Pesticides in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT)

A scoping study of current and future use, associated risks and identification of actions for risk mitigation

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WAGENINGEN UNIVERSITY & RESEARCH

FALCONSULT PEST & PESTICIDE MANAGEMENT

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SAGCOT, the 'Southern Agricultural Growth Corridor of Tanzania', is a coordinated initiative to boost agricultural output in southern Tanzania through public and private investment, to improve food security, reduce rural poverty and sustain the environment. The 'Sustainability and Inclusion Strategy for Growth Corridors in Africa' (SUSTAIN-Africa) programme by the International Union for Conservation of Nature (IUCN) develops and demonstrates climate resilient solutions for water security and inclusive land resource and agricultural development in growth corridors and areas of intensive economic development in Africa. To develop an efficient, competitive and sustainable agricultural sector in SAGCOT, possible adverse effects of pesticide use need to be addressed and minimized. For this purpose a scoping study was conducted, consisting of a literature survey, a scoping mission and a stakeholder workshop. The study revealed that there are many issues related to pesticide management and pesticide risks that need attention when the SAGCOT is further developed and pesticide use increases. The most important recommendations of the study are (1) better implementation and enforcement of current rules and regulations for pesticides, (2) training and awareness creation for pesticide users, (3) creation of a multi-stakeholder platform for exchange on best pest and pesticide management practices in the SAGCOT, (4) a regulatory body at the local government authority level to enforce/monitor pesticide management and life cycle, and (5) development of a monitoring and evaluation framework on pesticides for the SAGCOT.

Keywords: Tanzania, SAGCOT, pesticides, environmental risks, human health, IPM, extension

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Photo cover: Pesticide shop in the rural area near Sumbawanga. Photo: Harold van der Valk, Falconsult

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Preface

The IUCN National Committee of The Netherlands (IUCN-NL) has assigned Wageningen Environmental Research (Alterra), part of Wageningen University & Research, to conduct a study for the SUSTAIN-Africa programme on the possible environmental consequences of pesticide use in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) and to develop and initiate further initiatives such as training to counter the negative effects of increasing pesticide use.

This report provides the results of a scoping study (Phase 1) consisting of a literature survey, a scoping mission to Tanzania and in particular to the Kilombero, Ihemi and Sumbawanga clusters of the SAGCOT, and a workshop with relevant national and regional stakeholders.

The authors are grateful to Mr. Mark van der Wal of IUCN-NL for his inspiring support of the project and the missions. We would also very much like to thank the IUCN-Tanzania office, in particular Michael Nkonu (director), Edesia Wilson Lugainamila and Mujungu Nakomba, for their practical support during the work.

Last but not least we would like to thank all the stakeholders and persons that have welcomed us for discussion during the scoping mission in February/March 2016 and all the participants in the stakeholder workshop in Dar es Salaam in June 2016.

Summary

SAGCOT, the 'Southern Agricultural Growth Corridor of Tanzania', is a coordinated initiative to boost agricultural output in southern Tanzania through public and private investment, to improve food security, reduce rural poverty and sustain the environment. The 'Sustainability and Inclusion Strategy for Growth Corridors in Africa' (SUSTAIN-Africa) programme by the International Union for Conservation of Nature (IUCN) develops and demonstrates climate resilient solutions for water security and inclusive land resource and agricultural development in growth corridors and areas of intensive economic development in Africa. To develop an efficient, competitive and sustainable agricultural sector in SAGCOT, possible adverse effects of pesticide use need to be addressed and minimized.

In this report we provide the results of a scoping study of pesticides in the SAGCOT. The objectives of the scoping study were to:

1. assess current and future pesticide use in the SAGCOT growth corridor of Tanzania in general and when possible specifically for the Sumbawanga, Ihemi and Kilombero clusters,
2. assess possible risks of (increased) pesticide use in the SAGCOT,
3. identify possible interventions to reduce pesticide risks in the SACGOT,
4. identify stakeholders for pesticide management in the SAGCOT and Tanzania, and
5. consult these stakeholders to seek commitment and to prioritise future activities by SUSTAIN-AFRICA with regard to pesticide risk reduction.

The study consisted of a literature survey, a two-week scoping mission in the country and a two-day workshop with stakeholders.

The most important conclusions of the scoping study (literature review and scoping mission) are given below per topic.

Pesticide use

- Cereals and horticulture consume most of the pesticides.
- A limited number of 'old chemistry' pesticides dominate at agro-dealers in SAGCOT, in spite of a great number of registered pesticides at the national level.
- There are a considerable number of reduced-risks pesticides registered.
- A major increase of pesticide use is expected in maize, horticulture, and rice, through intensification, increase of area planted and increased occurrence of pests and diseases.

Environmental & human health effects

- There are many reports of adverse occupational impact of toxic pesticides and poisoning through handling and application by unskilled workers.
- Impact of pesticides on vulnerable ecosystems like aquatic ecosystems are likely (e.g., rice).
- Pesticides may cause a loss of important ecosystem services (supply of clean water, fisheries, natural pest control, pollination).
- An increased availability of pesticides may lead to more illegal uses (wildlife poisoning, fishing).
- Side-effects on non-target wildlife occur (e.g., bird control).
- Pesticide effects on wildlife are a potential threat to the tourism industry.
- Key ecosystems vulnerable to pesticides are present in the SAGCOT area or nearby, especially areas with surface water like the Kilombero flood plain and Lake Rukwa.
- Evaluation of pesticides used in some of the SAGCOT districts showed that these include many highly hazardous pesticides and pesticides that are harmful to the aquatic environment.

Policies & legislation

- Pesticide registration in Tanzania needs better human health and environmental risk assessment.
- Agricultural policy clearly promotes IPM and biocontrol.
- Implementation and enforcement of pesticide policy and legislation are currently not sufficiently effective.
- Environmental Impact Assessments of new/expanded agricultural development projects are conducted, but it is unclear if they are effective.

Pesticide life cycle & best practices

- In general, the situation with respect to pesticide risk reduction measures and best practices in SAGCOT seems the same as in other parts of Tanzania. There are many problems connected to pesticide use.
- Various aspects of the life cycle of pesticides are insufficiently managed:
  - inadequate diagnostic capabilities,
  - mixing of different (types of) pesticides,
  - unjustified pesticide use,
  - illegal cross-border pesticide trade,
  - minimal use of PPE,
  - no calibration of spraying equipment, and
  - inappropriate disposal of empty containers (re-use, environmental contamination).
- The level of farmer knowledge about responsible pesticide use is low, especially among smallholders.
- IPM schemes are not implemented at a large scale.
- Agro-dealers do supply unauthorised (and perhaps even counterfeit or 'fake') pesticide products and pesticides that compromise sustainability.
- There is a great need for more training of farmers and also agro-dealers/retailers on safe pesticide use and IPM.
- There are good possibilities and there is knowledge about the application of IPM to crops in the SAGCOT. However, IPM is still not much applied.
- There is readily available information and training materials on IPM in Tanzania and elsewhere, but this is not currently used.
- Extension services do not reach farmers to a sufficient degree.

During the stakeholder workshop, participants discussed and prioritised actions for pesticide management in SAGCOT. The most important recommendations, in order of priority, are:

1. Implementation & enforcement of rules, regulations, registration & quality control.
2. Training & awareness creation for pesticide users on harmful effects of pesticides.
3. Creation of a multi-stakeholder platform.
4. Regulatory body at LGA level to enforce/monitor pesticide management & life cycle.
5. Develop a Monitoring & Evaluation framework on pesticides for SAGCOT.

The outcome of the scoping study and workshop will serve as input for further actions to be identified and instigated by the IUCN and its SUSTAIN-Africa programme in collaboration with other SAGCOT partners and stakeholders.

1 Introduction

1.1 SAGCOT

SAGCOT, the 'Southern Agricultural Growth Corridor of Tanzania', is a coordinated initiative to boost agricultural output in southern Tanzania through public and private investment, to improve food security, reduce rural poverty and sustain the environment. Many of the planned crops in the corridor rely heavily on the input of pesticides for pest, disease and weed control. Pesticides, especially when used inappropriately, can affect human health, the environment and water quality. If left unconsidered, inappropriate pesticide use could therefore constrain the target of sustainable, green economic growth set by the SAGCOT program.

1.2 SUSTAIN-Africa

The 'Sustainability and Inclusion Strategy for Growth Corridors in Africa' (SUSTAIN-Africa) programme develops and demonstrates climate resilient solutions for water security and inclusive land resource and agricultural development in growth corridors and areas of intensive economic development in Africa. The programme works with government, private sector and civil society partners to integrate water, land and ecosystem management into investment strategies and development of related small and medium-sized enterprises as well as large scale business operations. SUSTAIN-Africa will result in benefits including:

- strengthened water security for communities in growth corridors,
- lower water risks for businesses,
- protection of local food security in growth corridors,
- increased opportunities for local entrepreneurship based on building value chains from landscape diversification and restoration,
- lower risks for public-private and community-based partnerships in land, water and ecosystem management allowing for higher return on investment,
- reduced social and environmental impacts of trade and investment because of lower impacts on water, land resources and ecosystems,
- communities and businesses both more resilient to climate change, and
- increased knowledge, skills and capacities in communities, businesses and governments on how to manage land, water and ecosystems to achieve sustainable and inclusive green growth whilst maintaining or restoring delivery of ecosystem services.

The SUSTAIN-Africa programme is managed and facilitated by IUCN. It was launched in 2014 in the SAGCOT growth corridor (Southern Agricultural Growth Corridor of Tanzania) and implemented by partners working collaboratively in coordinated work packages. A second focus area is Zambezi Valley Development Corridor in Mozambique. The Mozambique programme is currently in its inception phase.

1.3 Reducing risks of pesticides

To develop an efficient, competitive and sustainable agricultural sector in SAGCOT, possible adverse effects of pesticide use need to be addressed and minimized. Export crops in particular, depend on maintaining strict standards with regard to pesticide residues and sustainability of production. An efficient pesticide management system promoting responsible pesticide use is fundamental for sustainable agricultural growth.

In brief, pesticide management is concerned with the right procedures at the different stages of the pesticide life cycle:
1. Production and import
2. Registration
3. Procurement and sales
4. Transport and storage
5. Use
6. Disposal

Pesticide management aims to protect:
- Worker health (factory workers, retailers, applicators)
- Consumer health (food and drinking water), and
- Environmental health (water, soil, biodiversity, resistance)

Negative impacts of pesticide use can be reduced in a number of ways and at various levels in the pesticide life cycle such as governance (pesticide legislation, registration/authorisation), business practices (certification, inspection, labelling) and at the field level, for example through the promotion of Good Agricultural Practice and non-chemical pest control measures such as Integrated Pest Management (IPM) and biological pest control. Various aspects of pesticide management with respect to SAGCOT will be addressed in this report.

The overall aim of any intervention to promote sustainable use of pesticides is to use less hazardous pesticides.

1.4 Scoping study objectives

The project is divided into two consecutive phases. The first phase consists of a scoping study including a literature review, a scoping mission and a stakeholder workshop. The emphasis during Phase 1 is on describing current and future pesticide use and associated risks and on the current state-of-the-art in SAGCOT with respect to sustainable use of pesticides and pesticide management. The results of the Phase 1 scoping study are reported here.

The objectives of the scoping study were to:
1. Assess current and future pesticide use in the SAGCOT growth corridor of Tanzania in general and when possible specifically for the Sumbawanga, Ihemi and Kilombero clusters,
2. Assess possible risks of (increased) pesticide use in the SAGCOT
3. Identify possible interventions to reduce pesticide risks in the SACGOT
4. Identify stakeholders for pesticide management in the SAGCOT and Tanzania
5. Consult these stakeholders to seek commitment and to prioritise future activities by SUSTAIN-AFRICA with regard to pesticide risk reduction.

The focus of the scoping study was solely on pesticides (insecticides, herbicides, fungicides, etc.) and not on other agrochemicals such as fertilisers or any other environmental consequences of the development of SAGCOT like habitat loss or water management.

The scoping study consisted mostly of expert judgement and qualitative assessments and analysis. The study did not include any quantitative methods such as modelling and/or quantitative environmental risk assessment of pesticides.

Based on the outcome of Phase 1, Phase 2 will be designed. In Phase 2 the emphasis of the project will shift to promoting mitigation of pesticide risks by providing the necessary tools to relevant stakeholders. This may include training on pesticide management, but could also include monitoring, research and/or demonstration cases.

2 Study methods

2.1 Literature review

A review of relevant literature on pesticide use in the SAGCOT corridor was conducted in the first half of 2016. Collected literature included both scientific literature (peer-reviewed papers published in scientific journals) and grey literature (e.g., reports by government agencies, NGOs and the internet). The literature collected was especially aimed at:

- identifying current and possible future pesticide use in Tanzania and specifically in the SAGCOT corridor and those likely to be used in the future in Tanzania and in the SAGCOT corridor including their known hazards and risks.
- detailing relevant (national) pesticide policies, pesticide registration and regulation procedures (i.e., how pesticides are evaluated and approved for sales and use) and risk reduction measures.
- identifying the extent of pesticide pollution of aquatic and terrestrial ecosystems and current problems associated with pesticide use on humans and wildlife in the region and its clusters
- identifying stakeholders relevant to pest management, pesticide production, supply, distribution and use, nature conservation and environment in Tanzania and more specifically, in the SAGCOT corridor.
- establishing the extent of adoption of IPM and best practices and identifying any programmes (current or past) aimed at improving pesticide management in the agricultural sector of Tanzania.
- identifying any self-regulated/voluntary pesticide management schemes, for example through certification programmes.

2.2 Scoping mission

From February 29 to March 11, 2016, a scoping mission was conducted in Tanzania in order to:

- interview representatives of important stakeholders in Tanzania and in particular in the SACGOT corridor,
- compile information of their vision on present and future pesticide management and use in the corridor, their experience with pesticide-related risks to people and the environment and their ideas about risk reduction of pesticide use,
- make an inventory of the stakeholder needs in terms of knowledge and training to tackle problems associated with pesticide use,
- discuss needs and possibilities of monitoring pesticides in the environment and associated risks, and
- discuss possibilities for a suitable demonstration case within the SAGCOT area and notably the IUCN target clusters of Ihemi, Kilombero and Sumbawanga.

The scoping mission was conducted by three of the authors of this report:

- Dr. Francisca Katagira, private consultant on pesticide management and IPM, Dar es Salaam, Tanzania
- Dr. Ralph Buij, ecologist at Alterra, part of Wageningen UR, The Netherlands
- Ir. Harold van der Valk, pesticide management expert at Falconsult, The Netherlands

The scoping mission included travel to the SAGCOT clusters of Ihemi, Kilombero and Sumbawanga, and also to Arusha to visit the pesticide registrar (TPRI) and the Tanzania Horticultural Association (TAHA) which is expanding horticultural production for export from north eastern Tanzania to the SAGCOT corridor. A list of the persons and organisations visited during the scoping mission is provided in Annex 1. Types of stakeholders included:

- authorities at various levels (national, regional, local, water basin authorities),
- co-ordinators and partners of SAGCOT and SUSTAIN-Africa,
- international organisations and donors,

- agricultural, environmental and public health research institutions,
- wildlife and nature conservation organisations and other relevant NGO's,
- associations of farmers and bee keepers,
- water user associations,
- producer marketing groups and/or village committees,
- agricultural commodity traders and exporters,
- agricultural inputs suppliers, including national and local private companies involved in the manufacture and distribution of pesticides.

2.3 Stakeholder workshop

On June 28 and 29, 2016, a two-day stakeholder workshop was organised in Dar es Salaam in order to:

- present and discuss the results of the scoping study and the scoping mission,
- identify the most important conclusions with respect to pesticide use, adverse effects of pesticides, policies and legislations, and the pesticide life cycle and best practices in relation to Tanzania and SAGCOT in particular, and
- discuss, define and prioritise the most important opportunities and actions for registration and control, measures in the distribution chain, best practices and monitoring and research with respect to pesticide management and pesticide risk reduction in SAGCOT (training, monitoring, case studies, etc.)

The workshop was organised by the scoping study team in collaboration with IUCN-Tanzania and attended by more than 20 participants from various stakeholder organisations that were also consulted during the scoping mission. The participants are shown in Annex 1.

Discussion with rice farmers in Kilombero during the scoping mission, with Ms. Francisca Katagira at the right. Photo: Ralph Buij, Wageningen Environmental Research.

3 Agriculture and pesticide use in SAGCOT

3.1 Current situation

3.1.1 Crops

Land use in SAGCOT

Land use in most of SAGCOT is heterogeneous: a patchwork of cropland, forest, wood-/shrubland, and grassland. Only a small fraction of the cropland in SAGCOT consists of large, permanent farms; most agriculture is small-scale and interspersed with other land uses. The total land area of SAGCOT is estimated, in the SAGCOT Greenprint, at about 31 million ha, of which approximately 8.2 million ha (or 27%) are arable lands (Table 3.1). Conservation areas – all types confused – comprise 36% of the SAGCOT land area.

It was estimated in the SAGCOT Blueprint that in 2010 less than 30% of the arable land area was actually farmed, mainly by smallholder farmers. Only about 110,000 ha were cultivated by commercial farms (SAGCOT, 2011).

Table 3.1 *Land cover in the Southern Corridor, in 2009 (SAGCOT, 2013a).*

Land cover	Area (ha)	% of total area
Urban and other artificial areas	44,800	0.1%
Croplands (crops occupy ≥70% of area)	1,013,500	3.3%
Mosaic croplands (crops occupy <70% of area)	7,154,500	23.3%
Evergreen forest	1,284,100	4.2%
Deciduous forest	7,123,500	23.2%
Woodland	5,782,700	18.8%
Shrubland	3,789,200	12.3%
Grassland	3,111,100	10.1%
Wetland	431,700	1.4%
Water bodies	1,010,700	3.3%
Total land area	**30,745,660**	**100.0%**
of which conservation areas (i.e. national parks, game reserves, game controlled areas, forest reserves, state forest reserves, wildlife management areas, wetlands of international importance)	11,111,600	36.1%

For two out of three clusters concerned by this study, Ihemi and Sumbawanga, cultivated areas as a fraction of total arable land were estimated at about 45%, considerably higher than the SAGCOT average. For Kilombero, about a quarter of the arable land was actually cultivated (Table 3.2).

Table 3.2 *Cultivated areas in Kilombero, Ihemi and Sumbawanga clusters, in 2010 (SAGCOT, 2011).*

Cluster	Region: Districts	Total arable land area	Total cultivated area	% cultivated
Kilombero	Morogoro Region: Kilombero and parts of Kilosa and Ulanga Districts	312,000 ha	80,000 ha	26%
Ihemi	Iringa Region: Iringa Rural, Kilolo and Mufindi Districts	618,000 ha	279,000 ha	45%
Sumbawanga	Rukwa Region: Sumbawanga, Nkasi and Kalambo Districts	972,000 ha	460,000 ha	47%

Agriculture in the SAGCOT study clusters

<u>Smallholder farmers</u>

The last detailed agricultural census was conducted in 2007/2008 and published in 2012 (MAFC, 2012a). Subsequently, The Ministry of Agriculture, Food Security and Cooperatives (MAFC) published its Agriculture Basic Data until 2009/2010. These data were used to identify the main crops grown in the SAGCOT clusters, as they appear to be the latest district-level cropping statistics published nationally which use the same sampling methodology.

Tables 3.3, 3.4 and 3.5 show the areas planted by smallholder farmers for the major crops in the districts comprising the Kilombero, Ihemi and Sumbawanga clusters. The data are for the entire districts, even if only part of those districts may fall in the SAGCOT cluster.

Ihemi cluster. The main crop grown by smallholder farmers in the Ihemi cluster in 2009/2010 is maize (54% of total planted area). Pulses (20%) and sunflower (8%) are other important crops in the cluster. Of the permanent crops, sugarcane and mango are grown by smallholders on a limited scale.

Kilombero cluster. In Kilombero cluster, the two main crops grown by smallholder farmers are maize and rice, covering about 44% and 35% of the area planted, respectively. Cassava (6%) and beans (5%) are also grown on relatively large areas. Sugarcane, banana and pigeon pea are among the more important permanent crops, though their combined presence is only 5% of the planted area.

Sumbawanga cluster. Maize is the major annual crop grown by smallholder farmers in the Sumbawnga cluster, on 35% of the planted area. Sunflower is cultivated on 12% of the planted area, rice and beans on 10% each and cassava and sweet potato of 6% each. Most permanent crops grown in the cluster are "others", i.e. not specified in the census or Basic Data.

