Study on crop protection where the ‘Green Innovation Centres for the Agriculture and Food Sector’ (GIAE) initiative is being implemented

MALAWI

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KNOWLEDGE FOR LIFE

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Executive summary

Analysis of the legal framework relating to pest and pesticide management in Malawi was conducted through a desk study, followed by verification during a stakeholder workshop. The findings showed that legislation in Malawi is covered in several acts and regulations, the most relevant being the Pesticide Act 2012 (2000) and associated Pesticide Regulations 2012 (2002), together with the Environmental Management Act of 2017. A comparison of Malawian legislation against international guidelines from the FAO and the ILO, as well as with other regulatory best practices, such as those of the OECD, highlighted numerous areas where legislation in Malawi is missing or could be significantly strengthened. The main areas are pesticide sale and storage, disposal of unused pesticide and empty pesticide containers, use of application equipment and the registration of biopesticides. Support for Integrated Pest Management (IPM) in Malawi is emphasized in the Malawi National Agricultural Policy 2016. The study complemented information gathered on policy and legislation through obtaining information on farmer and extension agents' perceptions and practices relating to pest and pesticide management. This was gathered through questionnaires and interviews with stakeholders conducted in September 2017. Questionnaires were completed with 19 farmers and 19 extension agents in one geographic region of Malawi. Three focus group discussions (FGDs) were also held. Information from other key value chain stakeholders was gathered through key informant interviews (KIIs) in Lilongwe. The findings identified the main pest problems faced by farmers in soybean and groundnut and highlighted the pest management options being applied. These include the use of synthetic pesticides and homemade botanical pesticides, in addition to cultural control methods. However, the range of pesticide products being applied was limited and highly hazardous pesticides (HHPs) were being used. The survey findings also showed that the majority of farmers, as well as extension agents, had low levels of knowledge on safe pesticide use. This included concepts such as re-entry and post-harvest interval, and practice for safe pesticide storage and disposal. The majority of farmers use no personal protective equipment (PPE) for applying pesticides, or in some cases improvise equipment. Low use of PPE combined with difficulty in understanding hazard warning symbols on pesticide labels creates a risk for farmers using pesticides. This is corroborated by findings showing that some farmers also experience health problems associated with pesticide exposure. Stakeholders such as extension agents and retailers, who are in position to formally advise farmers, also showed low levels of knowledge on pest identification and pesticide safety awareness in the geographic areas covered by the study.

Analysis of the Malawian list of registered pesticides (2015) showed 158 registered active ingredients (AI), of which 49 are classed as HHPs according to the criteria used within this study. Only three pesticide AI were classed as low-hazard. The findings also show that methyl bromide, the only agricultural ozone-depleting substance listed in the Montreal Protocol, is registered in Malawi. Endosulfan, listed under the Stockholm Convention, is also registered. Some common biopesticides, including commercially produced neem products, are not yet registered for use in Malawi and cannot therefore be legally recommended as alternatives to synthetic pesticides.

A literature review of approaches applied to control the most common pests affecting soybean and groundnut in field and storage was conducted. Many of the recognized best practice approaches to pest management, including cultural methods, are already being practised by farmers and recommended by extension agents surveyed as part of this study. The findings suggest that additional practices, such as increased pest monitoring to enable rational use of synthetic pesticides, the use of biopesticides, and other options, such as planting of improved and resistant varieties, will support more effective pest management for the farmers surveyed.

Finally, recommendations based on the study findings and gathered from workshop participants are listed. These emphasize the need for awareness-raising among farmers and advisers on pest identification and sustainable management covering a broad range of topics. Policy-level support to incentivize the use of less toxic pesticides and increase availability and use of safer alternatives is recommended.

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Disclaimer

The views expressed in this document are those of the authors and do not necessarily reflect the views of GIZ and BMZ.

Abbreviations

AI	Active ingredients
AISL	Agriculture Input Supplies Limited
CABI	Centre for Agriculture and Bioscience International
DAR	Department of Agricultural Research
DDT	Dichlorodiphenyltrichloroethane
FAO	Food and Agriculture Organization
FAW	Fall armyworm
FGD	Focus Group Discussion
FISP	Farm Input Subsidy Programme
GAP	Good Agricultural Practice
GIZ	Gesellschaft für Internationale Zusammenarbeit (in English: “Corporation for International Cooperation”)
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GIAE	Grüne Innovationszentren in der Agrar-und Ernährungswirtschaft (in English: “Green innovation centres for the agriculture and food sector”)
GoM	Government of Malawi
HHP	Highly Hazardous Pesticide
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute for Tropical Agriculture
ILO	International Labour Organization
ISO	International Organization for Standardization
IPM	Integrated Pest Management
IUPAC	International Union of Pure and Applied Chemistry
KII	Key Informant Interview
MCTU	Malawi Congress of Trade Unions
MOAIWD	Ministry of Agriculture, Irrigation and Water Development
MRA	Malawi Revenue Authority
MRL	Maximum Residue Level
NASFAM	National Smallholder Farmers' Association of Malawi
NIP	National Implementation Plan
NPPO	National Plant Protection Organization
ODS	Ozone depleting substance
OECD	Organisation for Economic Co-operation and Development
PAN	Pesticide Action Network
PIC	Prior informed consent
POP	Persistent organic pollutant
WHO	World Health Organization

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Introduction

Almost three billion people still suffer from malnutrition. In particular, smallholder farmers in underprivileged regions of the world are highly vulnerable. Yield losses to pests, diseases and weeds are estimated to be of about 35% in major crops, and may exceed 50% in developing regions where pest control options are limited. This clearly underlines the key role played by pest management in safeguarding yields and ensuring food security. Sustainable pest management methods include biological, cultural, mechanical and physical (non-chemical) control methods. These non-chemical methods contribute to reducing pest pressure and damage. However, farmers around the world still rely on pesticides to control pest outbreaks. The Green Innovation Centres programme, led by GIZ under the special initiative One World – No Hunger, aims at boosting smallholder farmer productivity and improving the whole value chain to maximize farmers' benefits. The programme is currently active in 14 countries: Benin, Burkina Faso, Cameroon, Ethiopia, Ghana, India, Kenya, Malawi, Mali, Mozambique, Nigeria, Togo, Tunisia and Zambia. In order to align its Green Innovation Centres to the best practices in pest and pesticide management, GIZ mandated CABI to lead the present study.

The study covered the legal framework for pesticide management as well as pest management practices for the major pests of the Green Innovation Centres' focal crops. In total there were 16 focal crops across the 14 study countries. A desk study, including an analysis of the legal framework and a literature review of pest management practices for the focal crops, was conducted in all 14 countries. The International Code of Conduct on Pesticide Management, published by FAO and WHO, details the best pesticide management practices. These best practices are designed to minimize the adverse effects that may result from pesticide use and to foster the use of sustainable pest management strategies. The analysis of the legal framework compared each country's regulations and policies against the best practices. The legal framework analysis also included an analysis of the registered pesticides and of the hazards linked to their use. For eight countries – Burkina Faso, Cameroon, Ghana, India, Kenya, Malawi, Mali and Tunisia – the study was complemented by in-country data collection. This included KIIs and FGDs with each value chain's major stakeholders, including government officials, as well as questionnaires with extension agents and farmers. The information gathered in-country complemented and validated the findings of the legal framework analysis and provided a snapshot of pest management knowledge and practice in each country. This covered non-chemical and chemical pest management practices, pesticide management and knowledge of IPM.

Based on the results of the study, CABI produced, for each country, actionable recommendations for implementation by the Green Innovation Centres. Additionally, CABI identified areas where further training of farmers or extension agents would be required and identified gaps in national regulations and policies. In all 14 countries, the results of the study and the recommendations were presented in stakeholder workshops. The stakeholders validated the recommendations and discussed their implementation. Overall, the present study contributes to food security by fostering the implementation of sustainable pest management practices and the establishment of an enabling environment in the countries where the Green Innovation Centre programme is active. This reports presents the findings for the study in Malawi

Methodology

The methodology for the study was devised in such a way that it could be implemented in all 14 countries without any major changes in the approach. Approaches and tools for the desk study and in-country data collection were developed by CABI Switzerland, based on experience from previous studies. Based on the findings from the desk study, adaptations were made to the in-country data collection tools to ensure information gaps were filled.

