for breeders, layers (on the floor systems) and broilers.</p> <p>Cocciostats are usually continuously fed to broilers in the feed.</p> <p>Treatment</p>

Anticipated Pests		Recommended Management Measures
		<ul style="list-style-type: none"> <li>• Sulphonamides: sulfaquinoxaline (feed) (0.05%)</li> <li>• Amprolium Plus (0.024%) (water)</li> <li>• Sulfadimethoxine and Ormetoprin (water)</li> <li>• Sulfamethazine (0.1%) (water)</li> <li>• Sulfachloropyrazine monohydrate (0.03%) (water)</li> <li>• Toltrazuril</li> </ul>
Fungus	Aspergillosis :A.flavis	<p>Control Measures</p> <ol style="list-style-type: none"> <li>1. Removal or control of favourable areas for fungal growth This would include such things as removing wet litter, not using damp or mouldy straw/hay as litter or food, not using or removing spoiled grain and regular provision of fresh non-dusty litter.</li> <li>2. Dust control in brooder sheds This is an important area as dust in the air of brooder sheds appears closely associated with infection of young chicks. Good quality litter will also help</li> <li>3. Hygiene Attention to hygiene can prevent aspergilla numbers building up to a point where problems occur. This needs to be done in all stages to the end of the brooder stage. Eggs should be fumigated and/or washed in a recognized egg sanitizer used according to directions. The cold storage room, the incubator and the hatcher should be fumigated or cleaned regularly with a recognised disinfectant active against fungi. The brooder house should be cleaned and</li> </ol>

Anticipated Pests		Recommended Management Measures
		<p>disinfected before the hatching season begins. If individual pens are cleaned out during the breeding season they should be disinfected as well each time.</p> <p>Disinfectants that are active against aspergilla include those containing gluteraldehyde as an active constituent, Antec Virkon S and Antec Farm Fluid S.</p> <p>The above procedure will also control other diseases that may cause problems during incubation, hatching and brooding.</p> <p>There is no effective cure at this point in time.</p>
	A.fumigatus (airsaculitis)	<p>Control Measures</p> <p>Avoid damp litter or feed</p>
	1. Avian influenza	<p>Prevention</p> <ul style="list-style-type: none"> <li>• Killed vaccine is available in limited areas.</li> <li>• Quarantine, depopulation and Eradication of virulent form should be mandated. Strict biosecurity is needed.</li> <li>• Control of live birds market in large cities is important to prevent the spread of the virus.</li> </ul> <p>Treatment</p> <p>Broad-spectrum antibiotics are helpful to control secondary bacteria.</p>

In Zambia fish farming is almost totally dominated by culturing tilapia spp. although there are other species that may be cultured. This section thus focusses on Tilapia.

**Table36: Pest and Control Methods for Tilapia**

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
Viral nervous necrosis (VNN)	<i>Lates calcarifer encephalitis</i> virus (LcEV) – a betanodavirus	Virus	Pale or dark colouration; erratic swimming behaviour; spiral swimming; bloating; 'fainting'; extensive vacuolation of the brain & spinal cord; generally encountered during hatchery phase	Screening of broodstock; low larval rearing densities; optimal larval nutrition; improved broodstock nutrition; improved hatchery hygiene
Lymphocystis	Lymphocystis virus	Virus	Wart-like growths on skin & fins; generally only fatal if infection severe & associated with very poor environmental conditions	Removal of infected fish; improved environment
Vibriosis	<i>Vibrio harveyi</i> ; <i>Vibrio</i> spp.	Bacteria	Marine fish with darkening; lethargy; anorexia; reddened ulcerations on body; reddened abdominal fluid; associated with nursery systems, poor environment	Improved environment; antibiotic treatment

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
			& skin trauma	
Bacterial haemorrhagic septicaemia	Aeromonas hydrophila; AAeromonas sobria; Aeromonas caviae; Aeromonas spp.; Pseudomonas sp.	Bacteria	Freshwater fish with irregular reddened skin ulcerations; lethargy; anorexia; reddened abdominal fluid; pale gills; associated with poor environment & skin trauma	Improved environment; antibiotic treatment
Integumentary bacteriosis	Aeromonas sobria; Aeromonas hydrophila; Vibrio harveyi; Vibrio alginolyticus	Bacteria	Irregular reddened skin ulcerations; loss of scales; associated with poor environment & skin trauma	Improved environment; increased water exchange
Streptococcosis	Streptococcus iniae	Bacterium	Darkened fish; anorexia; pale gills; reddened abdominal fluid; reddened abdominal organs & inner wall	Antibiotic treatment; vaccination
Columnaris disease	Flavobacterium columnare; Flavobacterium johnsoniae; & Flavobacterium sp. (gliding forms) in freshwater	Bacteria	Pale skin patches on dorsal surface behind dorsal fin & on caudal peduncle; lethargy; most commonly occurs in nursery phase; in older	Treatment in potassium permanganate or copper baths may help in early disease; antibiotic treatment