It is important to note that variability in areas planted for individual crops from one year to the other may be high, and the 2009/2010 data are therefore indicative. Furthermore, the total areas planted as indicated in the SAGCOT Blueprint (Table 3.2) are quite distinct from the totals of the MAFC Basic Data (Tables 3.3 – 3.5), even though the latter do not cover all crops planted. This may be partly due to the fact that SAGCOT cluster borders are not always the same as the district borders used in the MAFC Basic Data.

More recent district-level data on crops grown in the three clusters are available from the District Agricultural Offices (Kashaigili *et al.*, 2014), but not published (yet) by the MAFC or the National Bureau of Statistics (NBS).

Table 3.3 *Area planted in 2009/2010 of major crops by smallholder farmers in the* ***Ihemi cluster*** *– Iringa Rural, Kilolo and Mufindi Districts (MAFC, undated).*

Crop group	Crop	Area planted (ha)				
		Iringa Rural	Kilolo	Mufindi	Total	% of total listed
Annual crops						
Cereals	Maize	66,880	48,630	78,860	194,370	54%
	Paddy rice	12,820	830	150	13,800	3.8%
	Sorghum	3,530	2,250	60	5,840	1.6%
	Wheat	120	630	4,360	5,110	1.4%
Pulses	Beans	21,220	9,330	43,600	74,150	20%
	Garden peas	2,820	2,380	6,700	11,900	3.3%
Oil seeds	Sunflower	10	18,970	8,710	27,690	7.6%
Roots and tubers	Sweet potatoes	2,400	1,430	3,630	7,460	2.1%
	Cassava	1,540	690	80	2,310	0.64%
	Irish potatoes	3,880	4,470	8,780	17,130	4.7%
Fruits and vegetables	Tomatoes [1]	338	1,142	422	760	0.21%
	Cabbage [1]	0	89	431	520	0.14%
	Onions [1]	1	642	8	651	0.18%
Cash crops	Tobacco	1,110	0	0	1,110	0.31%
Permanent crops						
	Sugar cane [1]	68	223	0	291	0.08%
	Mango [1]	167	17	21	205	0.06%
Total					**363,300**	

[1] No data available in MAFC (undated); Agricultural Census 2007/2008 data were used instead (MAFC, 2012b).

Table 3.4 *Area planted in 2009/2010 of major crops by smallholder farmers in the* ***Kilombero cluster*** *– Kilombero, Kilosa and Ulanga Districts (MAFC, undated).*

Crop group	Crop	Area planted (ha)				
		Kilombero	Kilosa	Ulanga	Total	% of total listed
Annual crops						
Cereals	Maize	18,960	86,040	26,240	131,240	42%
	Sorghum	430	3,690	1,570	5,690	1.8%
	Paddy rice	58,560	32,500	18,260	109,320	35%
Pulses	Beans	0	16,490	50	16,540	5.3%
	Cowpeas	600	2,040	550	3,190	1.0%
Roots and tubers	Cassava	5,290	7,330	6,630	19,250	6.2%
	Sweet potatoes	1,450	2,290	0	3,740	1.2%
Fruits and vegetables	Tomatoes [1]	58	725	118	901	0.29%
	Onions [1]	15	126	58	199	0.06%
Permanent crops						
of which:	Banana	2,860	760	370	3,990	1.3%
	Sugar cane [1]	4,751	3,617	138	8,506	2.7%
	Mango [1]	776	584	669	2,029	0.65%
	Orange [1]	1,757	105	212	2,074	0.67%
	Pigeon pea	0	3,600	0	3,600	1.2%
Total					**310,300**	

[1] No data available in MAFC (undated); Agricultural Census 2007/2008 data were used instead (MAFC, 2012b).

Table 3.5 *Area planted in 2009/2010 of major crops by smallholder farmers in the* ***Sumbawanga cluster*** *– Sumbawanga Rural [2] and Nkasi Districts (MAFC, undated).*

Crop group	Crop	Area planted (ha)			
		Sumbawanga Rural	Nkasi	Total	% of total listed
Annual crops					
Cereals	Maize	78,050	25,780	103,830	35%
	Finger millet	12,250	8,860	21,110	7.0%
	Sorghum	7,310	0	7,310	2.4%
	Paddy rice	23,600	5,370	28,970	9.7%
	Wheat	2,750	340	3,090	1.0%
Pulses	Beans	15,320	15,060	30,380	10%
Oil seeds	Sunflower	19,610	15,230	34,840	12%
	Groundnuts	8,250	7,890	16,140	5.4%
	Sesame	160	0	160	0.05%
Roots and tubers	Cassava	9,970	7,480	17,450	5.8%
	Sweet potatoes	12,080	6,640	18,720	6.2%
	Irish potatoes	13,370	1,640	15,010	5.0%
Fruits and vegetables	Okra [1]	547	271	818	0.27%
	Tomatoes [1]	355	79	434	0.14%
	Onions [1]	273	45	318	0.11%
Permanent crops					
of which:	Banana	10	70	80	0.03%
	Sugar cane [1]	883	143	1,026	0.34%
	Mango [1]	388	6	394	0.13%
Total				**300,080**	

1 No data available in MAFC (undated); Agricultural Census 2007/2008 data were used instead (MAFC, 2012b).

2 In 2012, part of Sumbawanga Rural District became the separate Kalambo District.

Large scale farms

Areas planted by **large-scale farms** are not included in the MAFC Basic Data, but were assessed in the 2007/2008 census. However, only regional level data were published and not individual districts (MAFC, 2012e). SAGCOT (2011) estimated that about 10,000 ha of sugar cane, 12,500 ha of rice and 8,000 ha of tea were planted by large-scale farms in all of SAGCOT.

Some of the larger-scale commercial farms operating in the study clusters are:

Presently, the Kilombero Sugar Company (KSCL) has two irrigated estates totalling about 8,000 ha of sugar cane in Kilombero District. In addition, an outgrower scheme consisting of about 8,000 smallholder farmers (up from 2,000 ha in 1998) grows 15,000 ha of sugar cane, and supplies about 43 percent of the cane crushed by the KSCL mills (Future Agricultures, 2014). This means that the area planted in with sugar cane in Kilombero District has increased from about 11,000 ha’s in 2009/2010 to 23,000 ha in 2014. Many outgrowers also cultivate paddy rice for their own consumption and to generate further income.

The Kilombero Valley Teak Company (KVTC) is a forestry company located in the Kilombero and Ulanga Districts. KVTC manages approximately 8,150 planted hectares of teak (New Alliance, 2014).

Kilombero Plantations Limited (KPL) produces rice and pulses on its 5,818 ha plantation. Most of this is rain-fed production, but KPL is in the process of developing irrigation on 3,000 ha. In addition, KPL works with outgrower smallholder farmers training them on System of Rice Intensification (SRI) technologies. They intend to scale up the outgrower scheme to over 5,000 farmers. (New Alliance, undated; Oakland institute, 2015)

Empien Company Limited, has recently started operating a 1,000 ha mixed farm at Ntatumbila Village (Nkasi District). Presently 320 ha are cultivated, with sunflower, maize, soybean and barley.

Msipazi farm in Nkasi District started operating only in 2015. Presently 130 ha of maize are grown, and a first crop of wheat was sown in early 2016. Land is still being cleared for this farm.

3.1.2 Pesticides

Registered pesticides

There has been a considerable increase in registered pesticides in Tanzania over the last decade, tripling in total number since 2007 (Table 3.6). The number of provisional registrations declined considerably. While the number of restricted pesticides grew, its fraction of the total number of registered pesticides declined. Most of the increase in restricted pesticides were herbicides.
No further assessment of these data was conducted, except for the number of reduced-risk pesticides (see Chapter 5).

Table 3.6 *Number of pesticide products registered in Tanzania.*

Pesticide group	2007			2011			2015		
	Full	Prov.	Restr.	Full	Prov.	Restr.	Full	Prov.	Restr.
Insecticides	76	124	18	358	74	22	502	54	20
Herbicides	36	53	1	205	22	17	313	20	24
Fungicides	35	51	5	247	23	5	344	19	6
Acaricides	13	11	13	33	8	13	38	8	13
Plant Growth Regulators	2			7			11		8
Nematicides		4	1	3	4		3		
Rodenticides	2	2		5	3		4	2	
Avicides		1		1	1				1
TOTAL	*164*	*246*	*38*	*859*	*135*	*57*	*1,215*	*103*	*72*
GRAND TOTAL		**448**			**1,051**			**1,390**	

Full = full registration for general use (5 years, renewable); Prov. = provisional registration for general use (2 years, non-renewable);
Restr. = restricted registration for specific uses/users (2 years, renewable).
Sources: TPRI (2007, 2011, 2015).

Pesticide imports and formulation

Regular statistics on volumes of import and local formulation of pesticides are not published in Tanzania, although a database is in preparation at TPRI. For a long time, accurate figures on pesticides importation have been difficult to obtain because when importers get the importation permits they sometimes import less than indicated on their permits, and no feedback is provided to the registrar of pesticides.

Lekei *et al.* (2014a) calculated that in the fiscal year 2013/2014, a total of 11,482 MT of pesticides (formulated products, unless indicated otherwise) were imported into Tanzania (Table 3.7). This is a more than 4-fold increase when compared to the 2,500 MT estimated in 2003 (Agenda, 2006).

Table 3.7 *Pesticide imports into Tanzania, from July 2013 to June 2014.*

Pesticide group	Import (metric tons)	% of total
Insecticides	1,390	12
Herbicides	2,425	21
Fungicides	6,528	57
Restricted categories (including fumigants, technical materials and high-risk products)	1,059	9

Source: Lekei *et al.* (2014a).

Data on pesticide import values are regularly published by the Tanzania National Bureau of Statistics (NBS, undated). A steady rise in import values is seen, increasing 4-fold from 8 million US$ in 2005 to 34.3 million US$ in 2013 (Figure 3.1), which is consistent with the increases in volume imported over approximately the same period.

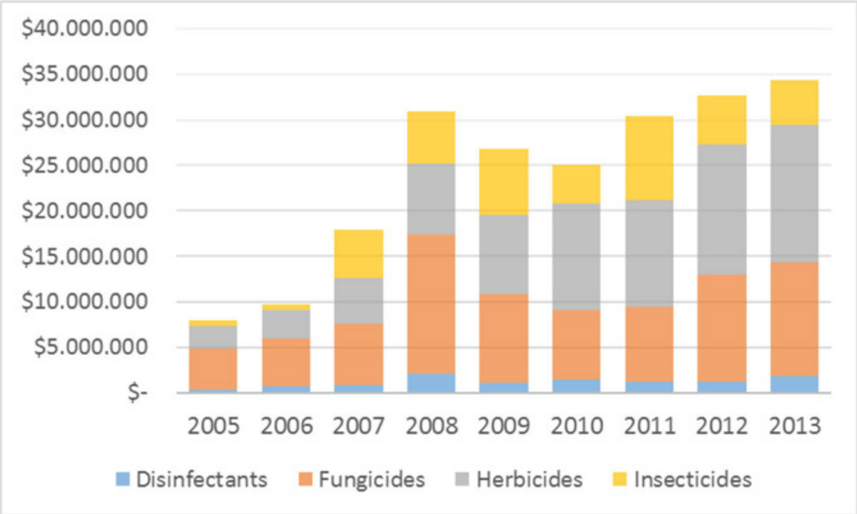

Figure 3.1 *Pesticide imports into Tanzania (import value in US$) (Source: NBS, undated).*

Pesticide use

It was estimated, a decade ago, that 18% of pesticides in Tanzania was used in the public health sector for malaria vector control, while 81% is used in livestock and agricultural sectors and 1% is used in other areas including protecting buildings from damage caused by insect pests (Agenda, 2006). A more recent estimate is not available.

The 2007/2008 Sample Census of Agriculture provides the latest data on pesticide use intensity by smallholders. Nation-wide, insecticides were most applied, on 9% of the area planted with annual crops; fungicides on 1% and herbicides on 2%. Regional pesticide use intensity was highly variable though (Table 3.8).

Table 3.8 *Percentage of the area planted with annual crops of smallholder farmers on which pesticides are used (2007/2008).*

	Insecticides	Fungicides	Herbicides
National	9%	1%	2%
By region			
Morogoro	2.4%	1.1%	14%
Iringa	23%	3.1%	0.5%
Rukwa	3.4%	0.8%	0.6%

Source: MAFC (2012a).

In Morogoro region, insecticide use was below the national average. Most insecticides were used on pulses, followed by fruits & vegetables, cereals and oil seeds & nuts (Figure 3.2). Herbicide use was higher, being applied on 14% of the area planted, mainly on cereals. Fungicide use in the region approached the national average; they were mostly applied on cereals and fruits & vegetables.

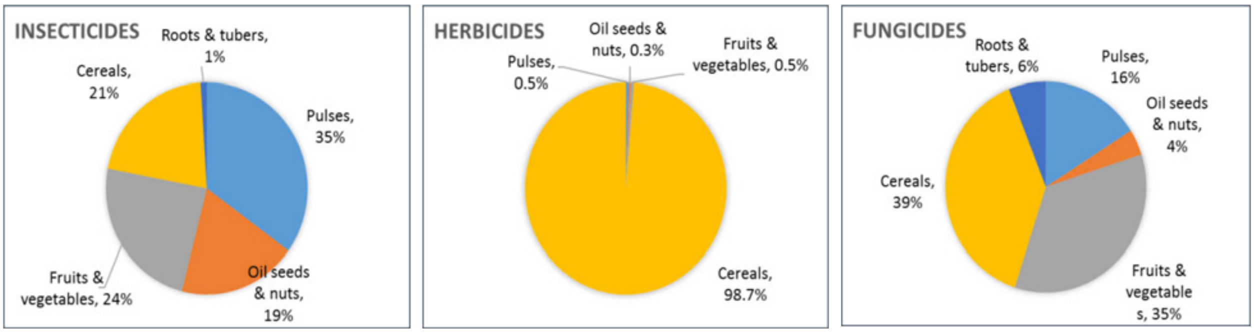

Figure 3.2 *Pesticide use by crop type, for smallholders in Morogoro region. Percentage is of the total area treated with that type of pesticide (MAFC, 2012c).*

In Iringa, pesticides were applied on ~160 000 ha in 2008, down 23% from the acreage receiving pesticides treatments in 2003. The reason of this decline was not clear; the high cost of pesticides, adoption of IPM or use of pest resistance varieties were all given as possible explanations. Insecticides were used considerably more in Iringa than the national average, on 23% of the planted area, but it was not specified on which crops (MAFC, 2012b).

Pesticide use intensity by smallholders in Rukwa region was below the national averages in 2007/2008 (Table 3.3). Most insecticides were used in cereals (mainly maize) and cash crops (e.g. tobacco, cotton) (Figure 3.3). Fungicides were mainly used in cereals (primarily maize), cash crops (tobacco and groundnut), and also in fruits and vegetables (mainly tomato and onion) (MAFC, 2012d).

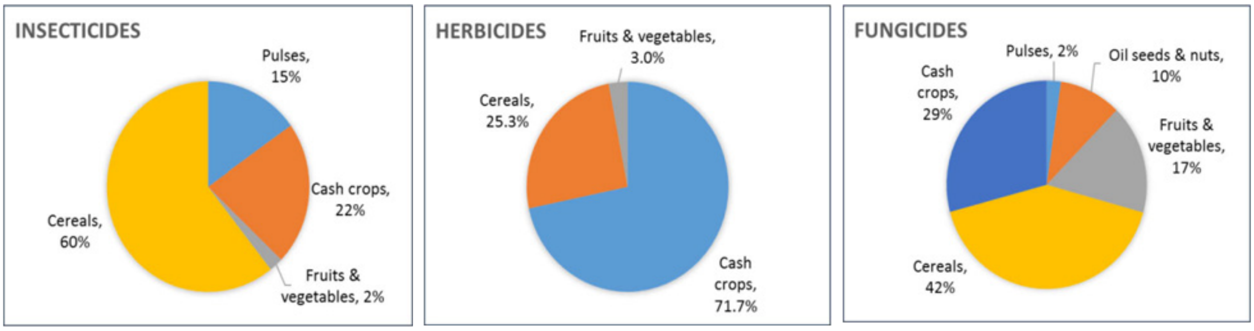

Figure 3.3 *Pesticide use by crop type, for smallholders in Rukwa region. Percentage is of the total area treated with that type of pesticide (MAFC, 2012d).*

No recent data appear to be available on pesticide use at national, regional or crop/sector level.

Our interviews in Rukwa region (Sumbawanga Rural, Nkasi and Kalambo districts) indicate that most pesticides are used in maize (mainly herbicides, some insecticides and fumigants/insecticides for grain storage) and in horticulture (mainly insecticides). Pesticide use on most other crops appears to be very limited (Table 3.9).

Visits to a number of agro-dealers in the region showed that the range of pesticides being sold is quite limited when compared to the products registered in Tanzania. All pesticides sold are relatively "old chemistry", except for the insecticide flubendiamide, specifically imported for use against the newly introduced pest of tomato, the tomato leafminer (*Tuta absoluta*). Various pesticide products would generally be considered as a posing a relatively high risk for use by smallholder farmers (profenofos, chlorpyrifos, paraquat).

Pesticide store in rural area of Sumbawanga. Photo: Harold van der Valk, Falconsult.

Table 3.9 *Main pesticides on sale in Sumabwanga Rural, Nkasi and Kalambo Districts (sample of 4 agro-dealers – this study).*

Pesticide group	Active ingredient	No. shops (selling products with these a.i.'s)	Cited uses (not exhaustive)
Insecticides	Profenofos	4	Maize, horticulture, beans
	Profenophos + cyhalothrin	1	Horticulture
	Chlorpyrifos	2	Horticulture, groundnut, maize
	Lambda-cyhalothrin + acetamiprid	1	Horticulture
	Lambda-cyhalothrin	3	Horticulture
	Cypermethrin	1	
	Flubendiamide	1	Tomato
	Fenitrothion + deltamethrin	1	Stored products
	Chlorpyrifos-methyl + cypermethrin	1	Stored products
	Aluminium phosphide	1	Stored products
	Pirimiphos-methyl	1	Stored products
Herbicides			
	Oxyfluorfen	1	
	2,4-D	2	Maize
	Paraquat	2	
	Ametryn +atrazine	1	
	Glyphosate	3	Maize, soybean, sunflower
	S-metolachor + atrazine	1	
	Fomesafan	1	Beans
Fungicides			
	Sulphur	1	Sesame
	Chlorothalonil	2	Sesame
	Mancozeb	4	Tomato, yam
	Mancozeb + cymoxanil	1	
	Mancozeb + metalaxyl	3	Horticulture
	Mancozeb + sulphur	1	
Anti-parasitics	Avermectin, Abamectin	2	Veterinary

Similarly, the most common pesticides sold in Kilombero District are shown in Table 3.10. Relatively large quantities of the herbicides 2,4-D and glyphosate, and the insecticides pirimiphos-methyl and endosulfan were sold. Most other insecticides and all fungicides were only distributed in small quantities.

It appears that pesticides shown in Tables 3.9 and 3.10 are typical of the pesticides sold by retailers throughout the country. Very similar inventories were made in 2006 in Arumeru District (Agenda, 2006; Lekei *et al.*, 2014b) and Karatu District in 2010 (Ngowi, 2011) (all in Arusha Region), and in horticulture in northern Tanzania (Lema *et al.*, 2014).

These inventories also show that few new pesticide products seem to come onto the market, even though many more have been registered over the same time period (see Table 3.6). Most of the new pesticides were registered for the cut flower industry and are mainly imported for that specific sector; some others are used for horticultural crops, especially in areas where the Tanzania Horticultural Association (TAHA) plays an important role to facilitate exports.

Table 3.10 *Main pesticides distributed by retailers in Kilombero District (Source: District Agricultural Team).*

Pesticide group	Active ingredient	Quantity distributed (kg or litres)		
		2012/13	2013/14	2014/15
Insecticides				
	Chlorpyrifos	50 L	73 L	396 L
	Deltamethrin	--	--	130 L
	Lambda-cyhalothrin	--	--	235 L
	Diazinon	115 L	138 L	196 L
	Fenitrothion	120 L	114 L	--
	Pirimiphos-methyl	3,200 kg or L	2,100 kg or L	2,100 kg or L
	Carbofuran	15 kg	17 kg	22 kg
	Endosulfan	1,000 kg	500 kg	250 kg
Herbicides				
	2,4-D	22,014 L	23,892 L	48,182 L
	Paraquat	--	--	1,852 L
	Glyphosate	8,674 L	8,537 L	48,182 L
Fungicides				
	Metalaxyl-M	30 kg	176 kg	103 kg
	Copper hydroxide	605 kg	389 kg	285 kg
	Epoxiconazole	--	--	17 kg
	Chlorothalonil	--	--	30 L
	Mancozeb	224 kg	197 kg	181 kg
	Mancozeb + metalaxyl	--	--	500 kg
Rodenticides				
	Zinc phosphide	60 kg	150 kg	5.5 kg

Large commercial farmers may use more specific packages of pesticides.