Desk study

A review of literature from the public domain and to which CABI has access was conducted to provide an overview of the agriculture sector within the country, to map the value chains for each focal crop and to assess the institutional and regulatory arrangements for pest and pesticide management. Existing literature on crop protection studies and advisory documents was also reviewed to identify the current crop protection methods being applied within the value chain for the focal crops, which are soybean and groundnut.

Utilizing a tool developed by CABI, the most up-to-date version of the national list of registered pesticides was analysed to identify the full list of AI and products which are registered for use in Malawi. For each AI registered, a profile was developed which includes the chemical class, use type, and associated hazards to human health and the environment. The profiles also included information on the crops and pests for which the pesticide was registered. The FAO *Guidelines on Highly Hazardous Pesticides* (2016) define HHPs as "pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems" and it lists criteria for determining whether or not an AI is an HHP. HHPs which are registered for use in Malawi were identified using these criteria. The toxicological profiles and information on target pests was also used to assess the availability of lower toxicity alternatives to the HHPs for specific crop pests. The National Pesticide Act, subsidiary legislation and other policies relating to pests and pesticides management were identified, and an analysis of the existing legal framework for pests and pesticides management was carried out. A cross comparison was made with international guidelines (e.g. from the FAO and the ILO) and other regulatory best practices (e.g. OECD).

The desk study information was used to compile a preliminary description of the policy setting process in Malawi. The status of implementation and the adequacy of enforcement of the regulations was then confirmed and complemented by data gathered through in-country interviews with representatives of the pesticide regulatory authorities, ministries and other stakeholders.

Data collection

A standardized approach was devised by CABI for the in-country data collection in order to enable cross-country comparison. The activities included KIIs, FGDs and questionnaires. The planning was then discussed and agreed with national GIAE staff. In country, all organizational aspects were taken over by the national GIAE staff. Questionnaires and FGDs with farmers and extension agents were conducted in Dowa and Mngwangwa EPAs, both within one hour drive of Lilongwe. All respondents were invited and meetings arranged by GIAE partners. Extension agents surveyed represented the following EPAs: Dowa, Chwamba, Nachisaka and Mngwangwa.

KIIs were arranged with each value chain major stakeholder. These included representatives of the Ministry of Agriculture, Ministry of Health, Ministry of the Environment, research institutes, agro-input manufacturers and suppliers, voluntary certification standards and certification bodies, where these exist, as well as trade and processing sector actors. Representatives from the Pesticide Control Board were not available at the time of the visit. The interviewees and their affiliation are listed in Table 1 in Annex I.

The information gathered enabled validation of the results of the desk study and also provided a better understanding of the interests and roles played by each stakeholder regarding pest and pesticide management.

The detailed questionnaires and FGDs with extension agents and farmers provided information on their knowledge, attitude and practice relating to the management of pests and pesticides. The non-chemical and chemical control methods recommended by extension agents or implemented by farmers were listed. Finally, knowledge of safe pesticide handling and management were assessed and the current practices documented. The questionnaires comprised structured and closed questions. Additionally, open-ended questions were included so respondents could provide more information about specific issues. Questionnaires were conducted with 19 farmers: nine in relation to soybean production and 10 for groundnut. In addition, 19 questionnaires were conducted with extension agents covering both soybean and groundnut production. For each crop, the information gathered through questionnaires was complemented with two FGDs with farmers and two with extension agents. These respondents were different to those who had completed the questionnaires. The FGDs were designed to foster discussion on issues related to crop protection, to provide a better understanding of the challenges faced by farmers and extension agents.

Limitations of the methodology and data

The in-country data collection was conducted over a period of seven working days and access to some potential respondents and stakeholders was not possible during the short period of the mission. The interviews were conducted during the September dry season (19–26 September) and the findings may reflect the concerns, including pest problems, that farmers and extension agents recalled or faced around that point in time. The study area was confined to Mngwangwa and Dowa EPAs, with extension agent interviews also covering Chwamba and Nachisaka EPAs.

These above limitations in the data collection methodology mean that the findings should be used to provide a snapshot of practice and perceptions in a specific area at a specific time; they cannot be reliably extrapolated to cover pest management contexts in other areas of the country or at different points in time.

Translation was also a major consideration during the study, with the majority of interviews being conducted in the local language by either GIZ national staff or interpreters hired to support the study. The information was then translated back into English in order to complete the questionnaire. The limitations of such a process are acknowledged.

Information collected during interviews with respondents has been provided as accurately as possible and in the way that it was originally presented to the study team via translation.

It was not possible during the study period to inspect crops or to visit farmers' fields and stores. Therefore, the identification of pests and diseases provided by the farmers was based on verbal descriptions only. Although misdiagnosis may have taken place in some cases, the study team has not

attempted to change the farmers' pest or disease identification or diagnosis. In addition, some respondents have reported using pesticides or conducting practices that are not considered suitable for the specific pest they list (using a fungicide to control insect pests, for example). Where this has been the case, no attempt has been made by the team to edit or 'correct' the information provided by the farmer.

Results/findings

Overview of agriculture sector performance and contribution to the economy

Agriculture is a source of livelihood for more than 90% of the population in Malawi and represents more than three quarters of national exports. Total area of land under cultivation has been steadily increasing, from 52% in 2007 to 61% in 2015, and the rural population has showed a small decrease, by 2% from 2000 to 2016. Further information is shown in

Annex II Overview of agriculture sector performance and contribution to the economy
Table 2 in Annex II.

General information about the focal crop value chains

Groundnut – Groundnuts are one of the most important food and cash crops in Malawi, grown by approximately one in five farmers. Although groundnuts are grown in nearly all of Malawi's 28 districts, the central region dominates production with 70% of the crop being grown in this region. Groundnut production has shown a significant increase over the last 10 years, with the area grown in hectares increasing from 258,111 ha in 2007 to 373,925 in 2014. Average yield, however, has remained at around 1,000 kg/ha. Around 95% (in 2015) of Malawi's groundnut production is exported, chiefly to Tanzania, Kenya, Zambia and South Africa. Export volumes of groundnuts declined over the last three decades due to quality issues, including aflatoxin levels that exceed limits permitted by many importing countries, including those of the EU. The Government of Malawi (GoM) has identified groundnut as a key sector for investment with the aim of tapping into the increase in global demand for groundnut. Groundnut products in Malawi include whole nuts sold as confectionary, processing for peanut butter, groundnut oil and groundnut cake for animal feed.

Soybean – Soybean beans are grown mainly as a cash crop in Malawi with smallholder farmers accounting for about 91% of total production. The main production areas are Lilongwe, Ntchisi, the Kasungu plains and Mzimba. soybean is grown mainly for commercial processing into oil and protein for animal feed and human consumption. Production figures are increasing annually, with the area harvested increasing from 79,465 ha in 2007 to 139,005 ha in 2014. However, yield over the same period has remained stagnant at around 900kg/ha.

Cassava is grown throughout Malawi and is the staple crop around the lake shore districts Nkhotakota, Nkhatabay Rumhi and Karonga. Commercial interest in cassava has grown over the last 10 years in response to a potential market for high quality cassava flour. Production in hectares has increased from 172,539 ha in 2007 to 222,750 ha in 2014. Average yield (kg/ha at harvest) has increased from 18,772 kg/ha to 22,504 kg/ha over the same period (FAOSTAT).

Maps showing soybean and groundnut growing areas of Malawi and values chains are shown in Figure 1.

Production of the GIAE focal crops soybean, groundnut and cassava are shown in Table 3.

Sources of agricultural inputs and support

Major value chain stakeholders for groundnut and soybean in Malawi are shown in

Table 5 and Table 6. These include certification organizations, collectives and associations, trading and processing companies, extension and advisory services (public and/or private) and NGOs and other agencies.

Organizational arrangements within the national governments for pest and pesticide management are shown in Table 7. The trend in pesticide use in Malawi is shown in Figure 5.