DISEASE	AGENT	TYPE	SYNDROME	MEASURES
	Tenacibaculum marinum in seawater		juveniles a mouth form with erosion of skin around upper & lower jaws has been seen; associated with overstocking, tank rearing, poor hygiene & skin trauma	
Bacterial gill disease	Various bacteria, <b>Flavobacterium</b> spp., <b>Cytophaga</b> spp.	Bacteria	Swimming at water surface; gulping; rapid opercular movement; excess mucus on gills; white patches on gills; most commonly occurs in nursery phase	Improve water quality; treatment with salinity reversal, potassium permanganate or quaternary ammonium baths; increase water exchange; reduce stocking density
Bacterial peritonitis	Various Gram-negative & Gram-positive bacteria including <b>Vibrio harveyi</b> & <b>Aeromonas hydrophila</b>	Bacteria	Darkened fish; lethargy; swollen abdomen; adhesions & bad smelling fluid in abdomen; abdominal fistulas; more common in recirculation systems	Cull affected fish; antibiotic treatment
Bacterial enteritis	Various Gram-negative bacteria	Bacteria	Acute disease in intensive larval rearing systems; anorexia; pin heads; darkened	Cull affected larval batch

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
			fish & death	
Fin and tail rot	Aeromonas spp.; Pseudomonas spp.; Vibrio spp.; Flavobacterium spp.; Cytophaga spp.	Bacteria	Erosion of soft tissue in fins and tail; may extend to involve entire tail & caudal peduncle	Improve environment; reduce stocking density
Epitheliocystis	Epitheliocystis organism – a <b><i>Chlamydia</i></b>	Bacterium	Swimming at water surface; rapid opercular movements; disease rare but seen in marine fish & in recirculation systems	None known
White spot	Ichthyophthirius multifiliis in freshwater  Cryptocaryon irritans in marine	Protozoa	'Flashing'; rubbing skin on surfaces; anorexia; swimming at water surface; white spots on skin & fins	Treatment with salinity reversal, formalin baths or combinations; treatment in copper bath for marine fish
Chilodonelliasis	Chilodonella spp.; Chilodonella hexasticha	Protozoa	Swimming at water surface; rapid opercula movement; flared opercula; seen in poor environmental conditions & in weakened fish	Treatment with salt, formalin or potassium permanganate bath or combinations
Trichodiniasis	<b><i>Trichodina</i></b> complex spp.	Protozoa	Swimming at water surface; rapid opercular	Increase water exchange; treatment with salt

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
			movements; excess gill mucus; typically follows cold water temperatures, high organic loads & high stocking densities	or formalin bath
Ichthyobodosis (costiasis)	Ichthyobodo necator	Protozoa	'Flashing'; rubbing skin on surfaces; opaque patches on skin; raised scales; swimming at water surface; rapid opercular movements; flared opercula	Treatment with salinity reversal; formalin or potassium permanganate bath
Piscinoodiniasis	Piscinoodinium sp.	Protozoa	Found in freshwater: In young fish opaque patches or a greenish discolouration of the skin; patches of skin lifting of surface & ulcers In older fish rapid opercular movements; excess gill mucus; dark green gill colour	Treatment with salt bath
Amyloodiniasis	Amyloodinium ocellatum	Protozoa	Found in marine conditions: In young fish opaque patches or a green discolouration of	Treatment with freshwater, copper, formalin or hydrogen peroxide bath

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
			the skin; patches of skin lifting of surface & ulcers In older fish rapid opercular movements; excess gill mucus; dark green gill colour More common in broodstock and in raceways; associated with low water temperatures or rapid drops in temperature	
Red sore disease	<i>Epistylis</i> sp.	Protozoa	Skin ulcers in freshwater pond fish; raised fluffy surface & secondary bacterial infections	Reduce organic levels in water; treatment with formalin bath
Gill fluke	<i>Diplectanum</i> sp.; <i>Dactylogyrus</i> sp.	Monogean trematodes	Rapid opercular movements; anorexia; white areas on gills	Treatment with salinity reversal, formalin, organo-phosphate or praziquantel bath
Skin fluke	<i>Neobenedinia melleni</i> ; <i>Gyrodactylus</i> spp.	Monogean trematodes	Marine fish with opaque cornea; white patches on skin; skin ulcers; associated with high salinity & cool water temperatures	Treatment in freshwater or hydrogen peroxide bath