The Kilombero Sugar Company (KSCL) mainly uses herbicides both before/at planting of the cane and during the ratoon stage. These include pendimethaline, metribuzine, chlorimuron, paraquat, MSMA, MCPA, diuron, hexazinone, atrazine, ametryn, glyphosate, acetochlor, triclopyr, Halosulfuronmethyl. Triadimefon is used as a fungicide. Insecticides seem not to be used much in cane (KSCL data, this mission).

Kilombero Plantations Limited grows rice and pulses. They apply a pest and disease monitoring system on the large-scale farm to ensure that pesticides are applied only when needed. The herbicide 2,4-D is used on the plantation, and glyphosate by outgrower farmers for weed control before planting. Insecticides, including chloropyrifos and imidacloprid, are used by smallholder farmers for control of rootgrubs, stemborers and whiteflies on rice. They also use lambdacyhalothrin for control of pests on tomato and the fungicides mancozeb and chlorothalonil on sesame.

Pesticide use intensity
While no trends in pesticide use at the region or district level have been published, pesticide import data are available for longer time period (see above). We therefore compared pesticide imports (as a proxy for pesticide use) with total crop production and areas planted over the same period. Data for the 27 main crops[1] included in the CountryStat database of the NBS were used. Horticultural crops are not included in this dataset. Trends over time in total production and area planted were compared with total pesticide imports.

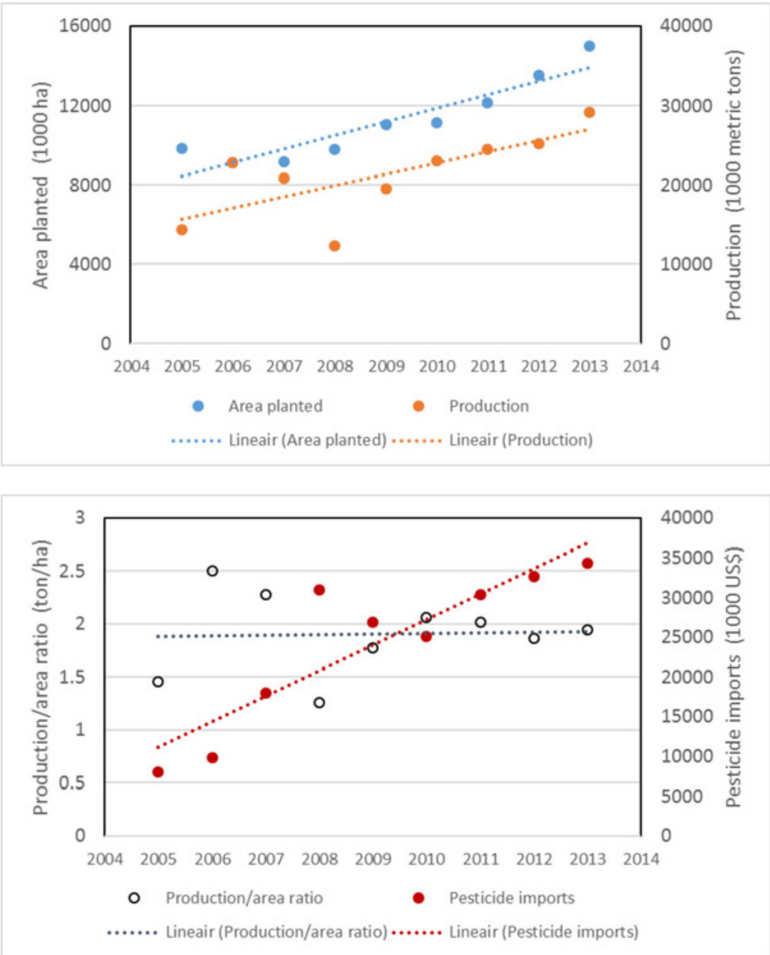

Figure 3.4 *A. Area harvested and total production of 27 key crops in Tanzania, for the period 2005 – 2013. B. Pesticide import value and production/area ratio for the same 27 crops.*

Figure 3.4a shows that the total national area harvested for the 27 key crops increased steadily between 2005 and 2013, from about 10 to 15 million hectares (1.5x). Over the same period, total production of the same crops increased from about 14 million to 29 million tonnes (2x). Much of the increase in agricultural production for these crops was therefore a result of the larger areas harvested. This is confirmed by Figure 3.4b, which shows that the production/area ratio has remained flat for the nine years concerned; i.e. on average, no increase in "crop yield" was observed. However, during the same period, pesticide imports quadrupled.

[1] The crops in the Production Core data set of the Tanzania NBS are: Barley, Beans (dry), Maize, Rice (paddy), Sorghum, Millet, Wheat, Seed cotton, Cassava, Sesame seed, Sunflower seed, Potatoes, Sweet potatoes, Pyrethrum (dried), Coffee (green), Tobacco leaves, Cashew nuts (with shell), Groundnuts (with shell), Tea, Pigeon peas, Cow peas (dry), Bambara beans, Oil palm fruit, Bananas, Peas (dry), Soybeans & Sisal.

Admittedly, this is a very rough assessment, and fruits and vegetables are not included even though they are known to consume much pesticides. It therefore goes too far to suggest that increased pesticide imports (and use) has not contributed at all to yield increases. However, since various crops included in the assessment do consume large quantities of pesticides, the trends observed in Figure 3.4 indicate that further assessment of the need and efficacy of pesticide use in Tanzania is merited.

3.2 Future situation

3.2.1 Introduction

Future development of pesticide use in SAGCOT depends on various aspects, including:

Cropping trends
- Expected increase/decrease in acreage of existing crops
- Expected acreage of new crops

Pests
- Possible increase in pest/disease/weed pressure
- Possible introduction and development of new pests

Extension / agricultural input distribution
- Increased coverage of agricultural input supplies
- Efficacy of advice on sound pesticide use, biocontrol and IPM
- Taxing/subsidy regimes favouring/discouraging pesticide use or IPM

Resulting in:
- Expected increase/decrease in existing pesticide use intensity (rates and frequency of application)
- Introduction of new (more or less hazardous) pesticides

No exact projections can be made of these developments on the basis of the available information. However, various elements for such predictions are presented below.

3.2.2 Crops

SAGCOT projections
In the SAGCOT Blueprint, projections are made of development of agricultural production in each of the clusters covered by this study (SAGCOT, 2011) (Table 3.11). The main focus of expansion in SAGCOT is on mixed crop and livestock farms, both of commercial and smallholder producers. Sugar estates and rice schemes are other key crops for expansion. The relatively greatest increases in cropped areas compared to the present situation are seen in bananas and sugar cane.

Table 3.11 *Projected additional cropped areas development Ihemi, Kilombero and Sumbawanga clusters (SAGCOT 2011).*

Cluster Type of farm	By 2015		By 2030		Increase compared to 2010 [1]
	No	Area	No	Area	
Ihemi					
Mixed crop & livestock farm (commercial & smallholder) (2650 ha)	6	15,900 ha	16	42,400ha	-- [2]
Banana plantation (150 ha)	1	150 ha	4	600 ha	new
Total Ihemi		**16,050 ha**		**43,000 ha**	
Kilombero					
Mixed crop & livestock farm (commercial & smallholder) (2650 ha)	1	2,650 ha	5	13,250ha	--
Rice scheme (including upgrading of current schemes) (2000 ha)	2	4,000 ha	7	14,000ha	+15 %
Sugar estate (expanding and new)	--		2	20,500 ha	+140 %
Citrus farm (600 ha)	1	600 ha	5	3,000 ha	+50 %
Banana plantation (150 ha)	2	300 ha	7	1,050 ha	+25 %
Total Kiombero		**7,550 ha**		**51,800 ha**	
Sumbawanga					
Mixed crop & livestock farm (commercial & smallholder) (2650 ha)	1	2,650 ha	23	60,950 ha	--
Rice scheme (including upgrading of current schemes) (2000 ha)	--		4	8,000 ha	+25 %
Citrus farm (600 ha)	--		14	8,400 ha	New
Banana plantation (150 ha)	--		13	1,950 ha	+2300 %
Total Sumbawanga		**2,650 ha**		**79,300 ha**	

[1] Increase in area planted in 2030 when compared to 2010 (Tables 3.3 – 3.5)

[2] Since the composition of mixed farms is not specified, increases in cropped areas for individual crops cannot be provided

Another indicator of the expected growth in agricultural production in SAGCOT is the projected increase in irrigation potential. The SAGCOT Blueprint very ambitiously sets an annual increase of 11,000 ha/year over the whole corridor, which includes both newly developed schemes and rehabilitation of existing schemes.

Expected increases in irrigation potential for Ihemi, Kilombero and Sumbawanga clusters are shown in Table 3.12. Areas of existing irrigation schemes are estimated for 2012/2013, based on data presented by Kashaigili *et al.* (2014). For the three clusters combined, a six-fold increase in irrigated areas is planned in SAGCOT until 2030.

It can be expected that the main crops grown under irrigation will be rice, sugar cane and, to a lesser extent, horticultural crops.

Table 3.12 *Projected additional irrigated areas (ha) in Ihemi, Kilombero and Sumbawanga clusters (SAGCOT, 2011; Kashaigili et al., 2014).*

Cluster	Present irrigation schemes	Projected additional irrigation potential (cumulative)		Increase in 2030 compared to 2012/13
	2012/2103	2015	2030	
Ihemi	7,950	7,650	20,600	+160 %
Kilombero	9,280	6,150	44,300	+380 %
Sumbawanga	2,200	1,250	47,700	+2000 %
Total (3 clusters)	19,430	15,050	112,600	+480 %

ASDP-2 projections

The 2nd Agricultural Sector Development Programme (MAFC, 2016) more recently identified priority commodities that are considered critical for economic growth and poverty reduction in Tanzania, while showing good prospects for improving productivity, commercialization and scaling up of production. Priority commodities for Southern Tanzania are show in Table 3.13. Most of these crops have also been identified in the SAGCOT Blueprint, with the exception of coffee and tea, which are seen as priority cash crops by ASDP-2, but not identified as such in the SAGCOT Blueprint.

Table 3.13 *ASDP-2 Priority Commodities (MAFC, 2016).*

Region	Priority food crops	Priority cash crops
West – South-Western highlands	Maize, pulses, rice, bananas,	Coffee
Southern highlands	Maize, rice, horticulture	Tea, coffee

Private investments

Various private investments have been announced for SAGCOT. Some of those intentions, for the 3 clusters under study, are listed below (New Alliance, 2014 & undated; scoping mission):

- **Kilombero Valley Teak Company (KVTC)** intends to add 2,500 – 3,000 ha of plantation (up from the existing 8,000 ha) as well as an Outgrower Support Programme of 200 ha/year.
- **Kilombero Plantations Limited (KPL)** intends to convert 3,000 ha, out of 5,800 ha, of rain-fed agriculture to irrigation, and to scale up its outgrower scheme to 5,000 farmers.
- **Silverlands Tanzania** intends to convert rain-fed agriculture to irrigation on 117 ha at Selous Farms.
- **HomeVeg Tanzania** intends to engage 6,000 smallholder producers of horticultural crops (location in SAGCOT not specified).
- **Empien Company (Nkasi)** intends to take an additional 300-400 ha of mixed crops in production.
- **Msipazi Farm (Nkasi)** intends to produce maize and wheat on several 100’s of ha’s.

Assuming all these investments effectively take place, they would comprise about 25% of the projected investments for 2015 in the three clusters (Table 3.11).

3.2.3 Pests

Increased pressure by pests (insects, mites, rodents, birds), diseases and weeds will often lead to a greater use of pesticides, in particular if alternative pest management measures are not in place. Cropping intensification and extension pose various risks with respect to increased pest[2] pressure, among others: Increased cropping frequency, while using pesticides, may lead to pest resistance. Reduced crop rotation may lead to increased pest pressure, development of secondary pests and pest resistance. Growing crops in monocultures increases the risk of secondary pest development. The introduction of new varieties may, if phytosanitary measures are insufficient, lead to new pests. This is a recognized problem for SAGCOT, as outlined in the SAGCOT Greenprint and the SAGCOT IPM Plan (SAGCOT, 2013a, 2014). Future intensification of agricultural production in SAGCOT will need to follow sustainable approaches, such as IPM, biocontrol, cropping/soil fertility practices leading to healthy crops, and use of appropriate reduced-risk pesticides.

Table 3.14 shows the actual key pests, diseases and weeds for major crops in SAGCOT and gives examples of possible future pest development. In all listed key crops, with the possible exception of sugarcane, unchecked expansion/intensification is likely to lead to increased pressure of, in particular, pests and diseases.

For example, almost without exception, programmes to expand/intensify horticultural production in Africa in Asia have led to increased pesticide use, in spite of good intentions at the programming stage to favour IPM and biocontrol. Only after pest resistance, pesticide residues and human health impact

[2] The term pest is used in this report as a generic term for pests, diseases and weeds.

had risen to untenable levels, were measures taken to effectively introduce IPM and limit the availability of problematic pesticides.

Table 3.14 *Present key pests, diseases and weeds for major crops in SAGCOT and indications of possible future pest development. Source: experiences of the scoping team and discussions with stakeholders.*

Crop	Present pests [1]	New/increased pest problems under intensification/expansion (not exhaustive)
Maize	Weeds: various Insects: stemborers, African armyworm Diseases: maize streak virus, northern leaf blight, grey leaf spots Post-harvest: larger grain borer	Intensification resulting in less mixed cropping and reduced use of legumes as short fallow, will increase stemborer infestations. Uncontrolled seed movement/distribution for extension of maize acreage can favour the spread of the maize lethal necrosis disease. Introduction of GM (genetically modified) maize may lead to a reduction of insecticide use but an increase in herbicide use.
Rice	Weeds: *Cyperus*, *Striga* Insects: stemborers, rice gall midge, flea beetles (as vector of RYMV) Diseases: rice yellow mottle virus (RYMV), rice blast	Double cropping in irrigated rice will increase insect pest and granivory bird infestations. Abundance of crops ie paddy may favour field rodents outbreaks Extension of rice acreage will increase granivory bird infestations. Inadequately managed irrigation schemes will increase weed pressure. High nitrogen fertilizer inputs can increase susceptibility to certain pests and diseases.
Beans	Insects: aphids, bean leaf beetle, bean stem maggot Diseases: angular leaf spot disease, anthracnose, bean rust	Intensive cultivation of beans without sufficient rotation will increase disease pressure.
Horticulture	Insects: many Diseases: various	Importation of new (insufficiently tested) varieties of vegetable/fruits can lead to new pests and diseases, or development of previously secondary pests/diseases. Extension of horticulture acreage can lead to further spread of tomato leafminer (*Tuta absoluta*) also further spread of fruit fly(*Bactrocera invedans*) Increased reliance on insecticides for pest control will lead to resistance development; and subsequent rise in insecticide use.
Bananas	Insects: Banana weevil (*Cosmopolite sordidus*) Diseases: Sigatoka diseases, Panama disease (Fusarium wilt) Race 1, Banana *Xanthomonas* wilt (BXW) Nematodes: various	Extension of banana acreage and increase if transport of bananas/planting materials will favour the introduction and spread the devastating Banana *Xanthomonas* wilt disease, Panama disease TR4 (tropical race 4). Lack of crop rotation and inappropriate soil management will increase nematode infestations.
Sugarcane	Weeds: various	Further spread of yellow sugarcane aphid

[1] Primarily based on the SAGCOT IPM Plan (SAGCOT, 2014).

3.2.4 Pesticides

Both the SAGCOT Greenprint (SAGCOT, 2013a) and the Strategic Regional Environmental and Social Assessment (SRESA) (SAGCOT, 2013b), make projections of future developments of agriculture in corridor. They use 3 scenarios, which in the Greenprint are referred to as: i. *Business as usual*, ii. *Agricultural intensification with prevailing practices* (AIPP), and iii. *Agricultural Green Growth* (AGG).

The *Business as usual* scenario assumes some gains resulting from current and planned investments in agriculture and rural development, but rural poverty and environmental degradation will continue to increase.

Agricultural intensification with prevailing practices takes into account that major external investments are made in the corridor to expand input-intensive agriculture, which will increase food production, but at the expense of adverse environmental impact and a possible undermining of the region's productive capacity.

The *Agricultural Green Growth* scenario, on the other hand, combines sustainable intensification and production growth with effective measures to reduce environmental degradation.

Quantified outputs of the Greenprint models are crop production volumes, deforestation levels, net greenhouse gas emissions and water use. The SRESA also models the use of chemical fertilizers.

Pesticides, however, are not included in any of these scenarios. The Alterra team has requested the models and model assumptions, to be able to apply those to the development of pesticide use, but has not (yet) received those. In the absence of more precise projections of potential future pesticide use, the following rough estimates were made.

Agricultural intensification with prevailing practices
In Chapter 3.1.2, national statistics for the main crops in Tanzania indicated that the 1.5x increase in acreage observed over the last 10 years, correlated with a 4-fold increase in pesticide imports (Figure 3.4). SAGCOT projected that the acreage planted between 2015 and 2030 in the 3 clusters of this study would grow from 26,250 ha to 174,100 ha (Table 3.11), which is a 5.6-fold increase. Assuming no changes in practices when compared to the previous decade, and thus a continuation of the national trend in pesticide use also in the SAGCOT clusters, a 15-fold increase in pesticide use would result in the 3 clusters between 2015 and 2030. Admittedly, this is a crude projection, but it is based on present trends. Even with a large margin of error, it indicates important increases in pesticide use.

Furthermore, as indicated in Chapter 3.2.3, most of the crops for which production will be expanded and/or intensified are likely to see higher infestation levels than presently is the case. This would add to rather than limit the projected increase in pesticide use.

SAGCOT expects to increase access of famer to agricultural input suppliers. While input retailers can, and even should, provide stewardship for the pesticides that they sell (e.g. advice on good application practices, protective equipment, empty pesticide container collection and management), it cannot be expected that retailers will advise farmers to reduce pesticide use. This type of advice will need to come from independent extension and advisory services. The Government of Tanzania is in the process of increasing the coverage by agricultural extension services in the country, which will ensure that more farmers are reached. However, it appears that most extension agents are generalists and may not be able to provide good pest management advice (yet). That, together with a tax regime that does not favour IPM/biocontrol (see Chapter 5), suggest that agricultural expansion/intensification in SAGCOT is likely to lead to (large) increases of pesticide use.

Agricultural Green Growth
If the above trends are to be broken, and the reliance on pesticides reduced, measures need to be taken to effectively change pest management practices in Tanzania in general, and in the corridor in particular.

The SAGCOT IPM Plan has given a considerable number of general recommendations on how to implement IPM and contribute to Agricultural Green Growth (AGG). However, these are not yet operationalized into practical activities. Until that is done, it is difficult to see how prevailing practices can be turned.

4 Environmental & human health impact

The (mis)use of pesticides can have serious adverse effects on human health and the environment. For example, there may be an increase in pesticide exposure and health risks to users and the environment. Furthermore, when substandard formulations are used these may contain impurities or chemicals that can increase toxicity to mammals and other non-target species. The development of pest resistance to pesticides can aggravate any such existing problems. According to the Strategic Regional Environmental and Social Assessment (SAGCOT, 2013b), the human and environmental health impact of the use of pesticides in the SAGCOT corridor is mainly related to the following:

- Use of toxic formulations by unskilled workers (including occupational health hazards);
- Impacts on water quality and aquatic ecosystems, especially of chemicals used in monoculture rice;
- Increased availability of pesticides for illegal uses in hunting and fishing.

In this chapter we review these impacts based on information retrieved during the interviews and workshop in April and July 2016 respectively. We also review some of the major environmental and human health issues related to pesticide use as presented in the scientific literature, with a focus on East Africa and Tanzania, including references to other sub-Saharan African countries.