Analysis of existing legal framework for pest and pesticide management

An overview of the legal framework for pest and pesticide management in Malawi is shown in Table 8.

Adherence to and implementation of international agreements relating to pesticides

- Malawi became a party to the Montreal Protocol in 1991 (accession) and has taken the following steps to implement it: it banned the use of methyl bromide by the end of 2004 and from 31 December 2004 imports of methyl bromide are impounded. However, methyl bromide is still included in the 2015 list of registered pesticides.
- Malawi became a party of the Rotterdam Convention in 2009. The country has submitted 38 import responses, the most recent being December 2012. It has failed to provide import responses for nine pesticides. The country provided notice of final regulatory action for two pesticides (methyl bromide in 2009 and DDT in 2010). No proposals for listing Severely Hazardous Pesticide Formulations (see

- Table 17) were submitted by the country.
- Malawi became a party to the Stockholm Convention in 2009 (ratified) and has taken the following steps to implement it: before ratification, Malawi had already devised the Persistent Organic Pollutant (POP) National Implementation Plan for 2005–2020 (NIP), a policy document with the objective to "develop and improve the optimal and most effective POPs management system while securing human health and environmental protection" (NIP for POPs Dec 2005).

Malawi is progressively phasing out POPs within the next 20 years as described in the NIP for POPs (2005). The plan lays out several objectives regarding the gradual elimination and safe disposal of POPs. Malawi acknowledges the exemption for vector control, and should the malaria vectors become or acquire resistance (to the current control option) Malawi shall request exemption to use DDT.

No specific legislation currently deals with POPs in Malawi. However, there are several regulatory frameworks in place governing the regulation, approval, monitoring, import and export of chemicals in the country. These regulatory frameworks include: (i) the Malawi Bureau of Standards Act (1987); (ii) the Environment Management Act (2017); (iii) the Pesticides Act (2002); (iv) ESCOM being a member of the Power Institute of East and Southern Africa; and (v) the Occupational Safety, Health and Welfare Act (1997).

The GoM has recommended the replacement of some POPs. The use of aldrin, heptachlor, dieldrin and endrin has been replaced by carbofuran, chloropyrifos and carbo-sulfan for soil pests. DDT has been replaced as follows. For cotton insect pests the alternative pesticides are deltamethrin, cypermethrin, lambda-cyhalothrin, thiodicard and carbaryl. For tobacco soil pests the alternatives are carbosufuran and carbosulfan. For maize stembores and armyworms the alternatives are deltamethrin carbaryl, fenitrothion and sumicidin. For household use against mosquitoes, the recommended chemicals are deltamethrin, permethrin and lambda-cyhalothrin (Malaya 2016).

Malawi became a party of the Basel Convention in 1994. In August 2017, Malawi also ratified the Ban Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

Regulations related to adherence to and implementation of the Basel Convention include the Environment Management Act, 2017 (EMA). Section 58 contains provisions on importation and exportation of hazardous substances and states that: "(1) A person shall not export any hazardous waste or substance, except under a permit issued by the Authority, and subject to conditions determined by the Authority". The Environment Management (Waste Management and Sanitation) Regulations, 2008 state a licence shall be granted "to export hazardous wastes or other wastes if the export is in accordance with an agreement or arrangement that conforms with the requirements contained in Article 11 of the Basel Convention, i.e. Bilateral, Multilateral and Regional Agreements".

Malawi has not ratified the ILO Safety and Health in Agriculture Convention (C184), although health and safety in agriculture is covered in the Malawi Occupational Safety Health and Welfare Act 1997. Section 51 notes that "manufacturers, importers and suppliers of hazardous substances used at workplaces, including those in the agricultural sector, shall provide sufficient information on such substances with the precautions to be taken." Furthermore, Malawi has ratified the 1971 Labour Inspection (Agriculture) Convention, 1969 (No. 129). Article 18 states that: "Labour inspectors in agriculture shall be empowered to take steps with a view to remedying defects observed in plant, layout or working methods in agricultural undertakings, including the use of dangerous materials or substances, which they may have reasonable cause to believe constitute a threat to health or safety". In addition, each member of the ILO that ratifies the Convention undertakes to extend to all agricultural wage-earners its laws and regulations which provide for the compensation of workers for personal injury by accident arising out of or in the course of their employment. Section 34 of the Pesticides Act (2012): states that: "Every employer who requires or permits an employee to use a

pesticide shall provide and require the employee to use facilities, equipment and clothing conducive to the safe handling of the pesticide."

Overview of national regulation related to pests and pesticides management

Pests and pesticides management in Malawi is covered by two key pieces of legislation: the Pesticides Act (2012), which is enacted by the Pesticides Regulations (2012), and the Environmental Management Act (2017). Other relevant legislation includes the following, further details of which can be found in Table 9:

- National Agriculture Policy (NAP) (2016)
- National Environmental Policy (2004)
- National Seed Policy (Revised) Plant Protection Act 1969 (No. 11 of 1969). Plant Protection (Fumigation) Regulations (Cap. 64:01) 2012 (1973)
- Biosafety Act (Cap. 60:03) 2012 (2002)
- Biosafety (Management of Genetically Modified Organisms) Regulations (Cap. 60:03). Malawi, 2012 (2007)
- Control of Goods Act, 1968 (Cap. 18:08)
- Control of Goods (Registration) Regulations (Cap. 18:08). 2012 (1968)
- Water Resource Act (2013)
- Occupational Safety, Health and Welfare Act, 1997 (No. 21 of 1997)
- C025 – Sickness Insurance (Agriculture) Convention, 1927 (No. 25)

Policies to promote reductions in unnecessary pesticide use such as policies on IPM, good agricultural practice (GAP), organic production and sustainable agriculture

Malawi's NAP 2016, under Policy Priority Area 6: Agricultural Risk Management, 3.6.4 states that the policy will "Promote integrated management and control of pests and diseases". Two outputs under this policy statement are: 1) "Test and explore biotechnology options for disease and pest control"; and 2) "Invest in and maintain infrastructure and equipment for pest and disease management, including dip tanks and mist blowers". In addition, the Malawi National Environmental Policy 2004, Section 5.1 on Agriculture and Livestock, outlines the objective: *"*To promote environmentally sustainable agricultural development by ensuring sustainable crop and livestock production through ecologically appropriate production and management systems, and appropriate legal and institutional framework for sustainable environmental management". It further adds a commitment to "Ensure that trade policies on agricultural commodities and inputs encourage environmentally sustainable production systems".

Activities included under the World Bank support to the GoM in the implementation of the Agricultural Commercialization (AGCOM) Project trigger the World Bank safeguard policy on Pest Management (OP.4.09) and a standalone Pest Management Plan (PMP) (GoM 2017a) has thus been prepared to meet the requirements. The objectives of the PMP include: "Promote the use of environmentally friendly practices in pest control; Monitor pesticide use during implementation of AGCOM activities; Ensure that project activities comply with Malawi's laws and regulations on use of pesticides, and World Bank safeguard policy OP 4.09 and; Provide an integrated pest management action plan which can be easily implemented in the event that pest management issues are encountered".

Research

There is no specific policy is in place to encourage and promote research on alternatives to existing pesticides that pose fewer risks, such as non-chemical preventive and direct control measures. Promotion of alternatives, although not linked directly to research, is covered in the

National Agricultural Policy 2010 (Section 3.2.2.4). Actions to implement this policy include. To "promote stability of agricultural production by developing varieties of crops which are tolerant to drought and resistant to pests, and "Improve cultural practices and integrated pest management systems for all crops, pastures and livestock to increase and sustain yields".

Regulations related to the manufacture of pesticides

The Malawi National Agricultural Policy, 2010, states that Malawi has no pesticide production or formulation facility. As such, pesticides are imported into the country from neighbouring countries mainly through direct bulk importation of ready-to-use formulations. Importing companies repack products to suit individual needs. Besides the formal sector, there exist significant informal and unrecorded markets where products that have been illegally imported are sold in the country.