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
Myxosporidiosis	Henneguya sp.; Kudoa sp.	Spore- forming protozoa	Disease uncommon but histologically spore cysts seen in gill filaments (Henneguya sp.) & brain (Kudoa sp.)	None known
Microsporidiosis	Pleistophora sp.	Spore- forming protozoa	Raised lumps on skin; soft white nodules in muscle	None known
Integumentary mycosis	Saprolegnia spp.; Achlya spp.	Fungi	Raised, fluffy growths on skin & fins; associated with low water temperatures & skin trauma	Salinity reversal and formalin baths; do not handle fish when water temperatures low
Branchiomycosis	Brachiomyces sp.; Achlya spp.	Fungi	Swimming at water surface; rapid opercular movements; white & red patches (mottled appearance) on gills; associated with cold water temperatures & high organic loads	No treatment known; reduce organic load & increase water exchange
Fish louse	Argulus sp.	Copepod	Disc-shaped parasite visible on skin; red foci; darkening	Treatment in organophosphate bath

DISEASE	AGENT	TYPE	SYNDROME	MEASURES
Anchor worm	Lernaea sp.	Copepod	Thin body of female parasite visible on skin with small red ulcer where parasite penetrates skin	Treatment in organophosphate bath

### Organic Based Crops

Agriculture practices that rely on techniques such as **crop rotation, green manure, compost and biological pest control** to maintain soil productivity and control pests on a farm constitutes the organic farming label. Major features of such farming practices is the exclusion or strict limited use of inorganic fertilizers, pesticides, plant growth regulators such as hormones, livestock antibiotics, food additives, and genetically modified organisms. Organic farming involves mechanical weed control (via cultivating or hoeing) instead of herbicidal weed control<sup>8</sup>. Sample organically acceptable practices are reflected below for production of Tomatoes and Onion on the basis of their high probability to be popularized for production among and across farmer categories in Zambia.

### Tomatoes (*Lycopersicum esculentum* mill)

**Table37: Pest and Control Methods for Organically grown Tomatoes**

Anticipated Pests		Recommended Management Measures
Insects	Red spider mite <i>Tetranychus ssp</i>	Biological Cultural Control <ul style="list-style-type: none"> <li>• Predacious mites</li> <li>• Isolate new crop from old crop,</li> <li>• Control host weeds,</li> <li>• Overhead irrigation,</li> <li>• Destruction of old, solanaceae crop residues,</li> <li>• Use of barriers,</li> </ul>

<sup>8</sup> International Federation of Organic Agriculture Movements (IFOAM),

Anticipated Pests	Recommended Management Measures
<p>African bollworm (<i>Helicoverpa armigera</i>)</p>	<p>Chemical control</p> <ul style="list-style-type: none"> <li>• Adult and Caterpillar Scouting is important to detect infestations</li> <li>• Hand picking of eggs and larvae can be an effective method if infestations are not too severe.</li> <li>• infested crop residues are carefully destroyed to prevent pest transfers</li> <li>• <b>BT</b>, <i>Bacillus thuringiensis</i>, an organic treatment that can control numerous other problems as well.</li> </ul>
<p>Tomato Russet mites</p>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Isolate nursery from old crop</li> <li>• Attend to nursery before old infested crop</li> <li>• Ripping out and burning of crop residue</li> </ul>
<p>Tomato Moth (<i>Lacanobia Oleracea</i>)</p>	<p>Control them just by picking them off. <b>Bt</b>, <i>Bacillus thuringiensis</i>, an organic treatment that can control numerous other problems as well.</p>
<p>White Fly (<i>Bemisia Tabaci</i>)</p>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Plant hygiene, Control weeds near the crop field growing</li> <li>• African marigolds has been reported to discourage whitefly, Neem extract</li> <li>• insecticidal soaps and botanical insecticides and oils can bring populations down to manageable levels, at which point natural predators</li> <li>• <b>natural predators</b> such as ladybugs, lacewings, or whitefly parasites</li> </ul>
<p>Green Stink Bug</p>	<p>Cultural control</p>