4.1 Environmental Impact

4.1.1 Effects on water quality, aquatic ecosystems and soils

One of the main environmental risks of pesticide use in the SAGCOT corridor is water pollution. This problem originates from various sources. A study conducted by one NGO showed that some farmers often prepare their pesticides for application close to water sources, including those used by communities for drinking and other household purposes (ENVIROCARE, 2010). Furthermore, after pesticide application people frequently clean and wash their pesticide sprayers and other equipment near water sources or on the farm fields. Such problems are generally observed in many developing countries (El Sebae, 1993), including those in Africa (Asfaw *et al.*, 2010; Macharia *et al.*, 2013), with limited access to accurate information regarding pesticide use and management. Run-off may be a big problem in the high rainfall areas of the uplands where pesticides are used, on cabbage, tomatoes and other crops; after heavy rains, the pesticide residues flush down to lower altitudes. Aerial spraying of pesticide is sometimes carried out on large scale sugarcane and rice farms and is always done for control of Red-billed quelea (*Quelea quelea)* colonies and roosts, which may result in drift of pesticides to surface water sources. Run-off and drift of pesticides to water bodies may affect aquatic ecosystems, notably aquatic invertebrates, fish and amphibians. Horticulture near water bodies has reportedly affected water quality in Ruaha and Selous reserves (Amani Ngusaru, pers. comm.).

Water pollution also appears to be a problem in rice cultivation (Benard *et al.* 2014). Rice farmers in the corridor generally lack knowledge or possibilities to manage the pesticides as prescribed by the manufacturers, which exacerbates water pollution (Stadlinger *et al.*, 2011; Benard *et al.*, 2014). The WWF Ruaha Program states that rice farmers often misuse pesticides, specifically the herbicide 2,4-D, and frequently dispose of empty containers in the rivers of the corridor (Benard *et al.*, 2014). The herbicide 2,4-D is widely used in the corridor. It generally has only moderate toxicity to birds and mammals and is slightly toxic to fish and aquatic invertebrates (see, e.g., Table 4.3). There has been some discussion about the carcinogenic risk of 2,4-D. The International Agency for Research on Cancer classified this herbicide as “possibly carcinogenic”, but the European Chemicals Agency (ECHA) does not classify 2,4-D as having carcinogenic potential and the US-EPA considers it unclassifiable, so overall there is no strong indication of its carcinogenicity.

Apart from small-scale farming, industrial farming has also been linked to water pollution. For example, one large-scale land deal resulted in the contamination of water sources in the Iringa region (Arduino *et al.*, 2012), where an area of 1,400 ha was rented to investors for agriculture and livestock-keeping in 2008. These activities possibly caused contamination of water sources serving a population of 45,000 with the fungicide ARTEA 330 EC (cyproconazole + propriconazole; Arduino *et al.*, 2012).

Lake Rukwa is the most important surface water body in Sumbawanga. Photo: Harold van der Valk, Falconsult.

4.1.2 Persistent organic pollutants in water, fish and sediments

Persistent organic pollutants (POPs) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. They include the organochlorine pesticides that break down slowly in the environment and accumulate in the fatty tissues of animals. Thus, they stay in the environment and food web long after the being applied, with potential significant impacts on human health and the environment. Agricultural fields in Tanzania are generally located in plains, highlands and valleys criss-crossed by rivers and streams, which carry pesticide residues into estuaries and into the Indian Ocean coastal region, contaminating sediments that act as a sink to most organochlorine residues in aquatic environments (Kishimba *et al.*, 2004; Mdegela *et al.*, 2009; Bettinetti *et al.* 2011). It was reported that analytical results of water, sediment, soil and some biota from some locations in Tanzania revealed the dominance of organochlorines in all samples, especially DDT and HCH (Kishimba *et al.*, 2004).

Despite a ban in agriculture since 1991 organochlorine pesticide DDT pollution was locally severe in coastal (Kibaha) Tanzania where obsolete pesticides received as donation from Greece were stocked (Marco & Kishimba, 2007). Sampling of organochlorine pesticides and metabolites in soil samples 5–14 years after clean-up of former storage sites in Tanzania indicated that there were no significant degradations or transformations of the POPs for most of the sites (Mahugija *et al.*, 2014), suggesting long-term and significant environmental problems associated with storage of obsolete POPs. The levels in aquatic biota near Kibaha storage sites were much higher than those in the water most likely due to bioaccumulation (Kishimba *et al.*, 2004). The concentration levels of organochlorines detected in the sediment and fish along the Indian Ocean Coast and in Lake Naivasha in Kenya reflected the agricultural usage of POPs including aldrin, dieldrin, lindane and endosulfan, as well as recent usage of DDT (Gitahi *et al.*, 2002; Barasa *et al.*, 2007, 2008).

At present, no organochlorine pesticides are registered anymore in Tanzania. Any organochlorine residues in the environment are thus likely the result of historical use, a limited number of contaminated former storage sites, use in the control of malaria (DDT, endosulfan), or in vegetables, cotton and coffee (endosulfan; Polder *et al.*, 2014) and possibly illegal use. Recent work has shown that at present, the concentrations of organochlorine pesticides in water and fish in Morogoro urban and peri-urban areas do not indicate a risk to consumers (Mdegela *et al.*, 2014). The measured POP levels in tilapia in four Tanzanian lakes were all below MRLs of the EU or were lower than recommended levels and the fish can be considered safe for human consumption (Polder *et al.* 2014). However, Polder *et al.* (2014) suggest that some of the POPs might pose a health risk to the fish species, which are already threatened by overfishing, and contribute to their decrease of both number and variety.

4.1.3 Secondary poisoning of wildlife

Pesticide pollution also impacts other wildlife resources, some of which are briefly discussed below.

Red-billed quelea is a small seed-eating bird which is considered a major pest of crops in East Africa (McWilliam & Cheke, 2004), including in the SAGCOT corridor. Quelea birds are traditional outbreak and migrant pest in Tanzania, although the magnitude of outbreaks varies among the years. There is a distinct possibility that queleas will increase with increased cereal crops intensification. Normally the birds' outbreak season begins in January and lasts to September/October in irrigated farms (Elliott *et al.*, 2014). This period coincides with growing season of cereal crops in most parts of Tanzania including Arusha, Kilimanjaro, Manyara, Coast, Mwanza, Mara, Mbeya, Morogoro, Dodoma, Singida, Tabora and Shinyanga regions.

Surveys for concentrations of quelea birds are conducted by Central Government in collaboration with Local Government authorities. Control of quelea birds is carried out by aerial spraying using the synthetic avicide Queletox®, which contains the organophosphate fenthion. Avicides are procured by the Tanzanian Central Government (Ministry of Agriculture) and then distributed to Plant Health Zonal Centers (Zonal Plant Protection centers). On average, 10,000 litres of avicide are procured annually, representing a spending of TShs. 350 million (c. USD 203,000) per year (Sergei Mutahiwa *in litt*. 2016). Despite a short half-life in the environment, fenthion has a high toxicity to birds, bees, fish and estuarine and aquatic invertebrates (EXTOXNET 2003). It has been reported that spraying of queleas with Queletox® has shown to affect many birds, particularly raptors that die from secondary poisoning after eating the dead and dying queleas (Keith & Bruggers, 1998). Adverse effects on non-target birds have also been reported from Tanzania (Cheke *et al.*, 2012). An alternative to quelea spraying is capturing them with nets; this would allow safe consumption of queleas afterwards and release of other bird species captured. This approach has been tested in Tanzania (Elliot *et al.*, 2014).

Table 4.1 *The use of Queletox® in the SAGCOT corridor between 2012 and 2015, with the numbers of queleas killed.*

Year	Districts	Ha sprayed	Birds killed (millions)	Queletox used (liters)
2012	Kilosa, Mvomero	28	3.5	300
2013	none	none	none	none
2014	Kilosa, Mvomero	197	21.8	750
2015	Morogoro, Kilosa, Mbarali	760	18.0	1,380

Source: Plant Health Services, Min. of Agric. Quelea Control Report 2012-2015 (March 2016).

In addition to fenthion for bird control, bromodiolone 0.005% rodenticide is used for the control of field rodents (*Mystomis* sp) and the rodenticide zinc phosphide was reported to be used especially in maize after planting although it is not registered in Tanzania but still sold. Endosulfan is also still in stock in shops but not registered. Although not officially reported, some farmers indicated during the scoping mission that toads, chameleons and insects (bees) appear to have declined in and around fields in the SAGCOT.

4.1.4 Impact of pesticide use on pollination services

Beekeeping is mostly restricted to forests throughout the SAGCOT corridor, although bees obviously also occur near and in farmland. The most common honeybee species is *Apis mellifera* subsp. *litterea*, but a different subspecies occurs in the mountains (*A. m. monticola*). Stingless bees are also found in the corridor. In some areas beekeepers are organised. The beekeepers are reached through extension services and trained in groups. Each district has a beekeeping agent. Beekeepers are sedentary and use traditional hives; some are paid by farmers. The types of honey vary with habitats, from Miombo honey to Acacia, Sunflower and Sisal honey. The districts with the highest potential for honey production, based on forest cover, are Mpanda, Manyoni and to a lesser degree Chunya, Urambo, Sikonge, Iringa and Mbeya. Pollination services have been little developed and are little known to small scale farmers. According to the National Beekeeping Policy of 1998,the Forest Act of 2002 and the Beekeeping Act of 2002, bees need to be kept more than 8 km from farmland, but closer when IPM is practiced.

4.1.5 Increased availability of pesticides for illegal uses in hunting and fishing

The use of pesticides to poison wildlife is a large and growing problem throughout East Africa, including Tanzania (Ogada, 2014). Common reasons for poisoning are control of animals causing damage on crops and livestock, harvesting fish and bush meat, harvesting animals for traditional medicine, poaching for wildlife products, and killing wildlife sentinels (e.g., vultures because their aerial circling alerts authorities to poachers' activities). Methods used to poison wildlife include baiting carcasses, soaking grains in pesticide solution, mixing pesticides to form salt licks, and tainting waterholes. All classes of pesticides have been used to poison wildlife, including organochlorines, organophosphates, carbamates, and pyrethroids. Carbofuran is the most widely abused pesticide in Africa to kill wildlife, but other substances, such as strychnine, aldicarb, diazinon and monocrotophos are also frequently used. Strychnine is often the pesticide used to poison wildlife in Tanzania (Ogada 2014). All of these pesticides are banned—or their use is severely restricted—in the United States, Canada and E.U. countries. Populations of large carnivores and scavengers, particularly scavenging birds such as vultures, have been decimated by poisoning (Ogada *et al.*, 2016a).

Currently in Tanzania, elephant and carnivore poisoning is reportedly not a major problem (yet) compared to some other countries such as neighbouring Kenya. Here, lions, hyenas, jackals, leopards, wild dogs and many hundreds of (now classified as Endangered or Critically Endangered) vultures have fallen victim in the past decade as a result of poisoned baiting of large carnivores, notably lions. This is a reaction by people, in response to loss of livestock (Ogada, 2014; Ogada *et al.*, 2016a). Lions are relatively vulnerable to poison owing to their tendency to scavenge and, because poisoning is indiscriminate, whole prides can be decimated at once (Frank *et al.*, 2006). In East Africa, lion populations have been devastated by poisoning in recent years. In the early 1990s, the entire population of lions in Amboseli National Park was lost, mainly through poisoning events, and it has been estimated that lions will soon be extinct in southern Kenya because of spearing and poisoning. In Kenya, proprietors of agro-vet shops near wildlife areas know carbofuran as "lion killer," as that is how their customers commonly refer to it. Packs of wild dogs have also been poisoned mostly in retaliation for attacks on livestock in Tanzania (Ogada, 2014). Furthermore, there is little doubt that spotted, striped, and brown hyena have been exterminated in large parts of their former range owing predominantly to poisoning. There is ample evidence that local communities continue to use poisons against these species of hyenas throughout their remaining populations. In addition, poisoning of elephant carcasses to kill overhead circling vultures in order to avoid detection is a recent and increasing phenomenon also in East Africa, including Tanzania (Ogada *et al.*, 2016b). In the rice fields of western Kenya, where carbofuran is used to poison birds for bush meat, it is known locally as *dawa ya ndege*, meaning “a poison for birds”.

Although at present wildlife poisoning may be relatively limited in the SAGCOT region there is a distinct possibility that increased pesticide use will become a threat to wildlife in the protected areas of the corridor. This includes Ruaha National Park, where 55 African white-backed vultures, a spotted hyena, a black-backed jackal, a hooded vulture, a tawny eagle, two bateleur eagles and a lion were killed in a single poisoning event in May 2016 (WCS, pers. comm. to R. Buij, May 2016). Because these vast areas are remote and rarely surveyed, such reported incidents are likely to represent the tip of the iceberg. Although different legislative acts on poisons and pesticides prohibit the poisoning of wildlife and the environment in Tanzania (Table 4.2), like many other African countries, Tanzania currently lacks forensic field protocols, as well as storage and laboratory facilities to examine wildlife poisoning.

Apart killing wildlife, presently people kill fish using pesticides in the SAGCOT corridor. Endosulfan is used for fishing in southern Tanzania, according to reports by NEMC (pers. comm. 2016) and similar incidents have been reported elsewhere in the region (Polder *et al.*, 2014).

Table 4.2 *Legislative acts of Tanzania with specific articles related to the poisoning of the environment or wildlife.*

Legislation	Article related to poisoning wildlife
African Convention on the Conservation of Nature and Natural Resources, 2003	Article IX. SPECIES AND GENETIC DIVERSITY 3.b.iii) *the prohibition of the use of all indiscriminate means of taking and of the use of all means capable of causing mass destructions, as well as local disappearance of, or serious disturbance to, populations of a species, in particular the means specified in Annex 3:* Annex 3. Prohibited means of taking: Poison and poisoned or anaesthetic bait
Tanzania Environmental Management Act, 2004	8. POLLUTION PREVENTION AND CONTROL 110.2. *A person who discharges any hazardous substance, chemical, oil or mixture containing oil in any waters or any other segment of the environment, commits an offence.*
The Forest Act, 2002	PART V-FOREST RESERVES Forest Reserves other than Village and Community Forest Reserves 26. *On and after the coming into force of a declaration of a national or local authority forest reserve, no person, other than an existing right-holder exercising an existing right within such forest reserve in respect of which the existing right has been determined shall do any of the following acts in any such forest reserve unless and until such a person has been granted a concession or a licence or a permit in accordance with the provisions of this Act-* *(o) hunt, fish, use or be in possession of any trap, snare, net, bow and arrow, gun, poison or explosive substance used or capable of being used for the purposes of hunting or fishing;*
The Tanzanian Wildlife Management Authority Act, 2013	74. Unlawful methods of hunting *(1) Any person shall not, except by and in accordance with the written authority of the Director General previously sought and obtained or in accordance with regulations made under this Act –* (a) use for the purpose of hunting any; (ii) poison, bait, poisoned bait, poisoned weapon, stakes, net, gin, trap, set gun, pitfall, missile, explosives, ball ammunition, snare, hide, spear, fence or enclosure;
The Wildlife Conservation Act	No articles specifically related to wildlife poisoning

4.1.6 Monitoring of pesticides in the environment

Despite the potential pollution risks and the Water Resources Management Act of 2009[3] which states what monitoring needs to be performed, currently there are no large-scale monitoring schemes for pesticide residues in water and soils in the SAGCOT corridor. However, during discussions with large scale rice and sugarcane producers (KPL and Kilombero Sugar Company) it was indicated that they regularly undertake water quality monitoring activities (water sampling and analysis) because they abide to international guidelines of sustainable agricultural practices via their international investors. Elsewhere, monitoring of pesticide residues in water and soils is lacking as a result of lack of awareness on pesticide pollution and also the limited available finances for monitoring activities including sampling and analysis of samples in the laboratories. Officers of the Rufiji Water Basin mentioned that monitoring of potential bioaccumulation of pesticides in fish would be needed to quantify residue current levels and changes following agricultural intensification in the SAGCOT corridor. However, we were informed that at present they do not measure pesticide levels and do not have the capacity to do so because there appears to be no funding for monitoring of pollution.

4.2 Human health impact

Farmers come into contact with pesticides, whether in the field, during pesticide application, weeding, pruning, harvesting, re-entry to collect fire wood or vegetables, or in their homes also through reuse of empty pesticide containers for various other uses such as storage water for domestic uses, storage of local brew, etc. Storing pesticides may lead to a range of acute and/or chronic exposures, with potential adverse health consequences (e.g., Ngowi *et al.*, 2007; Tomenson & Matthews, 2009). Although the inhalation, dermal and oral routes of exposure are the most common, pesticide residues in food and water may add to indirect exposures common in the general population. The various problems underlying health issues associated with the (mis)use of pesticides by farmers are discussed below.

Accidental poisoning with pesticides happens frequently, and people often report health issues that include vomiting, skin irritation, skin problems and neurological system disturbances (dizziness, headache). This is a common phenomenon throughout East and sub-Saharan Africa (London *et al.*, 1998; Nweke & Sanders, 2009; Asfaw *et al.*, 2010; Macharia *et al.*, 2013; Stadlinger *et al.*, 2013). These health effects are often related to mixing of pesticides, although little quantitative information is available for the SAGCOT corridor. The mixing (preparation before application) of the pesticide is normally done in the field but also near water sources such as wells and rivers. Farmers will use buckets for fetching and pouring water for mixing, and the contaminated clothes and the used knapsacks are subsequently washed in rivers or shallow wells which pollute them. Mixing of different pesticides in one spray tank is reported to be a particularly common practice among farmers in Nyandira, Kipera, and Dumila villages (ENVIROCARE, 2010). Farmers mix products in an effort to improve efficacy, and it is common that three products or more are mixed in one sprayer; for example, farmers mix Selecron, Farmerzeb and or Ivory 72 WP with addition of foliage fertilizer in one sprayer. The frequent mixing of pesticides is problematic for various reasons, and apart from causing health problems may lead to killing of the crop.

In Northern Tanzania about a third of the small-scale farmers which grow vegetables such as tomatoes, cabbages and onions applied pesticides in mixtures (Ngowi *et al.*, 2007), without specific instructions either from the labels or extension workers. Of interviewed farmers 68% reported having felt sick after routine application of pesticides. In addition to mixing of pesticides, accidental poisoning may also be related to other issues. For example, agro-dealers also sell food alongside their pesticides. People store pesticides in the kitchen and sell pesticides next to food items. This is an obvious health concern that is hardly dealt with in the region. However, only 10% of Kilombero farmers store pesticides in their houses, together with fertilizers and seeds, while 90% keep their

[3] http://faolex.fao.org/cgi-bin/faolex.exe?rec_id=079952&database=faolex&search_type=link&table=result&lang=eng&format_name=@ERALL

pesticide in a separate room. None of the farmers interviewed in the SAGCOT corridor in areas visited reported to store pesticides with food stuff.

During the scoping mission we were told that there are people, especially youth who own spraying equipment as means of earning a living, that go out every day for spraying jobs but in many cases do not know the products they are handling and do not even use PPE, thus getting exposed to unknown pesticides almost every day during the cropping seasons.

Monitoring of health issues is very limited at present. TPRI has the responsibility of monitoring residue levels in food, and provide information on discarding chemicals. However, in very few cases TPRI conducts monitoring due to limited number of staff to carry out this activity. Also TPRI is supposed to sample residue levels but this does not happen regularly at present. As such, pesticide contamination of food may be a bigger problem than assumed. Large companies train farmers to avoid misuse, and the ACT train agro-dealers and extension staff on responsible use of pesticides.

Food safety is not monitored hence pesticide residues are a potential problem.

4.3 Pesticides of concern

The most prominent risks of pesticide use in the SAGCOT is associated with those pesticides used near aquatic habitats. These risks exist throughout the Rufiji Water Basin, but they are most critical where intensive agriculture borders low-lying wetlands. This is particularly the case in the Kilombero Valley, whose floodplains form one of Africa's largest wetlands. Apart from being of high conservation value, the floodplains serve as a source of water for farming, livestock, fishing and for domestic uses for local communities. As shown in Chapter 3, crops include especially rice but also maize, and to a lesser degree sorghum, beans, grams, groundnuts, vegetables and various fruit species. In particular the proximity of such high-value wetlands to intensive rice fields is a potential problem for present and future water quality in the district.