The Pesticides Act (2000) addresses the manufacture of pesticides and makes general provision for siting of the production plant (but no specific instructions) and environmental protection, but does not prescribe any ISO standards to the manufacture of pesticides. Section 24: Licence to manufacture pesticide, states that: (1) “An application for a licence to manufacture a pesticide shall be made in the prescribed manner to the Board which, on payment of the prescribed fee, may issue a licence if the Board is satisfied that—

(a) the applicant is technically competent to manufacture the pesticide; (b) the applicant is aware of the toxicity of the pesticide and of the risks involved in using and handling it, and is equipped and able to effectively avoid or minimize the risks; and (c) the premises and manner in which, and conditions under which, the pesticide will be manufactured are appropriate for the purpose and will not endanger human or animal health or the environment and are in accordance with such conditions as may be prescribed”.

Section 17 of the Pesticides Act stipulates that “No person shall import, manufacture or sell a pesticide, which has not been registered under this Act”. It further stipulates that unregistered pesticides may be imported under an import permit issued under Section 20 for the purpose of analysis, registration or research, or under a pest emergency permit issued under Section 52 and manufactured for export in accordance with a licence to manufacture issued under Section 24. This means that only those pesticides that are registered under the Act can be imported or sold without a permit.

Price and trade policy, including subsidies

The Farm Input Subsidy Programme (FISP) is administered through vouchers or coupons that enable eligible households to purchase fertilizer, hybrid seed and pesticides at reduced prices

Registration (synthetic pesticides and biopesticides)

The Pesticides Act does not specifically refer to biopesticides and defines a pesticide as follows: “pesticide means any substance or mixture of substances intended to be administered on animals, plants or humans for preventing, destroying or controlling any pest”. Such a definition means that the provisions of this Act could therefore in a general sense be applied to biopesticides.

The Pesticides Act 2002 identifies the Pest Control Board as the body responsible for registration and sets out the powers and functions of the registration body.

The information required to be included in the application for pesticide registration is covered in the Pesticides Regulations under the Pesticide Act (Section 53). The list includes: name of the formulation, composition, toxicological data, results of efficacy trials, environmental effects (toxicity to fish, bees, etc.), information on intended uses and method of application (crop, target pests, dose) and residue trials (as residue data). The application interval and maximum number of applications are not mentioned specifically; rather, these are covered generally under proposed use (crop, pest, rate and mode of application and recommended pre-harvest interval set so that residue remaining on crop at harvest is within acceptable limits). Information on the recommended post-harvest and re-entry intervals is requested in the application. The disposal of containers/surplus pesticides is not mentioned in the application process. The information to appear on the label is also requested.

The registration application requests that the applicant indicate whether the pesticide meets the FAO specification and WHO specification, but does not request further details on which specification.

Information on how the Pest Control Board will make its final registration decision is provided in Section 19 of the Pesticide Act. This decision will be based on whether the pesticide is: “a) suitable and effective for the purposes for which it is intended; (b) does not pose a significant danger to human or animal health or the environment; (c) is desirable in that overall the effects of the pesticide are likely to be more beneficial than detrimental to Malawi, its people and the environment; and (d) will be properly packaged and labelled in accordance with this Act.”

The Pesticides Act does not specify the time period in which the registration decision should be communicated to the applicant, except that the communication should be made ‘*promptly* in writing’.

Section 17 (Registration process) of the Pesticide Act states that unregistered pesticides may be imported under an import permit issued under Section 20, for the purpose of analysis, registration or research, or under a pest emergency permit issued under Section 52 of the Act.

The legislation does not provide for distinct registration pathways for biopesticides/biological control agents and chemical pesticides. However, AI are defined as biologically and chemically active parts of a pesticide (Section 2).

The validity period for registration is covered in Section 21: “The registration of a pesticide shall be valid for a period of five years, and renew of the registration for further period of five years if the Board continues to be satisfied”.

Section 19 sets out the procedure in the event of a denial of registration: “If the Board decides not to register a pesticide, it shall promptly notify the applicant in writing giving reason for its decision”. The appeal procedure is outlined under Section 50: “An applicant for, or holder of, a pesticide registration or a licence or permit under this Act may appeal to the Minister”. Section 50 also stipulates that “Every appeal under subsection (1) shall be made in writing within sixty days from the date the applicant or holder receives the reasons for the decision of the Board”.

There is no specific requirement for a registration review period. However, Section 22 states that “The Board may suspend or cancel the registration of a pesticide”. This can be in response to new conditions or in view of new information, e.g. the conditions for application have not be complied with, continued registration is undesirable on the ground that the pesticide is harmful to human and animal health or the environment, or the pesticide is not effective for the intended use or has been withdrawn from the market.

The mandatory re-registration period in Malawi is five years (Section 21).

The responsibility for keeping records is assigned under Section 40, but the contents of records are only generally defined, e.g. “record of the quantities of pesticides manufactured… and any other information prescribed”.

Protection of trade secrets relating to the product being registered or the applicant is covered in the Pesticides Act, Sections 18-3, 40-4, 53: “The Board and the Registrar shall keep confidential all information (trade secrets)”.

Section 19 describes that a register compiling all registered products is made publicly available by the responsible authority: “The Board shall cause to be published in the Gazette periodically a list of all pesticides registered under this section”. Information to be included in the list of registered pesticides includes the trade names of products and their registration numbers. Section 19 (6) states: “If the Board decides to register a pesticide it shall—(a) assign a registration number to the

pesticide; (b) enter the purchase in the register of pesticides; and (c) issue a certificate of registration to the applicant.

Packaging and labelling

Section 28 of the Pesticides Act states that: “No person shall manufacture, import, export, sell, distribute or store any pesticide which is packed in a container which does not meet any standards which may be prescribed under this Act”. However, the Act has extremely limited regulations regarding pesticide packaging and containers. For example, no regulations can be found that specify the following: the products to which the packaging and labelling requirements apply, the technical requirements for packaging (that packaging is safe e.g. re-sealable and impermeable to its contents).

The Pesticides Act incorporates requirements for labelling into the registration process but pesticide packaging is not specifically included within the registration process.

Under Section 44 it is made an offence to manufacture, import, export, sells, distribute or store any pesticide packed in containers that have deteriorated or have been damaged rendering them dangerous to store, handle or use safely.

Section 28:2 does not specifically state that the repackaging or decanting of pesticide into food or drink or other inappropriate containers is prohibited, but states that: “No person shall manufacture, import, export, sell, distribute or store any pesticide which is packed in a container which is unsafe for storage, handling or use in that it is inadequate to prevent harm to human and animal health or to the environment”.

Reuse of pesticide containers is prohibited under Section 28: “‘No person shall, contrary to any directions given by the Registrar, or an inspector, use a pesticide container for any purpose other than to contain pesticides”. The Act does not mention exceptional circumstances when this might be allowed e.g. where there is a programme in place to refill containers.

Labelling requirements are covered in the Pesticides Regulations Section 7. This states that “Every pesticide container shall bear a label containing the following: product content, product name, use type, type of formulation, active ingredient name and naming system applied (e.g. ISO or IUPAC), concentration of the active ingredients, co-formulants (*described as other liquids)*, net contents, name of supplier / manufacturer, batch number and registration number”.

For hazard and safety information, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is not mentioned as being implemented in Malawi, but appears to be partially followed under the PCB Third Schedule Regulations 8 and 9, where hazard symbols and pictograms are specifically mentioned.

Requirements for pesticide registration in Malawi are covered in the Pesticides Regulations include that the label must contain: “Safety pictograms in accordance with guidelines approved by the Board”, as well as the following precautionary statements and designs: hazard colour bands, first aid and advice to medical professionals. There is no requirement that the label describes the necessary PPE to be worn when handling the pesticide. Instead, the label is required to contain a “safety precaution to inform the user on handling of the product with minimum hazard”. The requirements for label hazard statements are very general, e.g. use of terms such as “slightly hazardous”, but not specific terms such as “acute”, “chronic”, or “environmental”). There is no requirement for the label to contain information on how to address pesticide spills.