Anticipated Pests		Recommended Management Measures
	<i>(Nezara Viridula)</i>	Early planting
Diseases	Early Bright Alternaria Solani	Cultural Control and Sanitary methods <ul style="list-style-type: none"> <li>• Use clean seed</li> <li>• Hot water treatment of seeds</li> <li>• Destroy solanaceous weeds</li> <li>• Stack plants before the first flowers appear</li> <li>• Crop rotation should not be planted in areas where susceptible crops such as potato, pepper, eggplant</li> <li>• Avoid sprinkler irrigation</li> <li>• Destroy old crop residues, stake tomato in the rainy season</li> </ul> <ul style="list-style-type: none"> <li>• Clean your gardening tools and equipment, especially at the end of the season, to ensure that they don't carry over or spread a disease.</li> <li>• Remove unhealthy foliage; pull unhealthy plants to cut down on the spread of problems.</li> </ul>
	Late bright phytophthora infestans	
	Fusarium Wilt of Tomatoes F. Oxysporum	Cultural Control and Sanitary methods <ul style="list-style-type: none"> <li>• Use disease free – seed</li> <li>• In the field , remove or destroy tomato debris by deep ploughing after harvest</li> <li>• One year rotation</li> <li>• Use clean tools</li> </ul>
	Leaf Spot of Tomatoes <i>Septoria lycopersici</i>	Cultural Control and Sanitary methods <ul style="list-style-type: none"> <li>• Burning plant remains, removing old foliage up to first flowers</li> <li>• Crop rotation</li> </ul>
	Bacterial Spot on	Cultural Control and Sanitary methods



Anticipated Pests		Recommended Management Measures
	foliage and Tomato fruit <i>Xanthomonas Campestris</i> pv. <i>Vesicatoria</i>	<ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Production of disease free- free transplants , elimination of any potential for volunteers by disking fields periodically</li> </ul>
	Tomato powdery mildew <i>Leveillula taurica</i>	Cultural Control and Sanitary methods Proper irrigation
	Tomato Mosaic Virus	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Crop rotation</li> <li>• Avoid proximity to older crops or other host of virus</li> <li>• Decontaminate implements and hands which may be exposed to crop</li> <li>• Use of virus free seed</li> <li>• Cultivation of plants in sterilized compost in plastic bags</li> <li>• Application of strict hygiene can often reduce and sometimes prevent infection</li> </ul>
Nematodes	Root knot nematodes	<p>Follow rotation and include Tagetes spp</p> <p>Use resistant cultivars</p> <p>Apply compost or any livestock manure</p> <p>In case you choose to sterilize the soil, add earthworms, beneficial nematodes, and an assortment of micro-organisms as well, since doing so will restore the soil to full health and make it less vulnerable to further incursions by nematodes.</p>

**Onion** (*Allium cepa*. L)

**Table 38: Pest and Control Methods for Organically grown Onion**

Anticipated Pests		Recommended Management Measures
Insects	Thrips <i>Thrips tabaci</i>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Crop rotation ,</li> <li>• Sowing soon after rainy season,</li> <li>• Regular irrigation,</li> <li>• Mulching,,</li> <li>• isolate new crop from the old crop</li> </ul>
Diseases	Purple Blotch <i>Alternaria porri</i>	<p>Cultural Control</p> <ul style="list-style-type: none"> <li>• Crop rotation ,</li> <li>• Tolerant cultivars,</li> <li>• Increased spacing between plants.</li> <li>• Higher doze of nitrogen and phosphate increases number of leaves and decrease amount of disease ,drip irrigation</li> </ul>
	Black mould of Onion <i>Aspergillus niger</i>	<p>Cultural Control and Sanitary methods</p> <ul style="list-style-type: none"> <li>• Post- harvest black rot can be controlled if produce is stored and transported below 15<sup>0</sup> C or under very low humidity</li> <li>• Reduce the amount of physical damage to the storage organs</li> <li>• Onions with red scales tend to be more resistant than those with white scales</li> </ul>
Weeds	All Weeds	<p>Cultural Control</p> <p>inter-row cultivation</p>

## Organic Based Crops

Agriculture practices that rely on techniques such as **crop rotation, green manure, compost and biological pest control** to maintain soil productivity and control pests on a farm constitutes the organic farming label. Major features of such farming practices is the exclusion or strict limited use of inorganic fertilizers, pesticides, plant growth regulators such as hormones, livestock antibiotics, food additives, and genetically modified organisms. Organic farming involves mechanical weed control (via cultivating or hoeing) instead of herbicidal weed control<sup>9</sup>. Sample organically acceptable practices are reflected below for production of Tomatoes and Onion on the basis of their high probability to be popularized for production among and across farmer categories in Zambia.

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<sup>9</sup> International Federation of Organic Agriculture Movements (IFOAM),