There are quite a few pesticides used in the Kilombero District and by KPL that are hazardous to human health (Table 4.3). Some of these and other pesticides also affect environmental health in various ways. Of 37 WHO-listed pesticides (WHO, 2009) currently used in the District, 17 are hazardous for the environment and 14 are very toxic to aquatic organisms, while the majority is toxic to aquatic organisms (Table 4.3). The most hazardous pesticides used at this moment are flocoumafen, carbofuran and zinc phosphide. All three have negative impacts on human health when inappropriately used and they are very toxic to aquatic organisms. In addition, carbofuran has the reputation of being widely abused for harvesting of wildlife in East Africa (see paragraph 4.1). The reported increased use of carbofuran in the district is therefore a reason for concern. In addition to the three WHO Class I pesticides, 74% of WHO class II pesticides used in Kilombero have potential human health effects such as cholinesterase inhibition and nervous system dysfunction. Almost half (43%) of the WHO-class II pesticides are also very toxic to aquatic organisms. The increased utilization of some of these compounds, notably chlorpyrifos and diazinon, but also deltamethrin, lambda-cyhalothrin and paraquat, is also reason for concern, especially given the negative impact of these on human and environmental health elsewhere in Tanzania and sub-Saharan Africa (e.g., Stadlinger *et al.* 2011; Ogada, 2014; Benard *et al.*, 2014).

Table 4.3 *WHO-listed pesticides (WHO, 2009) distributed by retailers in Kilombero District (KD; Source: District Agricultural Team), including those presently used by Kilombero Plantations Limited (KPL) for the production of rice and pulses. The main human and environmental health effects are indicated, including toxicity to aquatic organisms. 'Crop' refers to the main crops for usage and 'Trend in use' to the trend in usage during the past years in Kilombero District. Pesticides are ranked based on their WHO-class. WHO-class I pesticides are marked in dark grey, WHO-class II pesticides are marked in light grey (WHO, 2009).*

Location of use	Pesticide	WHO Class (a)	Health effects (b)	Environmental effects (c)	Toxicity to aquatic organisms (d)	Registration status (e)	Crop (f)	Trend in use (g)
KPL	Flocoumafen	Ia	Blood	HE: terrestrial organisms	VT, BA	U		?
KD	Carbofuran	Ib	CI	HE: soil organisms, honeybees, birds. WP	VT	R	HC	+
KD	Zinc phosphide	Ib	NS, liver, kidney, heart	HE: birds, mammals	VT	U		?
KD/KPL	Pirimiphos-methyl	II	CI	HE: honeybees, mammals, terrestrial organisms	T	R	HC, MZ	0
KD/KPL	Chlorpyrifos	II	CI	HE: birds, honeybees. WP	VT, LTE, BA (fish, algae)	R	VAR	+
KD	Deltamethrin	II	NS	HE: honeybees, mammals	VT	R	VAR	+
KD/KPL	Lambda-cyhalothrin	II	NS	HE: mammals, honeybees	VT, LTE	R	CASH	+
KD	Diazinon	II	CI	HE: birds, honeybees. WP	VT	R	HC, CASH, RC, SC	+
KD	Fenitrothion	II	CI	HE: honeybees	VT, BA (fish)	U	VAR	-
KD	Endosulfan	II	SE, NS, blood	HE: birds, soil organisms. WP	VT, LTE, BA	U		-
KD	2,4-D	II	NS		Ha	R	VAR	+
KD	Paraquat	II	PC	HE: birds	VT, LTE	R	VAR	+
KD	Metalaxyl	II				R	VAR	+
KD	Copper hydroxide	II			T, LTE	R	CF	-
KPL	Imidacloprid	II	NS	HE: birds, fish, honeybees	T	R	VAR	?
KPL	Profenofos	II	CI	HE: honeybees, birds. WP	T, LTE	U		?
KPL	Dimethoate	II	NS, CI	HE: honeybees, birds. WP	T	R	VAR	?
KPL	Lindane	II	NS, PC, bone marrow, liver	WP	VT, LTE, BA (fish, "seafood")	U		?
KPL	Alpha-cypermethrin	II		HE: honeybees, mammals	T	R	MZ, BEANS	?
KPL	Clomazone	II		HE: mammals		R	RC, SC, BEANS	?

Location of use	Pesticide	WHO Class (a)	Health effects (b)	Environmental effects (c)	Toxicity to aquatic organisms (d)	Registration status (e)	Crop (f)	Trend in use (g)
KPL	Propanil	II	NS, PC, blood		VT, BA	R	RC, BEANS	?
KPL	MCPA	II	NS, heart		VT	R	MZ, HC, WHEAT, SC	?
KPL	Tebuconazole	II	PC			R	VAR	?
KPL	Propiconazole	II	PC	HE: mammals	T, BA (fish)	R	VAR	?
KPL	Flutriafol	II				R	WHEAT, BARLEY	?
KPL	Cuprous Oxide	II			T, LTE	R	HC	?
KD/KPL	Glyphosate	III	PC		T	R	VAR	+
KPL	Fluazifop-p-butyl	III				R	BEANS	?
KD	Chlorothalonil	U			VT	R	VAR	+
KD	Mancozeb	U	SE,C		T	R	VAR	-
KPL	Cyhalofop	U				R	RC	?
KPL	Oxyfluorfen	U	PC		T	R	ONIONS	?
KPL	Oxadiazon	U			T	R	RC	?
KPL	Azoxystrobine	U			T, LTE	U		?
KPL	Trifloxystrobin	U			T	R	HC, CASHEW	?
KPL	Captan	U			T	R	HC	?
KPL	Aluminium Phosphide	FM	NS, CS		T	U		?

(a) 1a: extremely hazardous; 1b: highly hazardous; II: moderately hazardous; III: slightly hazardous; U: unlikely to present acute hazard in normal use; FM: fumigant (WHO, 2009).

(b) CI: cholinesterase inhibitor; PC: possible carcinogen; SE: suspected endocrine disruptor; NS: impacts nervous system, CS: cardiovascular system (ILO, 2016).

(c) HE: hazardous for the environment (taxonomic groups of special concern listed). WP: pesticides among most abused for wildlife poisoning in sub-Saharan Africa (Ogada 2014).

(d) Toxicity aquatic animals: VT: very toxic; T: toxic, Ha: harmful, LTE: long term effect, BA: bio-accumulative (taxonomic groups of special concern listed; ILO, 2016, Lewis *et al.*, 2016).

(e) R: Registered for general use (full, provisional or restricted); U: not registered for general use (not in the register, experimental use; TPRI, 2015).

(f) HC: horticulture, MZ: maize, RC: rice, CASH; cash crops, SC: sugarcane, VAR: various (TPRI, 2015).

(g) [+] increase in use in Kilombero District (Table 3.10), [-] decrease, [0] stable.

5 Pesticide policies & legislation

This Chapter deals with some aspects of the pesticide life cycle explained in Paragraph 1, production and import, registration and procurement, and especially with their policy and legislation aspects. Pesticide policies, pesticide legislation and their implementation mostly belong to the domain of the authorities at the national regional and also local level but agro businesses also have their role in their implementation.

Governments should take care to:
- put in place appropriate pesticide legislation,
- put in place a system for pesticide registration and authorisation on the market including an evaluation of environmental and human health hazards and risks of pesticides,
- phase out highly hazardous pesticides,
- enforce laws and regulations, address problems of illegal import and trade of pesticides,
- stimulate post-registration activities such as,
  - safe use of pesticides through training and extension,
  - monitoring of pesticide imports and sales,
  - inspection of manufacturers, retailers and users, and
  - monitoring of residues in farmers produce (commodities for export!) and in the environment (water, soil, biota), and
- put in place an appropriate extension and education system on pesticide safety and best practices (professionals, farmers).

Businesses should:
- only produce and sell registered pesticides,
- promote sustainable use of pesticides through application of certification schemes and standards
- promote best practices and safe use of pesticides (for example through finance for personal protective clothing and extension and education programmes)
- (let) conduct inspections for certification
- collaborate with government to train extension staff especially by conducting training of trainers (TOT) on safe use of pesticides

The chapter discusses and evaluates to what the prerequisites for pesticide policies and regulations are currently met in SAGCOT.

5.1 Requirements for SAGCOT

Detailed reviews of the policy and regulatory framework relevant to SAGCOT have recently been made as part of the *Strategic Regional Environmental and Social Assessment (SRESA)* (SAGCOT, 2013b) and the *Situation Analysis for SUSTAIN-Africa Programme* (Kashaigili *et al.*, 2014). These reviews cover agricultural, environmental and health policies and legislation. Such a review will therefore not be repeated here.

The main conclusions of the above reviews were that a sound legal and policy framework exists in Tanzania for natural resources management and that an institutional framework is in place to address environmental issues. However, effective implementation of these frameworks faces significant challenges due to, among others, a weak capacity for enforcement, a low level of awareness with policy makers and other key stakeholders, and certain conflicting policies and legislation.
Instead, and building on these reviews, we assess whether a number of key pre-conditions for the sound management of pesticides in SAGCOT are effectively founded in Tanzanian policy and legislation. Possible gaps will be identified and suggestions for strengthening these aspects will be made.

The following pre-conditions for sound pesticide management in SAGCOT are assessed:
1. Pesticide registration includes human health and environmental risk assessment;
2. Pesticide registration favours reduced risk pesticides;
3. Agricultural policy promotes IPM and biocontrol;
4. Agro-dealers supply pesticides that do not compromise sustainability;
5. Implementation and enforcement of pesticide policy and legislation are effective;
6. New/expanded agricultural development projects are only established after an effective EIA;

5.1.1 Human health and environmental risk assessment

All pesticides have to be registered before they can be sold, distributed or used in Tanzania, under the Plant Protection Act 1997 and the Plant Protection Regulations 1998[4] (Govt. Tanzania, 1997, 1998). According to Section 18 of the Plant Protection Act, pesticide registration is the responsibility of the Minister of Agriculture. The Registrar of Pesticides is based at the Tropical Pesticides Research Institute (TPRI).

This legislation covers pesticides for use in agriculture and as a result, the Ministry publishes a list of authorized plant protection substances (TPRI, 2015). Other uses (disease vector control, veterinary, domestic) are formally not covered under the legislation. However, in practice, pesticides used for public health, domestic and veterinary uses are also evaluated and registered by the Ministry.

With respect to risks of a pesticide to human health and the environment, the Plant Protection Act states that: *The Minister shall register the plant protection substance … after the analysis of the plant protection substance shows that … the plant protection substance when used for its intended purposes and in the correct manner, or as a result of such use, does not have any harmful effects on human and animal health, ground water and the natural environment which are not justifiable in the light of the present state of scientific knowledge.* Which harmful effects are "not justifiable" is not defined in the Act or in subsidiary pesticide-related legislation.

Pesticide companies have to submit technical, toxicological and environmental data, analytical methods and the draft label as part of the application for registration of a pesticide (TPRI, undated). The application form for pesticide registration (Govt. Tanzania, 1998) indicates that a summary of the product's toxicology and other side effects needs to be submitted, but does not provide additional detail about the exact data requirements.

While explicit pesticide acceptability criteria have not been established under pesticide legislation, at operational level, the Pesticides Approval and Technical Sub-committee (PARTS) uses a number of criteria to decide whether or not a pesticide can be authorized for use in Tanzania. They include:
- Human health:
  - Acute toxicity: WHO Classification of Pesticides by Hazard: Class Ia, Ib and some II are not registered.
  - Chronic toxicity: not explicitly evaluated, beyond inclusion in the WHO Classification.
- Environment:
  - High persistence pesticides not registered.
- International Conventions:
  - Stockholm Convention: Registrations of all organochlorines have been cancelled except for lindane (still used for termite control).
  - Rotterdam Convention: No consent to import is given for 22 pesticides, and consent only under specified conditions for another 5 pesticides.
- Public health pesticides:
  - Only pesticides are registered that are recommended by the WHO Pesticide Evaluation Scheme (WHOPES)

[4] A new Plant Protection Act and a Pesticide Management Act have been drafted in 2013, but have not yet been adopted and enacted.

The PARTS approves the application for registration and seeks endorsement from the National Plant Protection Advisory Committee (NPPAC). After endorsement, the NPPAC advises the Minister to register the pesticide.

Most of the above criteria are hazard-based, and only limited risk assessments are presently being conducted, both for human health or the environment.

Human health and environmental legislation may also provide further acceptability criteria for hazardous chemicals in general, and pesticides in particular. The Occupational Health and Safety Act (Govt. Tanzania, 2003) stipulates that employees in agriculture should not be exposed to hazardous chemicals or hazardous environments, but what degree of hazard (or risk) is unacceptable is not specified.

Similarly, the Environmental Management Act (Govt. Tanzania, 2004) states that the discharge of any hazardous substance in water or any other segment of the environment is prohibited, except in accordance with guidelines prescribed under the Act. This has been operationalized by setting water quality standards for pesticides[5], under the Environmental Management Regulations (Govt. Tanzania, 2007; TBS, undated). Other concrete environmental standards for pesticides do not appear to have been defined yet.

Overall, it can be concluded that:

- Legislation is in place that allows human health and environmental risk assessment as a precondition for the authorization for use of a pesticide in Tanzania;
- Assessments to determine whether a pesticide poses an unacceptable risk to human health or the environment in Tanzania, and the SAGCOT corridor in particular, are presently not conducted in much detail; primarily hazard assessments are carried out. In particular, the assessment of environmental hazards and risk is lacking.
- Environmental, health and pesticide legislation provide only limited criteria that can be used to determine whether a pesticide is acceptable for use in Tanzania.

5.1.2 Reduced-risk pesticides

One of the ways to promote agricultural green growth in the SACGOT, is to ensure that sufficient reduced-risk pesticides, including biopesticides, are registered and available on the market. This study did not allow a complete assessment of which registered pesticides in Tanzania can be considered reduced-risk products, in part because national criteria for reduced-risk pesticides have not been established.

In December 2015, a total of 1390 pesticide products were registered in Tanzania (TPRI, 2015). A quick screen was conducted of these registered pesticides against the list of reduced-risk pesticides registered in the USA. By mid-2016, 80 conventional active ingredients were listed as reduced risk-pesticides for one or more uses in the US (US-EPA, 2016). Thirty-four (34) of these active ingredients are also authorized in Tanzania, in 203 commercial products (i.e. 15% of all registered pesticide products in the country).

Non-conventional reduced-risk pesticides include microbial pesticides, pheromones and some botanical products. Of these groups, 19 microbial pest control agents have been registered in Tanzania, covering 11 species/strains. As a comparison, in later 2015, 39 microorganisms (species/strains) were authorized in the EU. In addition, a number of botanical pesticides have been authorized for use in Tanzania. However, their use by smallholder farmers is still limited and awareness creation on their use is necessary.

Overall, it can be concluded that a considerable number of conventional and non-conventional reduced-risk pesticides are registered in Tanzania, and available for use in SAGCOT. However, in

[5] Permissible limits for municipal and industrial effluents discharged directly into water bodies: Organochlorine pesticides = 0.0005 mg/L; Pesticides other than organochlorines = 0.01 mg/L

comparison with Europe and North America, there may be room to further expand the range of reduced-risk pesticides in Tanzania, in particular microbial pesticides.

5.1.3 IPM and biocontrol

IPM policies

Since SAGCOT promotes intensive commercial agriculture in Southern Tanzania, the risk for a rise in pest, weed and disease pressure is high. This in turn may lead to increased use of pesticides, which could result in adverse effects on human health, the environment and agronomic sustainability. Therefore, a dedicated Integrated Pest Management Plan (IPMP) was elaborated for SAGCOT (SAGCOT, 2014).

The IPMP makes the following policy recommendations:

i. Promote IPM by following the ways presented in this document [= the IPMP];
ii. Establish ecologically-based IPM as a guiding principle for development at SAGCOT and realign relevant activities and strategies to support rather than undermine IPM and OP 4.09[6];
iii. Discourage conflicts of interest by screening out inappropriate SAGCOT partnerships that threaten to undermine IPM;
iv. Encourage effective collaboration across IPM projects, sectors and departments to support the integration of IPM and sustainable agriculture into SAGCOT;
v. Make better use of locally and regionally available knowledge and expertise in IPM and improve collaboration with farmers' groups, NGOs, national and international institutions with expertise in participatory and environmentally sustainable approaches to agriculture; and
vi. A new/reviewed list of approved pesticides is expected to be published before June 2014. This will have to be observed by the SAGCOT Investment Project management for adoption.

The fact that IPM is the recommended pest management approach for SAGCOT, was previously stressed both in the Strategic Regional Environmental and Social Assessment (SRESA) (SAGCOT, 2013b) and in the SAGCOT Greenprint, the framework for agricultural green growth that was developed for SAGCOT (SAGCOT, 2013a). In the Greenprint, the focus is on reducing reliance on pesticides and increasing use of biopesticides.

At the national level, the principal agricultural development policies and programmes also favour IPM as recommended approach to pest management in Tanzania.

The National Agriculture Policy (MAFC, 2013a) does not explicitly highlight IPM, but notes that pest management options need to be compliant with Good Agricultural Practices (GAP) to ensure export standards, environmental protection and bio-safety, which are critical requirements in international trade.

The Agricultural Sector Development Programme (ASDP-2) is the most recent overall development and investment programme promoting increased sustainable agricultural production in Tanzania. Most relevant for pest and pesticide management is component 2 of ASDP-2 which aims to enhance agricultural productivity and profitability. It is stated that *sustainable intensive production systems include among others natural resource management (land and water), conservation agriculture, integrated soil fertility, integrated pest, diseases, and post-harvest management*.

IPM is one of the listed spear points for agricultural research under the ASDP-2. Strengthening demand-responsive extension services is another key sub-component, with an important role for the farmer field school (FFS) approach. The third sub-component of enhancing productivity is expanding farmer access to agricultural inputs (discussed in more detail below).

In conclusion, the key national agricultural development policies focus on sustainable production intensification, for with IPM as a preferential pest management approach.

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[6] OP 4.09 is the World Bank's Operational Safeguard Policy 4.09: Pest Management

5.1.4 Agro-dealers

Private and public agricultural input distribution channels should in principle supply pesticides to farmers that do not compromise the sustainability of the agricultural production systems in SAGCOT; i.e. are low-risk for human health and the environment, do not lead to unacceptable residue levels (for export and local markets), minimize the development of resistance (both in agriculture and public health), are compatible with biocontrol or IPM, do not affect pollination or soil fertility, etc.

Input distribution policy
The National Agriculture Policy aims to *increase the utilization of productivity-enhancing inputs in a cost-effective, financially sustainable and environmentally sound manner* (MAFC, 2013a).

The ASDP-2 operationalizes this objective by focussing on strengthening of the national and local agricultural input supply systems (of seeds, fertilizer, agro-chemicals and tools) implemented by the private agro-dealer network. Planned activities include:

- Technical, safeguard and business capacity strengthening for about 1,000 active agro-dealers in the target areas;
- Local demonstrations of improved technologies by agro-dealers and extension workers (5-10 agro-dealers per target district);
- Stimulation of partnerships (contract farming, etc.) between farmers' organizations and agribusiness engaged in targeted commodity value chains for sustainable production and marketing systems (receipt systems).

Fiscal and financial policy for agricultural inputs
The National Agricultural Input Voucher Scheme (NAIVS) operated between 2008 and 2013 with the objective to raise maize and rice production. NAIVS provided 2.5 million smallholder farmers, for a three-year period, with a 50 percent subsidy on a one-acre package of maize or rice seed, and chemical fertilizer. The redemption of the voucher through commercial agro-dealers encouraged the development and expansion of sustainable wholesale to retail input supply channels (MOF, 2014).

Under the ASDP-2, another cycle of time-framed input subsidies is being considered which would not be limited to seeds and fertilizers, but is intended to be broadened to include pesticides, veterinary drugs and mechanization services (MAFC, 2016). Based on experiences under NAIVS, it is recognized that further input subsidies should be accompanied by advisory and backstopping support and strengthened agricultural research and advisory services, to increase efficiency of input use by farmers within an integrated management approach.

The import tariffs for ready-for-use agricultural pesticides (harmonized customs code 38.08) is 0%; for household pesticides it is 10-25% (EAC, 2012). Biopesticides would probably also fall under the exemption of import tax, but for biocontrol agents (insects) an import duty of 25% is listed.

Value Added Tax (VAT) in Tanzania for all types of pesticides is 0% (Govt. Tanzania, 2014). No exemptions are listed for biocontrol agents other than (possibly) biopesticides. However, more recently, biological control agents appear to be exempted from VAT as well.

However, both the taxation schedule for pesticides, as well as possible renewed input subsidies, still favour the use of pesticides. No differentiation is made between conventional chemical pesticides and biopesticides or other biological control agents, or between reduced-risk and high-risk products. Therefore, the present fiscal and financial policies do not promote integrated pest management and biocontrol, and contradict the agricultural sector policies mentioned above. This may be because increases in agricultural production are associated with increased use of agrochemicals (both chemical pesticides and industrial fertilizers), and therefore gives not sufficient consideration to Integrated Pest Management (IPM).