Regulations under Section 53 of the Pesticides Act describe the need for labels to include “directions for use which shall clearly indicate how, when and where the product can be legally, effectively and safely used and shall, where applicable, include — (i) warnings to prevent incorrect or inappropriate use; (ii) stage of the crop and a description of the crop on which and the conditions under which it is recommended that the pesticide be used; (iii) application rates, timing and method of application”. Specifically, labelling requirements for registration include pesticide mixing

instructions, maximum number of applications the interval between applications and incompatibility issues.

Section 29 (Labels) states that: “The text of the label and of any publication relating to a pesticide which is intended to be distributed or displayed with the pesticide shall be in English and in any other language or languages spoken in Malawi which the Board may require, and shall comply with such other requirements as may be prescribed”. Section 29 also prescribes that the container, “Prominently displays a clearly legible label which has been approved by the Board and is firmly attached to the container”.

Marketing

The Pesticides Act (Section 30) defines pesticides broadly as ‘any pesticide’. Specifically the Act states that “No person shall advertise any pesticide which has not been registered under this Act” and prohibits “advertising for unregistered pesticides, false or misleading advertisements and advertising that is contrary to the label”.

The authority responsible for enforcement of marketing is not specifically named but is implied to be the PCB.

Transport

Although not specifically relating to pesticides, the Environmental Management Act 2017 includes provision for transportation of hazardous waste: “No person shall transport within Malawi hazardous waste or substances, except under a permit issued by the Minister subject to such conditions as the Minister may impose.”

Import and export

The Pesticides Act (Section 20) states that a permit to import a limited quantity of an unregistered pesticide may be granted solely for the purposes of analysis, registration or research. One exception is in a pest emergency. In such a case, the Pesticides Act 52 (4) states that “a pest emergency permit—may authorize the importation and use of an unregistered pesticide; but only to the extent that, it is not possible to obtain the pesticide in adequate quantities or sufficiently, quickly from the party who has registered the pesticide in Malawi”.

The Pesticides Act covers the control and management of the import, export, manufacture, distribution, storage, disposal and use of pesticides, and import and export are under many of the same regulations. Section 20 states that, “no person shall import, manufacture or sell a pesticide which has not been registered under this Act”. The prescribed requirements for an import/export permit are the same as the registration requirements for pesticides manufactured and registered in Malawi regarding counterfeit, substandard or outdated pesticides, or of pesticides otherwise not meeting the prescribed requirements.

The application procedure for a pesticide import permit follows the same requirements as for manufacture and registration in Malawi and is covered in Section 53 of the Pesticides Act. The importation permit is in the Fifth Schedule Regulation 12.

Procedures and criteria for decisions on import permits appear under the fifth schedule reg. 12 of the Pesticides Act.

The exception provided in the Pesticides Act 52 – subsection 4 allows exceptions for of imports by public entities for specific purposes – one such case is for a pest emergency permit to import pesticides unregistered in Malawi.

The application to manufacture pesticides and exportation of pesticides are both covered under the Pesticides Act Sixth Schedule Regulation 16 (2). Therefore, it can be assumed that the same quality standards apply for both domestic and exported pesticides.

Requirements for sale

The Pesticides Act (Section 25) provides a general statement (25 1c) relating to the application for a licence to sell pesticides: “the premises and manner in which, and the conditions under which, the pesticide will be stored or offered for sale are appropriate for the intended purpose, and will not endanger human or animal health or the environment, and are in accordance with such conditions as may be prescribed”.

There is no specific statement that pesticides can only be sold in their undamaged original container. Instead, the Pesticides Act (sections 28 and 44 2c) states generally that no person shall manufacture, import, export, sell, distribute or store any pesticide which is packed in a container that is “unsafe for storage, handling or use in that it is inadequate to prevent harm to human and animal health or to the environment”. Under Section 29 on labelling there is provision that pesticides sold must display approved labels.

Licensing

The Pesticides Act Part V states generally that there is a prohibition on the manufacture, sale, etc. of pesticides without a licence. Specifically, Section 24 prescribes the need to hold a valid licence for manufacture, but does not mention the need to hold a licence to carry out pesticide packaging specifically. Similarly, the Act prescribes holding a valid licence for sale of pesticides and import and export but not specifically for transportation. Section 26 prescribes that commercial applicators are the only group requiring a valid licence for special pesticide applications.
The validity of the pesticide licence is set for five years and can be renewed (Section 24. 2b), although the renewal procedures are not described within the Act. Section 24.1 describes that the authority can impose fees for services associated with licensing, and Section 27 explains that when the board suspend, cancel or refuse a licence, the licensee shall be given an opportunity to make representations to the board .

Availability

No legislation found contains any provision to regulate the availability and use of pesticides in accordance with the hazards involved and the existing levels of user training.

Handling and use, including regulations on application equipment

Section 34 of the Pesticides Act, which is in line with the Occupational Safety, Health and Welfare Act, places the responsibility for the safety, health and welfare of employees on the employer, including in regard to providing facilities, equipment and clothing conducive to the safe handling of pesticides. Section 34 sets out the duty of employers in the following terms: “No person shall use or require an employee to use a pesticide in a manner or for a purpose contrary to the manner or purpose permitted by the Board on the registration of the pesticide or as may be prescribed”. The responsibilities of pesticide operators (farmers and farmworkers) when handling pesticides are described only very generally in the national regulations, e.g. that they should follow safety procedures. Within the Pesticides Act (34), the responsibility for safety is more on the level of the employer. For example, “Every employer who requires or permits an employee to use a pesticide shall provide and require the employee to use facilities, equipment and clothing conducive to the safe handling of the pesticide”.. There is however, no specific mention in the Act of the specific hygiene procedures that employees should follow when handling pesticides or for the need to report risks. Within this section of the Act, PPE is also only described generally as “clothing for safe handling of pesticides”. The Registrar may also require the employer to monitor health of employees exposed to pesticides.

There is no specific requirement related to provision of training in the Pesticides Act, but this is covered in the Occupational Health and Safety Act (Section 65) in relation to hazardous substances in the workplace: “Every worker in a workplace shall be adequately and suitably— (a) informed of potential health hazards to which he may be exposed to at the workplace; (b) instructed and trained in the measures available for prevention and control and protection against health hazards at the workplace.”

Safety when handling pesticides is also covered indirectly (handling an injurious or offensive substance) under the Occupation Health and Safety Act Section 58. This states that: “Where in any workplace workers are employed in any process involving excessive exposure… to any injurious or offensive substance…., suitable protective clothing and appliances, including, where necessary suitable gloves, footwear, screens, goggles, ear muffs and head covering, shall be provided and maintained at no cost to the employee for the use of such workers”

The Pesticides Act contains general provision to prohibit the use of pesticides in an unsafe manner that poses a threat to human health or the environment. This is covered in several sections, e.g. Section 25, Section 37 and Section 44.

Requirements for training

The Pesticides Act, Section 26 (Licensing of commercial applicators) prescribes that pest control operators (commercial applicators) must hold a licence or permit: “No person shall apply pesticides for gain except in accordance with a commercial applicator’s licence issued by the Board”. However, there is no specification of products or application methods. Section 53 prescribes the training requirements for applicators: “(i) prescribe the qualifications required by persons involved in the commercial applications”. However, these describe what the regulation may cover rather than what is actually enforced. There are no mandatory trainings prescribed, although the requirement for training is included in the Occupation Health and Safety Act Section 65, which states that “Specialized instruction and training shall be given to […] (g) workers handling hazardous substances”.

Restrictions related to vulnerable groups

There is no legislation containing provisions to prevent the use of pesticides by and sale of pesticides to children or pregnant and nursing women or any other vulnerable groups.

Requirements for PPE

The Pesticides Act, Section 34 promotes the general use of personal protective equipment: “Every employer who requires or permits an employee to use a pesticide shall provide and require the employee to use facilities, equipment and clothing conducive to the safe handling of the pesticide”. The Occupational Health and Safety Act, Section 58 also prescribes the use of protective clothing and appliances when handling hazardous substances (not specifically mentioning pesticides) and lists gloves, goggles and footwear.