In conclusion, present organizational, fiscal and financial policies on input distribution are likely to lead to increased availability of pesticides to farmers. However, in spite of the planned capacity building of private agro-dealers, there is no active policy towards favouring the sales of reduced-risk pesticides.

In fact, the fiscal and financial measures in place, and the planned public-private partnerships with input distributors, pose a high risk of favouring the use of the cheaper, older and less sustainable pesticides over biocontrol and IPM. This is confirmed by reviewing the present availability of pesticides at agro-dealers in SAGCOT (see chapter 3.1).

5.1.5 Implementation and enforcement

Policies are as effective as their degree of successful implementation and legislation is a paper tiger unless it is enforced effectively. This definitely also holds true for pest and pesticide management.

In spite of considerable investments in the agricultural sector under ASDP-1 and other programmes, the National Agriculture Policy (MAFC, 2013a) notes, among others, that:

- Agricultural extension services are insufficiently staffed and trained; show lack of linkages with research and farmers; and have a low participation of the private sector;
- The Plant Health Services (PHS) have inadequate capacity for pest surveillance; limited management options for pests and diseases; and weak sanitary and phytosanitary services;
- Agricultural input supplies are hampered by weak quality control.

Inadequate quality of pesticides on the market was confirmed in a recent study conducted in Mtwara and Lindi regions, by Mununa *et al.* (2014). They inspected 33 pesticide retail shops and distribution centres and found that in 40% of the visited outlets unregistered pesticides were being sold, and in 12% of cases pesticides were poorly labelled. Furthermore, 36% of the firms inspected had unqualified staff behind the counter.

The ASDP-2 therefore plans to considerably strengthen agricultural extension institutions and increase the role of the private sector in crop advisory services. It further aims to build capacity at the PHS to, among others, deploy pest management strategies and approaches that will enhance crop production and protect the environment, including the development and use of IPM technologies.

Key to the enforcement of pesticide legislation is the existence of effective pesticide control and inspection services. In Tanzania, this responsibility falls under the PHS, and in particular the TPRI. However, TPRI presently has only a handful of specialized pesticide inspectors in the field. As a result, pesticide importers, retailers and larger pesticide users are only inspected on a very irregular basis. In addition, the pesticide quality control laboratory at TPRI is in need of upgrading to allow the effective analysis of the more modern pesticide groups.

This was confirmed during our visits to SAGCOT, where agro-dealers indicated that they receive few if any visits from TPRI, while they expressed a clear need for information on registered pesticides and pesticide management practices and rules. Complaints about substandard pesticides being on the market were also fielded.

ASDP-2 explicitly plans to strengthen the regulatory framework to control quality and safe handling of pesticide products and their residues. Support activities will also cover the Office of the Registrar of Pesticides at TPRI and the Plant Health Services (PHS). As part of ensuring stakeholders' awareness about the existing agro-inputs legislation, it is expected that training of law enforcers will go together with stakeholders' awareness creation and monitoring of legislative compliance.

In conclusion, the present national capacity to implement pesticide and IPM policies, and to enforce pesticide-related legislation, can be considered weak. As a result, in spite of generally well-developed policies and legislation with respect to pest and pesticide management in Tanzania, their effective application appears to be seriously compromised.

5.1.6 Environmental Impact Assessment (EIA)

The Environmental Management Act (Govt. Tanzania, 2004) requires that the proponent or developer of a project or undertaking, as defined in the Act, conduct an environmental impact assessment (EIA), prior to its commencement or financing. The National Environment Management Council (NEMC) is responsible for reviewing the EIAs and issuing an Environmental Certificate.

The Environmental Impact Assessment and Audit Regulations (Govt. Tanzania, 2005) stipulate which agricultural projects – that may involve the use of pesticides – require an EIA. These include: Large scale cultivation; large scale monoculture (cash and food crops including floriculture); biological pest control; aerial spraying; and manufacture, transportation, use and storage of pesticide or other hazardous and or toxic chemicals. Furthermore, the following projects require registration, but may or may not require an EIA: horticulture and floriculture; urban agriculture.

The Regulations also set screening criteria to assess the compliance of a project with the legislation. Relevant to pesticides are the following criteria:
- The project will not substantially use a natural resource in a way that pre-empts the use, or potential use, of that resource for any other purpose;
- Potential residual impacts on the environment are likely to be minor, of little significance and easily mitigated;
- The project is not located in, and will not affect, any environmentally sensitive areas;
- The project will not cause water pollution, damage to wildlife and habitat, …

The Ministry of Agriculture, Food security and Cooperatives developed detailed EIA guidelines to provide agricultural project developers with guidance on how to formulate and implement sound projects that reduce adverse environmental, social and health impacts (MAFC, 2013b). The guidelines, among others, identify potential adverse effects of different types of agricultural projects, including of the use of pesticides, and propose mitigation measures.

Table 5.1 *Agricultural projects in SAGCOT issued with an Environmental Certificate by NEMC, from 2013 till present.*

1	Paddy production in Kilombero district
2	Rehabilitation of Kilangali Seed farm, Kilosa
3	Large scale farming Rufiji
4	Agriculture and animal husbandry Iringa
5	Cassava plantation Lindi
6	Vegetable farm at Utunge Rufiji
7	Kiyegema farm in Kiponzelo Iringa

Since the start of operations of SAGCOT, 7 agricultural projects in the corridor have received an environmental certificate from NEMC (Table 5.1). Several of these projects likely involved pesticide use.

5.2 Evaluation

In conclusion (Table 5.2), while agricultural policy appears to promote IPM and biocontrol in a very satisfactory manner, effective implementation and enforcement of pesticide policy and legislation are reason for concern. Similarly, it cannot be guaranteed that agro-dealers, in the present system, will supply pesticides that do not compromise sustainability. Human health and environmental risk assessment could be strengthened during the pesticide registration process. It is unclear how effective the present EIA process is with respect to reducing risks of pesticide use.

Table 5.2 *Summary of the degree of fulfilment of the reviewed pre-conditions for sound pesticide management in SAGCOT.*

1	Pesticide registration includes human health and environmental risk assessment	**—**
2	Pesticide registration favours reduced-risk pesticides	**±**
3	Agricultural policy promotes IPM and biocontrol	**++**
4	Agro-dealers supply pesticides that do not compromise sustainability	**——**
5	Implementation and enforcement of pesticide policy and legislation are effective	**——**
6	New/expanded agricultural development projects are only established after an effective EIA	**?**

Degree of fulfilment: ++ very complete, + complete, ± more or less complete, — incomplete, —— very incomplete, ? unknown.

6 Pesticide risk reduction on the farm (best practices)

Chapter 5 treated pesticide policies and legislation. This chapter deals with various aspects of pesticide management at the farm level such as storage, use and disposal.

In general, farms and farmers should:
- document pesticide use at the farm,
- use safe and appropriate storage methods,
- use safe and appropriate application techniques (calibrated and maintained sprayers, reduced drift etc.),
- use appropriate personal protective equipment (PPE),
- use safe disposal methods (and not re-use or sell empty pesticide containers),
- use less pesticides
- use less toxic pesticides
- use less persistent pesticides

The objectives above summarise some of the best practices with respect to pesticide management (see, e.g., OECD, 2012) that should be applied at farms. Best practices are those activities and standards that benefit safe use of pesticides and reduce pesticide risks to human health and the environments. Specific, more detailed best practices may vary from crop to crop and even from one location to another. Best practices are often embedded in broader crop cultivation approaches such as Integrated Pest Management (IPM) or organic farming.

In this chapter the results of the literature survey and the scoping mission findings with respect to the compliance to best practices in Tanzania and SAGCOT are reported. IPM is the most applied pest management approach in the world aimed at sustainable agriculture and reduction of agrochemicals use in order to reduce risks to people and the environment. Use of IPM in Tanzania and SAGCOT will therefore be discussed in a separate section. Finally, for the application of best practices and schemes like IPM, farmers, retailers, applicators and other personnel involved in pesticide use need to have sufficient and operational knowledge of pesticide risks and judicious pesticide use. This knowledge is passed by proper training and extension to stakeholders. The current state of farmer knowledge and training and extension will also be treated in a section of this chapter.

6.1 Compliance with best practices

When discussing the application of best practices with regard to pesticides, a distinction needs to be made between small-scale farmers and the larger companies and their affiliated outgrower communities (also see Chapter 3).

6.1.1 Smallholders

Situation in Tanzania

It has been well established that pesticide management practices in many sub-Saharan countries in Africa are far from ideal at present. De Bon *et al.* (2014) reviewed pest management in fruit and vegetables by small farmers. The main findings of their survey were that pesticide use in sub-Saharan Africa is increasing and that pesticides are used in an unsustainable way. For instance, the frequency of applications was found to be high and pesticides not registered for use in vegetables are used. They recommend training in best practices and IPM in horticultural value chains to all stakeholders involved, from wholesalers to retailers and farmers. Mitema (2009) presented similar findings for pesticides used for veterinary use and also recommended several good practices for use of acaricides. On the other hand, pesticide use in Africa is still much lower than in most other parts of the world, e.g., Williamson *et al.* (2008) reported that Africa accounts for only 2-4% of the global pesticide market and until recently, pest management strategies were still mainly traditional (Abate *et al.*, 2000). Some of the drivers encouraging pesticide use in Africa according to Williamson *et al.* (2008) are: susceptible crop varieties, increased pest incidence, lack of advice on alternative methods, a growing informal market with cheap unauthorised pesticides, and poor attention to the economics of pest control.

In Tanzania the situation is not different from other African countries. Despite some successful reductions of the use of very toxic pesticides in the past (Mmochi & Mberek, 1998) and the introduction of pesticide legislation in 1997/1999 in Tanzania, a recent analysis still revealed 'weaknesses and gaps in pesticide control and management' in the country in the areas of regulatory enforcement, risk assessment and risk management (Lekei *et al.*, 2014a).

In northern Tanzania Ngowi *et al.* (2007) investigated practices and perceptions of smallholder farmers that grow vegetables through questionnaires and interviews. They found that vendors often dispensed pesticides in smaller containers without labels and instructions for use. Moreover, many farmers applied pesticides in self-made mixtures containing up to 3 products at the same time. Frequency of application was also found to be high in this study. More than two thirds of the farmers reported to have felt sick after applying pesticides. The authors conclude that these vegetable farmers lacked appropriate knowledge on use and safe handling of pesticides caused by an almost absence of extension services and training. Instead, pesticide use was highly influenced by vendors.

Nonga *et al.* (2011) also investigated farming practices and use of pesticides (and other agrochemicals) in northern Tanzania, in the Lake Manyara basin, using similar methods. Their findings confirm those of Ngowi *et al.* (2007): indiscriminate use caused by easy access to agrochemicals in combination with lack of pesticide effects and scarcity of extension services with potential negative consequences for the water quality and biodiversity of the lake.

Farmers' knowledge and practices were also studied in the Arusha Region (Lekei *et al.*, 2014b). This study revealed a number of other practices such as storage of pesticides at home (79% of farmers) leading to potential exposure of farmers and family members, failure to use Personal Protective Clothing (PPE), use of uncalibrated spraying equipment, unsafe disposal of obsolete pesticides and empty containers (including some re-use for household activities). The farmers' self-reported prevalence of pesticide poisoning was high (79%).

Mununa et al (2014) who conducted a survey of 33 pesticide shops and distribution centres in the Mtwara and Lindi regions in southern Tanzania concluded that the poor quality of pesticides (substandard, illegal, impurities) sold by untrained pesticide dealers may also lead to problems for smallholders such as poor health and to environmental problems.

Situation in SAGCOT

Although the studies mentioned above targeted smaller areas and communities, they appear typical of rural Tanzania in general. We did not find any studies from the SAGCOT area itself, but the general image was confirmed during our scoping mission to the cluster as set out in the following paragraphs.

Counterfeit pesticides and improper labelling

Some of the agrochemicals sold in the SAGCOT corridor are reportedly counterfeit or substandard products, without specifications. This is a growing problem. The Ministry of Agriculture has a regulatory responsibility to verify the quality of sold pesticides, but such efforts are currently limited. The dealers that deal in counterfeit pesticides could be blacklisted by organised agro-suppliers. In 2012, 40% of pesticides sold in Tanzania were suggested to be substandard, as reported by AGENDA for Environment and Responsible Development. These included pesticides sold by official dealers. The farmers are increasingly spending more money on pesticides, and use substandard pesticides, in the wrong dosages or they use the wrong pesticides altogether.

Few rice farmers in the corridor know what kind of pesticides they were using and had never seen the original packages, as pesticides are usually sold per weight or already diluted without labelling (Stadlinger *et al.*, 2011). Suppliers sometimes repack pesticides, e.g., when the expiry date has passed. There is also a large problem related to the high proportion of illiterate people, who can't read labels in English or Swahili (c. 50% of labels is in Swahili and the other part in English). Even when there are labels in Swahili language these are still disregarded. In fact, more than 60% of farmers in the Kilombero region do not read the labels on the pesticide containers before applying (ENVIROCARE, 2010). Of the 40% who read the instructions, a small minority follow the protective and hazard guidelines on the labelling. Finally, the names of pesticides are being altered at a regular basis especially so when each registrant of a pesticide uses its own trade name (registration is by trade name). As a result, it is unclear to farmers which pesticides are being sold and used because they do not know that pesticides have common names and trade names and thus may end up buying the same pesticide with different trade names depending on the registrants.

Overuse

Pesticide usage in the corridor seems to be highly influenced by pesticides vendors who likely aim to achieve large sales of their pesticides (also see Chapter 3), which has also been reported elsewhere in Tanzania (Ngowi *et al.*, 2007). Also, some pests are developing resistance which contributes to increased use of chemical pesticides. Recently the *Tuta absoluta* pest occurred in the SAGCOT area, which Bytrade treated with bio-pesticides and put a lot of effort into promoting the products. However, for many crops, bio-pesticides are not available and 90% of pesticides sold are synthetic compared to 10% bio-pesticides. People are to some extent aware of dangers and harvest their own crops from fields adjacent to heavy pesticide use fields to reduce their own risks – but sell the more heavily sprayed crops to the public.

Overuse and inappropriate use is probably further enhanced by some miscellaneous observations from our scoping mission:

- pesticides are used as status symbol whereas many pests can be treated using traditional methods,
- people often and preferably use pesticides that have an obvious and direct effect, i.e., those that kill pests on plots visibly and rapidly, and
- farmers apparently dip tomatoes in fungicides with intention of extending their longevity before they transport them to long distances for sale.

Use of personal Protective Equipment (PPE)

Farmers often don't understand the health effects caused by pesticides and therefore do not take sufficient precautions to protect themselves from the negative impacts. In three villages in the Kilombero District the majority of the farmers (more than 75%) stated to have experienced leakages, especially of knapsack sprayers during pesticide application (ENVIROCARE, 2010). Farmers stated that it is common to get completely wet by leakage of pesticides from the knapsack sprayers and that they are used to this condition. About 80% of farmers do not use personal protective equipment (PPE) during application, or do not use it properly. Old clothes and shoes are mostly used rather than appropriate equipment (PPE). It was reported that 75% of farmers in Nyandira, Kipera, and Dumila villages in Morogoro did not buy protective gear for spraying (ENVIROCARE, 2010). Even farmers who could afford to lease land for investment in tomato production failed to invest in protective gear.

Some pesticide companies do sell protective gear that helps to reduce pesticide exposure, but the majority of day labourers come to work with very little protection. Gloves and masks are only locally available, and many of these are not renewed when international projects end their activities. Rice farmers in the Rufiji Delta rarely use protective equipment because half of the farmers are not aware of pesticides' health hazards, while many others did not know where to purchase protective gear (Stadlinger *et al.*, 2011). Consequently, health risks are a major concern based on current farmers' pesticide handling and application practices, even though pesticide use still is relatively low.

Disposal of obsolete pesticides and empty containers

The SAGCOT area has little or no management of obsolete pesticides and empty containers, as reported for other countries in the region (e.g., Badenes-Perez & Shelton, 2006). Sale and safe use or disposal is not being organised. Empty containers are disposed of in the bush or in holes in the ground. Pesticide waste and containers are also often thrown directly in the river (e.g., rice farmers in Rufiji), where they contaminate the aquatic environment and thus constitute an exposure pathway for the environment, but also for children playing with the containers (Stadlinger *et al.*, 2011).

Additionally, 20-litre containers are used to store drinking water, local brew and for other domestic uses. In the Kilombero district, empty pesticide containers reportedly are also reused for storing salt, oil and water (ENVIROCARE, 2010).

Disposal of obsolete pesticides and stockpiles does not happen, according to the famers organisation ACT. There is no collection or buy-back of empty containers. The Ministry of Agriculture confirms the absence of a management system for empty containers. This is mostly due to lack of resources and facilities for disposal. In some areas farmers were trained to practice triple rinsing of containers after utilizing the pesticides and spray the rinsate onto the crops. Triple rinsing minimizes the amount of pesticides in empty containers after which containers are stored in places considered safe while waiting for a solution for disposal. Empty containers remain an important problem while obsolete stocks are not likely to exist at the small scale farmer's level because they buy only enough quantities for immediate use. Under the Africa Stockpiles Program (ASP), obsolete pesticides and 310 ton of contaminated soil were transported to Germany for incineration/disposal but c. 800 ton still remains (NEMC, pers. comm. 2016). A landfill is apparently planned for other hazardous waste, but not for empty containers.

Expiry dates on pesticide containers are another problem: farmers rapidly dispose of pesticides that are beyond their supposed expiry date. There are cases where dealers change expiry dates when they recognise that pesticides have expired. Furthermore, farmers are sometimes using banned products such as endosulfan which was used for a very long time, but is not registered anymore in Tanzania. Some USD 4 million is needed to collect and safely store stockpiles of endosulfan (FAO Tanzania, pers. comm.). Storage is often inadequate or in the wrong places, thus people misuse pesticides found in storage and sometimes steal from storage facilities (Stadlinger *et al.*, 2011, 2013). Of 20 farmers in the Kilombero District, more than 80% did not keep expired pesticides in their houses, stores or farms. The remaining 20% were the farmers that buy pesticides in large quantities depending on the size of the field and intended use. The remainder of the stocks are either brought home for other pest control uses, or sold to other farmers. Farmers continue to apply pesticides in the next growing season (ENVIROCARE, 2010). About 90% of the respondents disposed of obsolete pesticide and the associated waste by throwing it in the field, nearby bushes or forest. This has contributed to the collection and reuse of the pesticide empty containers by different people (not only farmers), as confirmed by most interviewed farmers. The livestock keepers and other communities surrounding the field/shamba areas collect empty pesticide containers for storing milk, oil, water and other domestic uses depending on the size of the containers. For example, the Sukumas in Signali village tend to cut the plastic pesticide containers to make ornamental hand rings for wives and children.

The Kilombero district headquarter offices at Ifakara has stockpiles of obsolete pesticides and empty containers in store. These reported obsolete pesticides were collected for disposal in previous years from farmers in the district under the instruction of NEMC. To date, the stock has not been disposed of and is often shifted from one place to another, especially when the rooms are needed for other uses.

Although the studies mentioned above targeted smaller areas and communities, they appear typical of rural Tanzania in general. We did not find any studies from the SAGCOT area itself, but the general image was confirmed during our scoping mission to the cluster.

6.1.2 Plantations

Examples of larger companies and their affiliated outgrower communities, as well as their training efforts, are discussed below.

Kilombero Plantations Ltd. (KPL) was set up to introduce a smallholder outgrower rice-scheme around a large scale rice farm. The scheme is based on a new System of Rice Intensification (SRI) technology and includes farmer financing programme for 5,000 farmers. KPL follows International Finance Corporation (IFC) standards which combine investments and advisory services to ensure environmental and social sustainability. Their investors – Norfund and AgDeCo - insist that they invest in and abide by IFC standards. Following IFC standards means that pesticides classified as highly hazardous in the WHO Classification are not used. KPL receives visits of foreign investors (see Box 6.1), so they need check-ups of methods for them to be up to standards.

Box 6.1 KPL investors and IFC standards

Norfund - the Norwegian Investment Fund for Developing Countries –was established by the Norwegian Parliament in 1997. Norfund's objective is to contribute to sustainable commercial businesses in developing countries. Investment by Norfund opportunities are made subject to assessment according to the IFC's environmental and social performance standards. These standards provide guidelines for the assessments that are undertaken during Norfund's investment process, and they also contribute to holding the enterprises accountable in relation to a given set of standards.

AgDevCo is a social impact investor and project developer operating exclusively in the agriculture sector in Africa. Their mission is to reduce poverty and improve food security by investing in agro companies with a smallholder component. AgDevCo invests in socially-responsible businesses, which have the potential to make a major positive social impact in their communities. In addition to direct investment, they provide on-the-ground technical support and specialist agricultural advice to management teams.

Some relevant excerpts from Performance Standard 3 of IFC
Resource Efficiency and Pollution Prevention
January 1, 2012

Pesticide Use and Management

14.
The client will, where appropriate, formulate and implement an integrated pest management (IPM) and/or integrated vector management (IVM) approach targeting economically significant pest infestations and disease vectors of public health significance.

The client's IPM and IVM program will integrate coordinated use of pest and environmental information along with available pest control methods, including cultural practices, biological, genetic, and, as a last resort, chemical means to prevent economically significant pest damage and/or disease transmission to humans and animals.

15.
When pest management activities include the use of chemical pesticides, the client will select chemical pesticides that are low in human toxicity, that are known to be effective against the target species, and that have minimal effects on non-target species and the environment.

When the client selects chemical pesticides, the selection will be based upon requirements that the pesticides be packaged in safe containers, be clearly labeled for safe and proper use, and that the pesticides have been manufactured by an entity currently licensed by relevant regulatory agencies.

16.
The client will design its pesticide application regime to (i) avoid damage to natural enemies of the target pest, and where avoidance is not possible, minimize, and (ii) avoid the risks associated with the development of resistance in pests and vectors, and where avoidance is not possible minimize. In addition, pesticides will be handled, stored, applied, and disposed of in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides or other GIIP.

17.
The client will not purchase, store, use, manufacture, or trade in products that fall in WHO Recommended Classification of Pesticides by Hazard Class Ia extremely hazardous); or Ib (highly hazardous). The client will not purchase, store, use, manufacture or trade in Class II (moderately hazardous) pesticides, unless the project has appropriate controls on manufacture, procurement, or distribution and/or use of these chemicals. These chemicals should not be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly.

Source:
http://www.ifc.org/wps/wcm/connect/25356f8049a78eeeb804faa8c6a8312a/PS3_English_2012.pdf?MOD=AJPERES

Rice farming at Kilombero Platations Ltd. Photo: Ralph Buij, Wageningen Environmental Research.

Farmers mention limited communication between KPL and the surrounding farmers and among farmers as a problem hampering effective pest management. Importantly to them, the growing season for KPL starts later and they use a different crop, whereas most farmers plant depending on their financial situation. Also, pesticide wind drift may be affecting other crops, such as when aerial herbicide spraying is conducted. In early 2016, spraying of glyphosate herbicide, according to farmers, may have affected crop growth at neighbouring farms held by small-scale farmers. KPL don't normally spray from the air but in 2016 they did and used a 1-km buffer with surrounding farmland as compared to the 500-meter buffer zone that is recommended. During the time of the scoping mission TPRI was investigating the situation, as people desired compensation. Water and blood samples were taken, people had also complained of stomach problems. In case loss is proven, farmers are compensated for such losses.

The past 3 years KPL have developed an Integrated Pest Management (IPM) program. They depend on international consultants for the development of the IPM plans and activities; a consultant from Oxford University, UK comes every two years. KPL has a number of staff that monitor pests, including traps at farms for insect pests. This allows them to apply the insecticides at the right time and minimize mortality of beneficial insects. This has three results:

1. Such application is more efficient,
2. Environmental impact is minimized, and
3. Expenses decrease.

They monitor insect pest levels and symptoms of fungal diseases, and other diseases such as Rice Yellow Mottle Virus and other viruses. KPL have an Environmental Management Plan that includes soil and water sampling, respectively once and four times per year. This entails tests for water and soil quality as well as agrochemical levels. They monitored bees and butterflies as part of the EIA, but little follow-up was provided.

Empty pesticide containers on the farm are triple-rinsed after which they are stored or taken back to suppliers in Dar es Salaam; some are re-used for storing spare parts. Environmental dangers at present include the use of the popular herbicide 2,4-D, classified by WHO as a moderately hazardous weed killer, and lack of training for farmers.

Rice outgrowers within the project known as Smallholder Rice Intensification (SRI), indicated only to be using glyphosate, a broad-spectrum systemic herbicide. Rice outgrowers are using the rainfed system on their rice fields and have no irrigation system in place. From 2009 up to March 2016, KPL had trained 7,403 farmers (out of 100,000 rice outgrowers) from 10 villages within 65 km from KPL rice scheme (approximately 100 km around the KPL farm) on use of glyphosate for the control of the notorious nut grass (*Cyperus rotundus*) and on Good Practices (GAP). KPL engaged extension workers who live in the villages and provide farmers with fertilizer, spray equipment, PPE, etc. The rice produced by the scheme including KPL is sold in Dar es Salaam and exported to Uganda.

Farmers indicated that during storage of their farm produce, including maize, they use rodenticides for control of rodents. KPL established a shop for farm inputs for farmers including weed killers as glyphosate which they use during land preparation, phosphates fertilizer used at planting, urea for top dressing, PPE and sprayers and others used for vegetable production.

The **Illovo Kilombero Sugar Company** employs 2,545 people in Tanzania (including seasonal and non-permanent workers), supports an estimated 9,500 people through outgrowers, and supports further estimated indirect and induced employment of between 2,400 and 10,000.

Kilombero Sugar company officials reported that they are practicing sound pesticides management on the farm. Mainly pre- and post-emergence herbicides are used, few insecticides. The pesticides are acquired through a tender with a supplier. All pesticides used are registered for use in Tanzania and their safety data sheets are available. TPRI does the efficacy testing of pesticides in a lab, thereafter they are tested in the field. Most tests/field trials are done by the Sugarcane Research Institute. Kilombero Sugar Company has a comprehensive list of pesticides used and carries out weed scouting in order to develop a herbicide application programme according to the type of weeds and their density. They then develop a weed map which may differ from farm to farm (from block to block). They then use a specific type of herbicide and dosage dependent on the type and quantity of the weed.

They also use a so-called "hazardous pesticides chemical controller system", by which the purchase of pesticides is phased by buying 50% of the required quantity at the start of the season in May, then 40% of the requirement in August and finally 10% in January. Before buying they always consider the stocks in the store and adjust accordingly. For each section, they have a list of pesticides in store, to ensure they don't have leftover at the end of the season considering that pesticides have 2-year supplier guarantee period. This prevents the build-up of stocks which might end up becoming obsolete. In sugarcane the insect problems are rather limited.

The outgrowers use less pesticides, mainly herbicides. Calibration of spray equipment is done every three months, while tractor boom spraying calibration is done every month; after each calibration certificates are issued. The estate has 6 farms and 6 farm managers who are responsible for their respective farms and advise on and monitor all activities. Intensive soil testing in relation to fertilizer use was done in the past two years. The size of the sugar estate is c. 10,026 ha and the area occupied by outgrowers is c. 15,000 ha.

Water quality monitoring is done by The Rufiji Water Basin Authority. Every month water samples are taken from the Ruaha River. Currently there is no testing for pesticides, so no pesticide residues in water can be identified. Most pesticides degrade quickly in the soil, their toxicity is low for birds, rodents and other animals. The problem pesticides are 2,4- D and paraquat which are sold to outgrowers. Paraquat is also used at Ilovo Kilombero Sugar estate in low dosages, but is being phased out of use. Various pesticide dealers are reportedly selling large amounts of 2,4-D and paraquat to the outgrowers.

The Sugar Board has facilitated training of extension workers in Mauritius and also facilitates transport facilities to extension staff. However, training of outgrowers is necessary especially on mixing and spraying of pesticides. Such training is expected to be provided by dealers who supply the pesticides, but this is not done. On the estate there is limited loss of crops due to elephants, baboons, hippopotamus and buffalo that cross the cane fields.

The biggest problem of pesticide use on sugarcane farms is lack of knowledge by outgrowers, especially on the mixing of pesticides and the appropriate disposal of containers. Ilovo Kilombero Sugar estate has an incinerator and burns 200 containers per day at 1200 °C. Currently they are considering increasing the capacity to cater for the outgrowers to avoid re-use of empty containers for domestic use.

There is a pest and disease committee for the sugarcane areas. They monitor pests and disease and their control. One of the ways of assisting the outgrowers pest management is by including them in the committee. A representative of outgrowers was nominated to participate in the committee, however the committee is not fully functional at this stage. The Sugar Board of Tanzania is also represented in the committee.

Ilovo Kilombero Sugar estate has internal audits once every month to make sure they qualify for the external audits (Sustainable Auditing/Best Practice). They have a water footprint program, where they test the difference of water quality that comes in and out of the system. This includes blue water (rains) and green water (rivers). Within the system, the grey water is polluted by agrochemicals. Because Associated British Foods owns 51% of Ilovo they are very strict on environmental issues, since international investment is only possible by following rigid standards.

6.2 Integrated pest management (IPM) & biological control

The FAO uses the following definition for Integrated Pest Management: "Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

For IPM practitioners this means (Ehler, 2006):
- simultaneous management of multiple pests,
- regular monitoring of pests, and their natural enemies and antagonists as well,
- use of economic or treatment thresholds when applying pesticides, and
- integrated use of multiple, preventive and suppressive tactics.

Biological control through natural enemies of pest species is an important component of IPM. A review by the International Institute of Tropical Agriculture (IITA; Alene *et al.*, undated) showed that important pests in Africa can be controlled by biological control and that biological control programmes have also been successful economically.

In IPM innovative approaches are also applied such as 'push-pull' technology where pest insects are repelled from the main crop and attracted to a 'trap' crop, either by the use of semiochemicals or by intercropping with (locally available) repellent and trap crops (Hassanali *et al.*, 2008; Khan et al, 2014).

An efficient implementation of IPM potentially leads to an increased yield, a decrease in pesticide use and to fewer environmental and human health effects (Pretty & Pervez Bharucha, 2015).

Nwilene *et al.* (2008) reviewed the impact of integrated pest management on food and horticultural crops in Africa and described several successes such as biological and varietal approaches to pest management, human capital development and farmer field schools. Despite these successes they conclude, however, that the potential of IPM in Africa is still poorly realised. This has many reasons, among others inadequate deployment of high-yielding crop varieties, harmful pesticide regimes, political instability, conflicts in social values and civil wars, inappropriate agricultural policies, biased global trade policies, lack of market information, and poor rural infrastructures. Moreover, according to the authors few African countries have adopted IPM as the official national crop protection policy and there are no frameworks and resources to support research and training in IPM.

6.2.1 IPM

The increased use of pesticides on cotton and coffee coupled with growing concern about the environment and consumer protection at international, regional and national levels made it imperative for Tanzania to look into possibilities of undertaking IPM activities in agriculture to minimize pesticide use. With assistance from the Government of Germany IPM activities started in 1992 in the Western Cotton Growing zone. This was mainly for cotton and a few food crops including maize, sorghum and sweet potatoes. Later IPM activities were extended to Northern Tanzania on coffee, bananas, and vegetables. Lack of resources, especially funds for promoting IPM, resulted into shelving of the developed IPM packages. The IPM packages which were developed were not disseminated to other areas with similar conditions and crops. In the IPM programme in cotton it was found that, without IPM, farmers sprayed 6 times while 2 times was sufficient (Shinyanga project, pers. comm. to F. Katagira). IPM is presently restricted to programs that focus on the conservation of amphibians; elsewhere there are only local initiatives by extension farmers.

As already set out in Chapter 5, SAGCOT has an IPM plan (SAGCOT, 2014). The work plan is based on previous experiences with IPM elsewhere in Tanzania and includes a budget estimation for implementation ($1,375,000). It describes existing and anticipated pest problems in SAGCOT's main crops. All earlier developed IPM packages were compiled and documented in this plan. In the document it is clearly indicated that the packages that were developed by the Tanzania-Germany IPM project can be adopted for use in the SAGCOT areas after verification. Lessons learned from the previous programmes emphasise participative capacity building of IPM farmer groups, institutional collaboration, and political, financial and logistical support. SAGCOT intends to use the strategy that will involve sensitisation-capacitation-adoption and scale out. It is also stated that it will mainly undertake training, provision of resources and logistic support. Before adoption by farmers the packages will be tested/verified by researchers, farmers and extension staff. Farmer Field Schools (FFS) and IPM farmers groups will be used for testing/verification in a participatory manner. All major cash and food crops, their pests and diseases are included in the SAGCOT IPM Plan 2014. In the Table 6.1 examples of IPM packages are provided for maize and paddy rice, extracted from the SAGCOT IPM plan.

A remark must be made here. In the SAGCOT IPM plan the recommended pesticides for the SAGCOT corridor are shown. However, some of the recommended pesticides are banned, as in the case of endosulfan. Others, pendimethalin and glyphosate just to mention a few, have been presented to international forums as potential carcinogens (not proven), so caution is needed for individuals who use these products regularly.

Table 6.1 *IPM Packages for maize and paddy. Source: SAGCOT IPM Plan (SAGCOT, 2014).*

Crop	Pests	Recommended IPM package
Maize (field)	Stalk borers (*Busseola fusca)*	• Remove/burn/burry maize stalks to eliminate diapausing larvae • Early sawing to reduce infestation • Intercropping with pulses • Use neem powder (4-5g)per funnel • Use neem seed cake 4 g per hole during planting • Use the extract of *Neuratanenia mitis* a botanical pesticide
	African armworm(*Spodoptera exempta)*	• Scout the crop immediately the forecast warns of expected army worm outbreaks • Apply recommended pesticide or botanical extracts i.e. neem when larvae are sighted
	Seedling weevils *(Tanymecus* spp. & *Mesokeuvus* spp)	• Timely planting escape damage • Scout the crop • Apply recommended pesticide
	Gray Leafspot	• Use resistant varieties • Crop rotation • Observe recommended time of planting • Remove crop debris from the field
Maize (post-harvest)	Larger grain borer (LGB) Weevils Moths	• Use of tolerant varieties • Timely harvest • Proper drying to moisture conten 12% • Dehusk the cobs and shell the grains • Use airtight containers for storage of grain • Regular inspection of storage facility to check the pest infestation • Addimix maize grain with the recommended storage insecticide
Paddy rice (field)	Stem borers (*Chilo partellus, C. orichalcociliellus, Maliarpha separatella, Sesamia calamistis*	• Early planting • Plant recommended early maturing varieties • Destruction of eggs in seed beds • Recommended fertilization • Use recommended spacing • Clean weeding • Plough after harvesting to expose eggs • Destruction/removal of stubble after harvesting

6.2.2 Biological control

In 1987 Tanzania was invaded by Cassava mealy bug which devastated the cassava crop and farmers experienced serious food shortage especially in areas including Kigoma, Mwanza, Mara, Ruvuma (Mbamba bay) where cassava is the main staple food. During that time, unlike the current situation where the demand for cassava for various uses is high, it was considered to be a poor man’s crop. The only feasible control option was to look for biological control agents as it is sustainable without any cost to farmers. All costs involved were covered by the government. The biological control agents *Apoanagyrus lopezi* (a parasitoid) was imported from the Africa-wide Biological Center (IITA) in Cotonou, Benin, and released in all infested areas in the country including in the SAGCOT. Later in 1990, a national biological control programme was established by the Plant Protection Services (Plant Health Services) at Kibaha Sugarcane Research Institute in 1990. The main activities being implemented by the programme include:

- Conducting surveys to determine distribution, abundance, and damage severity of invasive pests.
- Identification of suitable natural enemies through literature search and laboratory studies.
- Importation, conducting laboratory trials, mass rearing and release of effective natural enemies in pest infested areas.
- Conducting post release monitoring surveys to evaluate efficacy of introduced bio-agents.
- Conducting training/awareness creation on the occurrence and proper management of released bio-agent in farms.

- Research on other management options compatible to biocontrol which can enhance the performance of introduced bio agents.
- Coordinating biocontrol research conducted in the country.

Cassava green mite (*Mononychellus tanajoa*) is a serious pest on cassava and the biocontrol agent *Typhlodromalus aripo* (a predatory mite) was imported and released. Other pests followed, including the Diamond back moth (*Plutella xyllostela*) in *Brassica* crops (cabbage, spinach, kale), which resisted pesticides within short periods. Thus, biological control was the solution. These problems were countrywide. In Table 6.2 the crops infested and the biological control agents which were released, specifically in the SAGCOT area from 1989 to 2013, are shown.

6.2.3 Push-pull technology

The push-pull technology has proved to be effective for the control of stemborers (*Chilo partellus*) and in suppressing striga weed (*Striga asiatica*). Stem borers and striga are major constraints to increased maize production in various parts of Tanzania like the southern highlands (including the SAGCOT), the Lake Victoria zone and eastern Tanzania. In order to address the problem a new technology known as push-pull was initiated in 2004 at the National Biocontrol Center. The technology involves the use of highly susceptible trap plants such as Napier grass (*Pennisetum purpureum*) to 'pull' stemborers from farmers' fields, and leguminous plants, Silver leaf desmodium (*Desmodium uncinatum*) and Green leaf desmodium (*Desmodium intortum*) to repel (push) ovipositing stemborers from the same field. Desmodium is also used to suppress striga weed in striga-infested fields. The results were very positive and the method was later introduced to the northeastern Tanzania in Tanga (Muheza), Morogoro (Kilosa) and the Lake Victoria zone in Mara (Tarime). The technology can be disseminated to the SAGCOT corridor for the control of both stem borers and striga, which are among the important pests negatively affecting the production of maize and sorghums. Availability of Desmodium seed is a problem but seeds can be obtained from Kenya. In addition, the Uyole Agricultural Research station located in Mbeya sometimes has the seed in stock.

The benefits of the technology are:
- availability of adequate and nutritious animal fodder,
- reduction of up to 69% striga infestation,
- reduction of up to 84% of stem borer infestation,
- increase of up to 3 liters per cow of milk production in areas where farmers practice livestock keeping,
- improved soil fertility due to desmodium plants, and
- reduced soil erosion due to availability of desmodium as cover crop.

Table 6.2 *Areas Released with Natural Enemies in the SAGCOT corridor (Morogoro, Iringa, Mbeya, Njombe, and Rukwa Regions). Source: National Biological Control Center (2015).*

Natural enemies released	Pest	Host crop	Region	District	Status of establishment	Intervention required	Year
Apoanagyrus lopezi (parasitoid)	Cassava mealybug	Cassava	Mbeya	Kyela- along shores of lake Nyasa	Well established. Reoccurrence in hot spots	More releases in hot spots	1989-1994
			Morogoro	Kilosa- released in all affected villages	Well established. Reoccurrence in hot spots	More releases in hot spots	1992-1994
				Kilombero- first releases done in affected villages in Ifakara and later in 1992 to 1994. Released in all affected villages in Kilombero district	Well established. Reoccurrence in hot spots	More releases in hot spots	1990-1993 and 1992-1994
				Morogoro Rural- released in all affected villages	Well established		1990-1993
Typhlodromalus aripo (predatory mite)	Cassava green mite (*Mononychellus tanajoa*)	Cassava	Mbeya, Iringa, Morogoro, Rukwa	All districts in the regions were affected	Initially well established. In 2015 low populations observed, thus requires continuous releases and use of hairy varieties	Repeated releases in all affected areas. Monitoring and training of farmers and extension staff	1998-2004
Diadegma semiclausum (parasitoid)	Diamond back moth (*Plutella xyllostela*)	Brassica crops (cabbage, spinach, kale)	Morogoro	Mvomero – in Mgeta, Langali, Pinde villages. Morogoro- rural	Initially well established. In 2015 low populations level observed, due to high chemical sprays	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
			Iringa	Kilolo- in Lulanzi, Iramba, Ibumila villages	Well established. –in 2015 low population level due to high levels of chemical sprays	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
				Iringa rural - Makota, Kaningombe	Well established. In 2015 low population level due to high levels of chemical sprays.	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
				Mufindi - Kassanga,Hihomasa, Kibengu,Ungesa,Isalavanu	Well established. In 2015 low population level, due to high levels of chemical sprays	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
			Mbeya	Mbeya rural - Imezu, Inyala, Galijebe, Rungwe-Idweli, Isongele, Ndaga isongele, Usoha	Well established. In 2015 low population level, due to high levels of chemical sprays	Repeated releases. - Monitoring and training of farmers and extension staff	2002-2005

Natural enemies released	Pest	Host crop	Region	District	Status of establishment	Intervention required	Year
				Rungwe-Idweli,isongele, Ndaga isongele, Usoha	Well established. In 2015 low population level, due to high levels of chemical sprays	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
				Mbeya municipal - Ituha, Ilomba	Well established. In 2015 low population level, due to high levels of chemical sprays	Repeated releases. Monitoring and training of farmers and extension staff	2002-2005
Cotesia flavipes (parasitoid)	Cereal stem borer (*Chilo partelus*)	Maize, sorghum	Morogoro, Iringa, Mbeya, Rukwa	All districts in the 4 regions	Well established but presently at low population level, due chemicals dusting/sprays	Repeated releases. Monitoring and training of farmers and extension	2000-2005
Encasia dispersa, E.guadelopae (parasitoids)	Spiralling whitefly (*Aleurodicus dispersus*)	Horticultural crops (banana, pawpaw, tomato, guava, cassava, etc.)	Mbeya, Iringa, Rukwa	All horticultural growing districts	Well established and control is still very good	Monitoring, training of farmers and extension staff to discourage chemical pesticides spraying	2005-2013

6.3 Farmer knowledge, training & extension

Many agricultural pesticides in developing countries such as Tanzania are used by small-scale farmers, whose livelihood and well-being may be negatively affected by those pesticides (De Bon *et al.*, 2014; Williamson *et al.*, 2008). Although at present pesticide use appears to be rather limited in the SAGCOT corridor, application of the majority of pesticides is little informed (see Chapter 3). This means application does not take precautions to prevent negative impacts on human and environmental health.