There is no explicit requirement under the Pesticides Act that a pesticide label should list the type of PPE required. However, the Occupational Health and Safety Act (Section 51: Hazardous substances) states that, “Containers of hazardous substances shall carry, or be accompanied by instructions for the safe handling of the contents and procedures to be followed in case of spillage”.

Storage

The prohibition on the reuse of a pesticide container for any non-pesticide storage reason unless authorized is covered in Section 28 of the Pesticides Act: “No person shall, contrary to any directions given by the Registrar, or an inspector, use a pesticide container for any purpose other than to contain pesticides”. Indeed, Section 28 also states generally that, “No person shall manufacture, import, export, sell, distribute or store any pesticide which is packed in a container which—is unsafe for storage, handling or use in that it is inadequate to prevent harm to human and animal health or to the environment”.

Disposal of unused pesticides

Monitoring and recording stocks of obsolete pesticides is the responsibility of the Pesticides Control Board Registrar. The Registrar is also mandated to make frequent checks of all premises where pesticides are stored to ensure safety measures are being complied with and stocks maintained in a proper manner, including the appropriate disposal of obsolete pesticides.

General disposal of unused pesticide is covered under Section 37 of the Pesticides Act, which states that: “No person shall dispose of any pesticide or pesticide container or packaging in a manner that is unduly hazardous to human or animal health or the environment or is contrary to any written law.”

The Environmental Management Act 2017, under Section 57 (License to Waste), requires that any person or entity seeking to dispose of pesticides or pesticide waste seek authorization from the competent authority. In addition, any person who is in the business of handling, storing, transporting, classifying, destroying or disposing of waste, including pesticide waste, shall apply for a licence under the Environmental Management Act.

Disposal of empty pesticide containers

The Pesticides Act includes a general statement under Section 37 (Disposal of pesticides and pesticide containers) to the effect that, “No person shall dispose of any pesticide or pesticide container or of packaging in a manner that is unduly hazardous to human or animal health or the environment or is contrary to any written law”. The Environmental Management Act 2017 (60) states that “A person shall not discharge any hazardous substance, oil or other mixture containing oil in any waters or any other segment of the environment except in accordance with the guidelines prescribed by the Authority in consultation with a relevant lead agency”. Moreover, a ban on the reuse of pesticide containers is covered by the Pesticides Act’s Section 28 (2): “No person shall, contrary to any directions given by the Registrar, or an inspector, use a pesticide container for any purpose other than to contain pesticides.”

Residue monitoring in food and maximum residue levels

Regulation of pesticides in food is covered under Section 31 of the Pesticides Act (Control of pesticide residues in food): “(1) No person shall manufacture, export, sell or distribute any food or feed for human or animal consumption if a pesticide has been applied to it, or to the crops from which it was made, in contravention of this Act”. It is noteworthy that this covers exports as well as domestic production. The Pesticides Act contains provision for the establishment of standards relating to the maximum residue limits of pesticides in food, food products, feedstuffs and food by-products. However, the Act does not follow the MRLs set by the *Codex Alimentarius*.

The duty of care is with the provider of food or animal feed but there is no mention of which authority is responsible for monitoring. However, enforcement is mentioned in Section 33 (Imposition and sampling), which states that, “An inspector shall have power— (a) to enter and inspect premises where food or animal feeds are stored or sold”.

Other relevant human health and environmental protection regulations

Malawi’s National Environmental Policy 2004 describes the policy’s goal as being the “promotion of sustainable social and economic development through the sound management of the environment and natural resources”. The policy covers a range of sectors, including, for example, agriculture and livestock, forestry, water, tourism, settlement and human health, conservation and biological diversity, as well as overarching themes, such as gender and youth. Specifically on human health relating to the environment, the policy aims to strengthen the health inspectorate in relation to urban and rural areas, in order to assess the risks and consequences of environmentally related health problems. The policy does not explicitly mention pesticides.

Poisons centres have been identified as a required capacity for implementation of the International Health Regulations (WHO 2005). However, Malawi currently has no national poisons centre (the nearest one is in Harare). In addition, Malawi is part of the Quick Start Programme of the Strategic Approach to International Chemicals Management (SAICM) (WHO 2015)

Compliance and enforcement

Section 53 of the Pesticides Act states that regulations may be formulated that “prescribe the requirements for pesticide containers and packaging”. Compliance in relation to other areas of pesticide trade and use, such as transportation, distribution or sale, are not noted in the legislation.

The powers of inspectors are detailed in Section 39, as follows: “An inspector may—(a) enter on any land, premises, aircraft, vessel or vehicle, at or in which any pesticide is or may be reasonably suspected to be manufactured, stored, transported, sold, distributed or used to determine whether the provisions of this Act are being complied with; (b) require the production of, inspect, examine and copy licences, registers, records and other documents relating to this act and; d) take samples of any articles and substances to which this Act relates and, as may be prescribed, submit such samples for tests and analysis; (f) enter and inspect farmers’ fields to ensure that only the recommended pesticides are used on specific crops and according to the prescribed procedures.”

Compliance and enforcement of pesticide legislation is partially covered under the Pesticides Act – in particular, Section 41, which describes procedures for intervention if irregularities are found during inspection. For example: “The inspectors shall give a receipt to the person from whose custody anything has been seized…”. Section 44 of the Act (Offences) also stipulates the value of fines for non-compliance. For example, it stipulates a fine of K100,000 for any person who imports, manufactures, stores for sale, sells or advertises an unregistered pesticide in a way that contravenes the Act. Section 44 also defines those actions that are considered to be offences. For example, the sale of any food or feedstuff for human or animal consumption which the seller knows contains pesticide residue levels in excess of any limits prescribed by law. The legislation does not include special offences relating to public officials.

Farm characteristics and production practices in focal crops

Data was gathered from farmers via questionnaires and FGDs. Ten farmers growing groundnut and nine farmers growing soybean were interviewed. As these crops are commonly grown at the same time in the same farm, or in rotation, some practices described by farmers were common for both crops. Analysis of data is shown in Annex II.

Summary information about farmers in study area

The average age of the farmers interviewed was 43 years, with a range from 74 to 23 years. Of the 19 farmers interviewed, 10 had completed primary level education, eight high school level and one had not attended school (Annex II, Figure 6).

Cropping systems

The majority of farmers grow both soybean and groundnut either on separate plots of land at the same time or in rotation with each other and other crops in succession on the same plot of land. Common rotations include soybean rotated with maize, groundnut and potato and groundnuts rotated with soybean, maize, millet, beans, onions and sweet potato. The production areas for soybean and groundnut varied among the 19 farmers interviewed, from a smallest area of 0.001 ha to a largest of 1.2 ha. Although farmers were asked to estimate the land area for the specific crop, where crops are grown in mixed-cropping systems or on multiple small plots of land, this estimation would have been difficult for them to make accurately.

Interviews with extension agents provided the following estimation of the percent of farmers by gender growing soybean, groundnut and cassava.

Crop covered by study	% female farmers	% male farmers
Cassava	28	72
Groundnut	64	36
Soybean	55	45

Groundnut varieties grown include GC7 and Wofira plus local varieties. For soybean, Tikolore and Nasoko are grown along with local varieties

Pest and disease problems in the focal crops

Soybean pests and diseases – Field

The main pests for field soybean as listed by farmers at the time of the study in September are shown in Annex II Figure 7. Field pests included ants and semi-loopers described by three farmers, followed by aphids and unspecified larva. Other pests such as armyworm, cutworm, grasshoppers and termites and symptoms such as yellow leaves were described each by one farmer.

Soybean pests and diseases – Post-harvest

Rodents and weevils were the most common soybean storage pests listed by farmers (Annex II Figure 8), with each reported by three out of eight farmers. This is followed by bruchid beetles, ants, aflatoxin[1] (caused by Aspergillus fungus) and unidentified larva.

Groundnut pests and diseases – Field

The main field pests and diseases of groundnut listed by farmers (Annex II Figure 9) were termites (listed by five farmers), followed by aflatoxin (caused by Aspergillus fungus) and groundnut rosette, which were each listed by three farmers. Other pests included grasshoppers, ants, aphids, grazing livestock, birds and rodents and leaf spot. FAW was also listed by one farmer (FAW was not verified by observation). FGDs with farmers noted that there has been an increase in the types and numbers of pests on groundnut over the last few years.