The majority of Tanzanian farmers have insufficient access to knowledge about pests and the recommended pesticides for their control (e.g. Ngowi *et al.*, 2007; Williamson *et al.*, 2008). There are relatively few trained agricultural extension workers (see Box 6.1 for extension services) to give advice to farmers and as a result farmers depend on pesticide dealers for technical advice. However, the majority of dealers are unable to provide appropriate advice. As a consequence, the expected sustainable pest control is not attained. In addition, most pesticide companies have scanty, if any, field extension workers to train the retailers or farmers on appropriate pesticide handling and use, and on the requirements for human and environmental health protection (Williamson *et al.*, 2008). According to the Agricultural Council of Tanzania (ACT), farmers often request information from pesticides stockists or retailers, because extension services are virtually absent at the village level to give advice to farming communities. As a result, farmers usually copy pesticide use including application methods from other farmers.

Apart from the lack of knowledge about products and their application, various pests are unknown to farmers and dealers, especially new pest introductions such as *Tuta absoluta* on tomato production, *Bactrocera invadens* on mango and other fruits, or Gray leaf spot *Cercospora zeae-maydis* on maize (Ministry of Agriculture). Most farmers lack the photographic equipment to register pests but when they do, pesticide stockists or dealers are mostly unable to reliably identify the pests. In many cases, stockists/dealers don't have adequate knowledge about the products they are selling thus fails to give the desired advice to the farmers.

Box 6.2 Extension services in Tanzania

At present, there are two types of extension services at national level and local government level in Tanzania. The latter delivers the actual service. Adequate extension services for pesticide users is currently absent in most areas of the SAGCOT corridor. A major problem with the extension services in Tanzania is that there are few staff trained in pest management in specific crops. Although there are extension officers in each district, they require training on pest management and also pesticide application techniques also regularly be updated, for example when new pesticides arrive on the markets. The ambition level according to Ministry of Agriculture is to have one adequately trained extension agent per 1000 households as compared to presently only 50% of this quota is met. E-extension using smartphones is an alternative that may be used to reach farmers, but is only applied very locally. This could include messages that indicate when to use fertilizers, water, etc. Apparently this is in a pilot phase in the corridor at present.

There are isolated cases where the agricultural extension officers receive information from farmers about health problems after handling/spraying certain pesticides such skin irritation, chest pains and environmental problems such as pollution of water sources by run off from sprayed fields, death of snakes or decreased populations of snakes such as is the case in some coffee growing areas. However, much of this information stays with the extension officers and is not dealt with. The reporting about these issues should be formalised which is not happening at present because the reporting system is not in place. However, the national action plan for of implementation of the Rotterdam Convention has included monitoring of pesticides effects on human health and the environment. This still at the pilot phase in Kilolo district (Iringa region) in villages growing tomatoes. The reporting system is in place in the pilot areas and expected to identify pesticides with negative impacts to human health and the environment.

Farmer field schools (FFS) are a useful addition and alternative to extension services. Although there are FFS in almost all districts of Tanzania, still many farmers have not taken part thus are not trained. On addition to that not all crops are covered by the FFS. With regard to SAGCOT only a fraction of farmers has been to the FFS, thus despite the existence of training manuals for judicious use of pesticides in rice, horticulture, wheat and cassava, these have reached only a limited number of farmers. It has been reported that even with farmer field schools and functional extension services there are still problems including lack of personnel protection equipment(PPE), unknown dosages being used, types of pesticides used, this has been attributed to farmers not sufficiently aware of sound pesticides management and the consequences poor management including misuse of pesticides.

Training of farmers is done by different stakeholders including NGOs such as Envirocare and also by pesticide suppliers such as Bytrade. Envirocare started with pesticide related projects: DDT on maize and coffee, education for safe use, storage, advice on organic farming, sustainable farming, and on bio-pesticides. In 2010 an inventory was performed of small and large farms on a government contract. Four thousand (4000) farmers were trained on organic coffee growing. They used seminars and radio to teach farmers on how to read labels, how to use pesticides, and how to protect themselves by using PPE and protection of the environment.

Bytrade supplies pesticides for control of pests on most crops throughout the country and has six agronomists in charge of training farmers. This team undertakes the training of trainers (TOT) and move to different areas with the seasons. Bytrade trainers are linked to NGO networks to disseminate the technical information to farmers. The agronomists send photos of crop disease, and the main office proposes the effective treatment. They promote bio-pesticides, for example on pests on tomatoes, and explain labels and instructions to get maximum benefits from their pesticide products. The explanation also includes best practices in terms of pollution. Bytrade sells products to credible dealers with licences for agrochemical business and signs agreements with such dealers. To be licenced, the dealers must be trained by the licensing authority, which is TPRI. If a product is tampered with, they take action to reduce the impact and prevent it from happening again. Two cases were tracked where people diluted pesticides during transportation of the pesticides. The TPRI instructions to destroy the product were followed in response. When Bytrade promotes and sells a product it also promotes use of PPE. Few farmers use extension officers, most of them visit the neighbours for advice. Efficacy is assessed through trial and error. The sources of technical information to farmers include:

- Extension officers- They organise meetings, establish demonstration plots, and organise farmers groups. In Kilolo district in Iringa region there are 70 extension workers and the ratio of extension staff to farmer estimated to be 1 to every 600 farmers. The funding for movement facilities is limited, in total the 70 officers have 8 motorbikes.
- Agro-dealers
- Neighbouring farmers
- Commercials on the radio
- Some large farms have input supplies and information at their gates and inform farmers.
- Local NGOs are reaching many farmers, USAID had a program that reaches many farmers to teach IPM.

In Kilombero district farmers indicated need for more training. They also mentioned need for:

- Regular training of pesticide sellers (retail or wholesale trade) and agricultural extension officers, especially on the sound use of pesticides.
- Few farmers to be trained on sound management of pesticides as trainers of trainers (TOTs), so as to train other farmers on safe use and handling of pesticides.
- Livestock keepers to be trained on the impact of the chemicals used in their livestock to human health. Among the problems mentioned was that sometimes farmers use pesticides to treat human wounds, stomach ache, etc. Also farmers sometimes make mixtures containing acaricides used on livestock and insecticides for crops and spray such mixtures on their crops for the control of certain pests.
- Many farmers complained on consuming contaminated milk by acaricides or animal drugs because they do not observe the recommended safety periods.

7 Synthesis

7.1 Principal findings of the scoping study

The most important conclusions of the scoping study (literature review and scoping mission) are summarised below. The conclusions are organised according to the four previous chapters.

Pesticide use

- Cereals and horticulture consume most of the pesticides.
- A limited number of 'old chemistry' pesticides dominate at agro-dealers in SAGCOT, in spite of a great number of registered pesticides at the national level.
- There are a considerable number of reduced-risks pesticides registered.
- A major increase of pesticide use is expected in maize, horticulture, and rice, through intensification, increase of area planted and increased occurrence of pests and diseases.

Environmental & human health effects

- There are many reports of adverse occupational impact of toxic pesticides and poisoning through handling and application by unskilled workers.
- Impact of pesticides on vulnerable ecosystems like aquatic ecosystems are likely (e.g., rice).
- Pesticides may cause a loss of important ecosystem services (supply of clean water, fisheries, natural pest control, pollination).
- An increased availability of pesticides may lead to more illegal uses (wildlife poisoning, fishing).
- Side-effects on non-target wildlife occur (e.g., bird control).
- Pesticide effects on wildlife are a potential threat to the tourism industry.
- Key ecosystems vulnerable to pesticides are present in the SAGCOT area or nearby, especially areas with surface water like the Kilombero flood plain and Lake Rukwa.
- Evaluation of pesticides used in some of the SAGCOT districts showed that these include many highly hazardous pesticides and pesticides that are harmful to the aquatic environment.

Policies & legislation

- Pesticide registration in Tanzania needs better human health and environmental risk assessment.
- Agricultural policy clearly promotes IPM and biocontrol.
- Implementation and enforcement of pesticide policy and legislation are currently not sufficiently effective.
- Environmental Impact Assessments of new/expanded agricultural development projects are conducted, but it is unclear if they are effective.

Pesticide life cycle & best practices

- In general, the situation with respect to pesticide risk reduction measures and best practices in SAGCOT seems the same as in other parts of Tanzania. There are many problems connected to pesticide use.
- Various aspects of the life cycle of pesticides are insufficiently managed:
  - inadequate diagnostic capabilities,
  - mixing of different (types of) pesticides,
  - unjustified pesticide use,
  - illegal cross-border pesticide trade,
  - minimal use of PPE,
  - no calibration of spraying equipment, and
  - inappropriate disposal of empty containers (re-use, environmental contamination).
- The level of farmer knowledge about responsible pesticide use is low, especially among smallholders.
- IPM schemes are not implemented at a large scale.
- Agro-dealers do supply unauthorised (and perhaps even counterfeit or 'fake') pesticide products and pesticides that compromise sustainability.

- There is a great need for more training of farmers and also agro-dealers/retailers on safe pesticide use and IPM.
- There are good possibilities and there is knowledge about the application of IPM to crops in the SAGCOT. However, IPM is still not much applied.
- There is readily available information and training materials on IPM in Tanzania and elsewhere, but this is not currently used.
- Extension services do not reach farmers to a sufficient degree.

Healthy wildlife is crucial to the tourism sector in Tanzania. Photo: Ralph Buij, Wageningen Environmental Research.

7.2 Outcome of the stakeholder workshop

During the first day of the stakeholder workshop the findings of the scoping study were presented and discussed. In general, the participants agreed with the issues raised by the scoping study team and with their conclusions. The results of the study were vividly discussed and many participants came up with examples from their own daily work to illustrate and endorse the conclusions. The constraints for achieving sound pesticide management in Tanzania and SAGCOT can perhaps be summarised in the conclusion that (1) policies, legislation, expertise and training infrastructure are more or less in place, but that (2) in the present situation enforcement is often lacking and therefore that (3) training and extension to support enforcement and to increase the knowledge of people handling pesticides are therefore much needed.

On the second day of the workshop the participants split into four groups with different themes:
- *Registration and control* (incorporation of risk assessment, inspection, quality control),
- *Measures in the distribution chain* (import & formulation, distribution & retail, disposal),
- *Best practices* (IPM, biological control, organic agriculture, use of PPE, extension), and
- *Monitoring & research* (pesticide sales & use, environmental monitoring, human health monitoring, resistance, yield, etc.)

Each of the groups was asked to determine for SAGCOT (1) what is needed to reduce pesticide risks, (2) what is already done to reduce pesticide risks, and (3) what is currently lacking to reduce pesticide risks. Finally, the groups were asked to identify the three most urgent and promising activities to be deployed to reduce pesticide risks in SAGCOT. A list with the resulting twelve most urgent activities for SAGCOT is presented in Table 7.1.

Table 7.1 *Most urgent activities to reduce pesticides risks in SAGCOT identified by participants of the stakeholder workshop on pesticide management in the corridor.*

Theme	Activity no.	Description
Registration & control	A	Government to increase resources for enforcement/quality control/registration
	B	Training (priority with pesticide users)
	C	Increase number of inspectors (or alternative)
Distribution chain	D	Reliable system for data management (collection, distribution and use)
	E	Coordinate and harmonize capacity building activities
	F	Regulatory body at LGA level to enforce/monitor pesticide management (life cycle)
Best practices	G	Awareness creation and sensitization on harmful effects of pesticide
	H	Creation of multi-stakehoder fplatform for exchange on best pest and pesticide management practices in SAGCOT
	I	Implementation and enforcement of rules and regulation
Monitoring & research	J	Develop monitoring & evaluation framework on pesticides
	K	Quantitative impact assessment of pesticides (environmental, health, economic& social effects)
	L	Training and awareness creation

Finally, all participants were asked to anonymously vote for the tree most urgent and promising activities out of the list in Table 7.1. Activity no. 1 of each participant was awarded 3 points, activity no. 2 got 2 points and activity no. 3 one point. Based on this ballot a ranking was established. The top five of this ranking is as follows:

1. Implementation & enforcement of rules, regulations, registration & quality control (A, C, I, 23 pts.)
2. Training & awareness creation for pesticide users on harmful effects of pesticide (B/L, 23 pts.)
3. Creation of a multi-stakeholder platform (H, 13 pts.)
4. Regulatory body at LGA level to enforce/monitor pesticide management & life cycle (F, 11 pts.)
5. Develop M&E framework on pesticides for SAGCOT (J, 10 pts.)

When the priorities were identified discussions continued. The participants made it clear that funding and resources to realise these goals are a prerequisite. The execution of the Agricultural Sector Development Programme 2 for Tanzania (ASDP-2, see Chapter 5) may provide opportunities for this purpose. ASDP follows a bottom-up approach, plans by Local Government Authorities (LGA) are the basis for its implementation. It was also put forward that the activities identified may be implemented first in one cluster as an example for the other clusters in SAGCOT and that a team to organise this initiative could be set up at the cluster level. Such an initiative could include creation of a monitoring & evaluation framework. This should be co-ordinated by the Ministry of Agriculture. It is clear that many stakeholders should be involved in the initiative such as the government (Ministry of Agriculture, local authorities), NGOs, the private sector and farmer organisations.

With respect to the multi-stakeholder platform proposed it was observed that similar platforms already exist and a new one may not necessarily need to be created. An agriculture platform with all key players in the value chain already exists in Iringa. Ihemi has a Cluster Green Group at the cluster level. The existing ASP platform has become a broader chemicals management forum. SAGCOT itself runs an Environmental Feeder Group that includes some pesticide experts, but this group mainly operates at the national level. The climate change learning alliance may serve as an example.

Some miscellaneous suggestions by the stakeholders during the workshop included:

- Also look at the risks of pesticides to consumers.
- Pay attention to innovative methods for surveillance (of pests) and extension of information such as the use of mobile phones.

- There is a gap between extension and research. Scientists studying pesticides (in Tanzania) should pay more attention to advocacy of their results.
- Lack of resources may not always be the first priority. Lack of co-ordination and strategies may be just as important.
- Also train the inspectors and border posts in the clusters.
- Register agro-dealers in smaller villages (many are not registered).

Participants of the stakeholder workshop in Dar es Salaam, July 28-29, 2016.

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Appendix V: Indicative Programme of Development to 2015
Appendix IX: SAGCOT Production and Investment Model
Appendix XI: Cluster development projections to 2030
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Annex 1 Persons met during scoping mission and workshop

Persons that also participated in the stakeholder workshop are marked with an asterisk (*). The project team is not included in the list.

Divason Abel	Kwasi Agricultural and Marketing Cooperative Society (Agrodealer). Sumbawanga City
Dismas C. Amri*	District Crop officer- Kilombero District
Andrea Atahanas	African Wildlife Foundation (AWF). Dar es Salaam
John Banga Nakei	Environment and Social Specialist - SAGCOT Centre
Janet F. Bitegeko	Executive Director. Agriculture Council of Tanzania (ACT). Dar es Salaam
Manfred Wilson Bugubugu	Agrodealer. Mtowise (Sumbawanga)
Carter Coleman	Chairman, Kilombero Plantations Limited (KPL)
Pius Chang'a	Vegetables grower- Mahenge village – Kilolo district
Abubakari Day	Farm Manager- Kilombero Sugar Company
Salum Diwani	Director. Bytrade Tanzania Ltd. Dar es Salaam
Mr. Erasto	District Extension Officer. Kalambo District (Sumbawanga)
Daktari Hango	Policy & Planning Division. Ministry of Agriculture, Livestock and Fisheries. Dar es Salaam
Tano Hangali	Registration Officer. Tropical Pesticides Research Institute (TPRI), Ministry of Agriculture, Livestock and Fisheries. Arusha
Germanus Hape	Assistant Ecologist – Tanzania National Parks, Mikumi
Mariam Hassan	Water Engineer- Ministry of Water and Irrigation
Fredrick Jailos	Environmental Officer/Deputy Systems Rice Intensification (SRI) Manager - Kilombero Plantations Limited
Henry James	Irrigation Officer. Katuka Irrigation Scheme, Kalambo District (Sumbawanga)
Emmanuel Joo	Head. Zonal Plant Health Services, Southern Zone, Ministry of Agriculture, Livestock and Fisheries (Mbeya)
Pasikali Joseph	Rice grower- Mkangawala village –SRI, Kilombero District
Twilumbe Kadeha	District Agric Extension officer, Kilolo district -Iringa
Paul Wilson Kajange	Agrodealer. Matai (Sumbawanga)
Kajimba	Acting District Agricultural Officer. Kalambo District (Sumbawanga)
Victor Kakengi	Scientist. Tanzania Wildlife Research Institute (TAWIRI). Arusha
Yona Kalinga	Senior Agronomist-Kilombero Sugar Company
Diomedes Kalisa*	Food and Agriculture Organization of the United Nations (FAO). Tanzania Representation. Dar es Salaam
Geneveva Kamuhabwa	Pesticide management specialist. Plant Health Services. Ministry of Agriculture, Livestock and Fisheries. Dar es Salaam
Japhet J. Kashaigili*	Professor. Sokoine University of Agriculture, Morogoro
Karunde Kasim	Environment Engineer- Ministry of Water and Irrigation
Justa Katunzi	Crop Development Division - Extension Services. Ministry of Agriculture, Livestock and Fisheries. Dar es Salaam
Mfaume Kayanda	Vegetables grower- Mahenge village – Kilolo district
Willibrord Kazonda	Mtandao wa Vikundi vya Wakulima Tanzania (MVIWATA) - National Network of Small-Scale Farmers Groups in Tanzania. Matai (Sumbawanga)
Litsol Kibona	Extension Officer. Kalambo District (Sumbawanga)
Kiliani Kikoti	Village extension worker –Mkangawala village- recruited by KPL
Rogathe Kisanga	Environment Division, Vice-President's Office. Dar es Salaam
Salome Kisenge*	Monitoring & Evaluation Manager, ENVIROCARE

Arnold C. Kisiraga*	Senior Environmental Management Officer. National Environment Management Council (NEMC). Dar es Salaam
Friday Kumba	Farmer. Mtowise (Sumbawanga)
Eliningaya J. Kweka	Director. Vector Ecology and Control. Tropical Pesticides Research Institute (TPRI), Ministry of Agriculture, Food Security and Cooperatives. Arusha
Mr. Kwileluye	District Agricultural Officer. Sumbawanga Rural District (Sumbawanga)
Loyce Lema	Executive Director - ENVIROCARE
Mattias Lema*	Department of Resource Management. Ministry of Natural Resources and Tourism. Dar es Salaam
Hilda Liemba	Rice grower- Mkangawala village –SRI, Kilombero District
Tabu Likoko	Horticulture specialist - Crop Promotion Section-Ministry of Agriculture, Livestock and Fisheries. Dar es Salaam
Mosses Logan*	Agricultural Officer, Kilolo district Coordinator of programmes, Iringa
Edesia W. Lugainamula	Finance officer. International Union for Conservation of Nature (IUCN), Tanzania Country Office. Dar es Salaam
Anna Lyimo-Kessy	Acting Director of Research and Information System. Tanzania Investment Centre. Dar es Salaam
Deodatus Maganga	Rice grower- Mkangawala village –SRI, Kilombero District
Evergris W. Mackfura	Community Development Officer- WWF Ruaha Water (Fresh water) Programme
Richard E. Maganga	Maganga Agrchemicals. Nkasi (Sumbawanga)
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