Groundnut – Post-harvest

The groundnut post-harvest pests and diseases listed by farmers (Annex II Figure 10) included rodents (listed by seven farmers) and termites (three), followed by ants, weevils, bruchid beetles and insect larva (worms), each listed by individual farmers.

Crop protection methods

Soybean – Field management

Ants and semi-loopers were listed as the main field pests for soybean by farmers, and farmers applied more approaches (nine, three of which were cypermethrin) to control semi-loopers than they did for ants (only two methods) (Annex II Table 10). Overall, application of cypermethrin was one of the most common pest management options applied by farmers for soybean pests and diseases at field stage (see Annex II Figure 11 and Figure 12, showing the most frequent responses). Cypermethrin was applied against semi-loopers, armyworm, cutworm, grasshoppers and termites. Other chemical options include chlorpyrifos for controlling termites, tobacco leaf for controlling ants and Tephrosia extract against semi-loopers, army worm, cutworm and root knot nematode. Non-chemical options described by individual farmers included use of ash, handpicking and uprooting. Control options were not listed (meaning farmers did not have an option or did not provide an answer) for viral disease, white larva and thrips.

Soybean – post-harvest

Control options listed by farmers (Annex II Table 11) include chemicals such Temik (Aldicarb) and Indocide (a medicinal anticoagulant with the active ingredient indomethacin) for controlling rodents as well as using cats. Options provided by farmers for controlling insect pests include Dithane, Actellic and botanicals such as tobacco and Tephrosia extract.

Groundnut – Field management

Control options for groundnut field pests and diseases described by farmers (Annex II Table 12) included cypermethrin, used by four farmers each to control cutworm, termites, grasshoppers and

[1] Aflatoxin was the term used by the farmer to describe the 'pest'. However, correctly, aflatoxin is a natural and toxic compound produced by the fungus *Aspergillus*.

spider mites respectively. In FGDs farmers also stated that they use cypermethrin to control all types of pests. Botanical products including Tephrosia extract were used by one farmer to control cutworms and glyricidia was used by one farmer against an unidentified larva. Non-chemical control methods were more commonly used in groundnut than soybean, with six out of 11 farmers listing handpicking (to remove termites, rosette disease, aphids and chafers) and five listing uprooting and burning infected plants as control options for rosette, leafspot, larva and a black spot disease. FGDs with farmers also showed that farmers uproot plants infected with rosette but do not consider this to be effective at controlling the spread of the disease. They also practice crop rotation as a control option.

Groundnut – post-harvest

The major post-harvest pest of groundnut, rodents, was controlled mainly be chemical means (Annex II

Table 13). Temic (Aldicarb) was listed by four farmers to control rodents and cats listed as a control option by two. Two farmers used Cypermethrin; one used it for weevils and the other to control termites. Non-chemical options for insects include ash and sun drying. The same techniques were noted from farmers FGDs, along with use of tobacco to control storage pests. Aspergillus fungus (the source of aflatoxin) was mentioned as a disease affecting stored groundnut by farmers in the FGD and by one in response to the questionnaire. The GoM has issued guidelines on aflatoxin control and advises use of the Mandela cork method to dry groundnut. Extension agents also recommend the use of variety CG7, but due to seed recycling the farmers interviewed in the FGD are finding that the resistance of this variety has weakened.

Bottlenecks and difficulties in plant protection

Restricted pesticides

Two pest control products used by farmers that appear on the GIZ pesticide procurement list as class A chemicals are Phoskil (active ingredient Monocrotophos) – used to control semilooper by two farmers in soybean – and Temik (active ingredient Aldicarb), which is used to control rats in stored groundnut.

Understanding pesticides

In response to questions on their understanding of pesticide terminology, between 50 and 60% of farmers growing groundnut and/or soybean (N=19) said they had never heard of nine out of the 10 terms presented. Seventy-four percent had never heard of the term ‘resistance’ and 69% of farmers had never heard of the term ‘active ingredient’. Over 60% had also never heard of (i.e. were unfamiliar with) pesticide label colour codes and pre-harvest intervals (Annex II Figure 13).

Some farmers have noted that pests are becoming resistant to cypermethrin.

Pesticide sources and availability of pesticides, particularly low toxicity products and alternatives to synthetic pesticides

Farmers’ responses to questionnaires indicated that their main source of pesticides was agro-input dealers (74% of farmers), followed by extension agents and street-sellers for 17% of farmers each (Figure 14). Farmers were able to find information on which pesticides were available from a variety of sources (Figure 15), including extension agents (74% of farmers) and directly from agro-input dealers (32%). Farmers also received information from the radio, friends and, less frequently (for 5% of farmers), from village leaders, family members, mobile vans and lead farmers. In FGDs, farmers commented that retailers did not provide them with any pesticide information, only information on the price.

Responses from farmers relating to the availability and affordability of various agricultural inputs (Figure 16) indicate that, on average, for all inputs mentioned, 47% considered inputs to be available and 33% considered them to be affordable. The highest positive response was that 61% of farmers considered pesticides (botanical and synthetic chemical) to be available, but only 44% thought they were affordable. Disease-free seed was considered available by 56% of farmers and affordable by 44%. For most inputs (biological control agents, disease-free seeds and seedlings) these figures are lower. For example, just 11% of farmers consider inoculum affordable. Responses show that affordability was also considered more restrictive than availability for all inputs, except PPE. However, during FGDs, farmers indicated that availability is the main challenge.

Farmers did not use commercial sources for alternatives to synthetic pesticides. The data gathered from interviews shows that farmers made homemade botanicals from Tephrosia and tobacco.

State of the implementation of international agreements relating to pesticides (FAO’s International Code of Conduct on Pesticide Management)

A review of the Malawian legislation against the FAO/WHO Code of Conduct for Pesticide Management indicated that significant gaps exist in all areas. Where relevant legislation did exist, enforcement in practice appears weak.

Extension agents' awareness of selected national legislation relating to pesticide management is shown in
Figure 17. Their perceptions of whether the legislation is being implemented is also shown for comparison. Awareness of selected national policies ranged from 32 to 53% of extension agents, while percentage of extension agents who consider that these policies are being implemented is lower, ranging from 11 to 32%. In some cases, extension agents said they were aware of policies that do not yet exist in Malawi, e.g. a policy to establish services to collect used containers.

As shown in the data, extension agents act as sources of information and training for farmers. The lack of extension agent knowledge on legislation will therefore restrict their ability to support awareness and implementation of legislation with these stakeholders on the ground.

Pesticide handling and use, particularly relative to the implementation of national laws and regulations

Poor quality pesticides, counterfeit pesticides and unregistered pesticides are acknowledged to be a challenge for Malawi (as confirmed in correspondence with the Department of Environmental Affairs). However, no data is available on the scale of the problem. The Department works though the Immigration Department to try to control counterfeit products entering Malawi (e.g. by providing training for immigration officers), but enforcement is considered weak. One reason for this is the low capacity within customs and immigration.

In regard to repackaging and labelling, visits to two pesticide retailers by the study team noted that the majority of pesticides were sold in original containers with visible and legible labels. However, repackaging into smaller containers was also taking place in order to suit farmers' requirements for smaller, more affordable units. Where repackaging took place, containers' labels were frequently missing, were peeling off or had been reprinted and reduced in size to the extent that they were illegible. Out of date pesticides were also seen for sale. Neither of the two premises visited stocked PPE. The reason given was that there was no demand for PPE from customers.

Officially, retailers in Malawi are inspected by the PCB and one retailer visited stated that is inspection was monthly.

Retailer knowledge of the pests of groundnut and soybean appeared limited.

Health and safety

The majority of farmers (14 out of the 18 who answered this question) were responsible for spraying pesticides on their own fields. In two cases, the interviewed farmer's family member sprayed pesticide and in a further two hired labour was used.

Only 10 farmers out of 19 had received training on pesticide application; this was from extension agents in nine cases and one via the radio. One pesticide retailer interviewed also said he advises farmers on the correct application of the pesticides he sells.

Farmers were asked whether they had experienced any effects on their health after applying pesticides. Out of the 16 farmers that responded to this question, 69% listed some effect on their health, the most common being irritation to eyes and irritated skin (Figure 18). Information from farmer FGDs also showed that almost all farmers in the group had suffered one of the following: headaches, vomiting, tiredness and impaired vision. Farmers believed that these symptoms would stop on their own so they did not seek advice. Handwashing was the only safety precaution mentioned by farmers in FGDs.

Use of PPE

Of the 19 farmers interviewed, 47% said they wore rubber gloves to both mix and to apply pesticides, and 35% wore a protective mask or face cover (Figure 19). Other types of protective equipment, such as long-sleeved shirts and trousers, were worn by less than 30% of farmers

interviewed. The definition of a mask given by farmers included a scarf or piece of cloth used to cover the mouth and nose. Some farmers described using masks and gloves they had sourced from the local medical clinic.

Challenges to using PPE

The most common responses from farmers on the reasons they do not use PPE are that it is not available (41% of farmers), which is confirmed by responses in FGDs, or that it is too expensive (29% of farmers) (Figure 20). Of course, the converse of these responses is that the majority of farmers do not consider that price and availability are the main factors preventing them from using PPE (the responses suggest that 71% of farmers do not consider price a restricting factor).

The main source of PPE for farmers (Figure 21) is agrodealers (41% of farmers interviewed), followed by hospital/clinics for face masks. Less than 15% of farmers source PPE from extension agents or markets. During interviews with extension agents they confirmed that they very rarely provide farmers directly with PPE. Twelve percent of farmers make their own PPE or improvise, including using plastic bags as gloves and cloth for masks. Information gathered from retailers during KIIs showed that they do not stock PPE as there was no demand from farmers for such equipment.

Understanding label warning symbols

The proportion of farmers interviewed (N = 19) who read pesticide container labels and can correctly identify warning symbols is shown in Figure 22. The findings show that 58% of farmers questioned said they read the pesticide label. This figure is for reading the label only and does not represent farmers' capacity to understand the information on the label. Standard warning symbols for 'use water proof boots' and 'use face protection' were correctly identified by 47% of farmers. 'Use coverall', 'very toxic' and 'environmental toxicity' were identified by 21% of farmers (two individuals) and 'use waterproof gloves' by 11%. No farmers were able to correctly identify label symbols for 'use apron', 'harmful/irritant' or 'corrosive'. The pesticide retailer interviewed said they routinely provide verbal information on safe pesticide application to farmers with low literacy levels and who are unable to read the labels.

Safe container storage and disposal

Farmers' responses to questions relating to storage of pesticides showed that 44% of farmers store pesticides in the house (Figure 23). A location that was inaccessible to children was listed in 38% of responses and a locked location in 31%. Thirteen percent of farmers said they kept the pesticides in the original container. Other locations mentioned by individual farmers are putting the pesticide container inside a box or a plastic bag.

Figure 24 shows that the most frequently practised option for disposing of used pesticide containers was burning followed by burying (practised by 41% of farmers, i.e. seven farmers out of the 17 responding). Used containers were also thrown into pit latrines by 29% of farmers. Rinsing of containers was practised by 12% (two farmers out of 17). No farmers said they reused the container for other purposes and none used a container collection system. Farmers in FGDs stated that they understood that pesticides could contaminate water resources and poison humans and most made an attempt to bury empty containers or dispose of them in pit latrines.

Knowledge of pests, IPM and rational pesticide use

Figure 25 shows questionnaire responses from farmers (i.e. the 19 farmers growing soybean or groundnut) concerning their knowledge and awareness of various IPM techniques. The majority (more than 50%) of farmers were aware of and were implementing the following: cover crops, crop rotation, field sanitation host removal, appropriate planting times, field monitoring using clean/certified planting material and destruction of infected plants. Less than 50% of farmers were aware of or implemented other IPM techniques such as the heat treatment of planting material, use of attractants and repellents, pheromones for monitoring and mass trapping. In FGDs, farmers described IPM as being a mixing of tactics for controlling pests.

Farmers in FGDs noted that IPM was cost effective and also more effective at controlling pests than chemical means only. The most cost effective options were considered to be early planting, timely harvesting, crop rotation and monitoring.

In response to questions on frequency of scouting for pests, 63% of farmers said they do this on a weekly basis, 21% on a daily basis and 5% on a monthly basis for field pests. Eleven percent said they never scout (Figure 26). For storage pests, all farmers said they scouted for pests: 39% on a weekly basis, 33% on a daily and 28% on a monthly basis (Figure 27).

All farmers were able to describe the basis on which they made the decision to apply pesticides or not. Several farmers mentioned that the decision was made after scouting their field to assess presence of pests or crop damage.

In deciding the most appropriate time to spray pesticides, 53% of farmers (N=19) took the weather into consideration. All 53% considered rain in their decision making, 32% considered sun and 26% wind (Figure 28).

The majority of farmers based their choice of pesticide on availability (58% of responses), followed by effectiveness (47%), price (37%) and recommendation (26%) (Figure 29). At an individual level, decisions on which pesticide to use were often based on multiple factors (Figure 30).

Training and sources of information

Farmers had various sources of information on pest management, with the most commonly cited being radio (>80%) followed by extension agents and local leaders. Less than 20% of farmers listed printed material and retailers as their information sources (Figure 31).

In relation to pesticide application, 10 out of 19 farmers said that the person applying the pesticide had been trained and the main source of training was extension agents. In one case, training was received via the radio and another from a friend.

Farmers relied on several sources to help them calculate the correct pesticide dosage (Figure 32), with 63% receiving advice from extension agents, 47% reading the pesticide label and 11% asking friends and neighbours for support.

The majority of farmers (68%) preferred to receive training through extension agents, followed by model farmers and field days (both 44%). The least preferred training methods were radio/TV (22%) and e-learning (11%) as shown in Figure 33.

Analysis of GAP/GCM and other voluntary standards applied to focal crops

Although no organization in Malawi is a member of the Roundtable on Responsible Soy and therefore none are certified under this scheme, its principles production are being promoted by NASFAM (Farmer Support Programme 2013).

The Malawi Organic Growers Association (MOGA) supports farmers with quality control and marketing for crops grown under the organic certification scheme in order to facilitate farmers' access to local and international markets. Part of certification includes the need for annual inspection and submission of samples for testing. Testing is done for the MOGA by the Malawi Bureau of Standards, agricultural research stations, and the Lilongwe University of Agriculture and Natural Resources. For the international market there is a need for further certification from others such as Control Union (Holland) and Soil Association (UK). The international certification organizations include Ecocert (France), Control Union (Holland) and Afrisco (South Africa).

State of the science on crop protection

Public expenditure allocated to agricultural research is low, accounting for only 3.6% of agricultural public expenditure on average from 2006 to 2013. Moreover, 86% of this budget was contributed by donors (FAO 2015).

Improved aflatoxin mitigation, management and control for groundnuts was identified as one of the top four issues that the country needed to address in support of export growth. The Ministry of Industry and Trade, with the support of the Standards and Trade Development Facility (STDF), initiated a consultative process to develop a programme for the control of aflatoxins in groundnuts to facilitate export development (MAPAC 2013).

A literature review and analysis of existing studies on field/post-harvest crop protection in focal crops in the study countries can be found in Annex V.

Advisory service characteristics and the advice they provide

It has been estimated that there are around 120 different organizations providing direct extension services to farmers in Malawi. These include Government, private sector, NGO, church-based and farmers based organizations. Indirect support is provided by organizations such as Farm Radio Trust which broadcasts extension messages to farmers via radio. The public extension service, the Department for Extension Services under the Ministry of Agriculture, Irrigation and Water Development (MOAIWD), suffers from limited reach with a ratio of one extension officer to approx. 3,000 farmers. This is compounded by low access to field transport and high staff turnover (Ragasa 2017).

Advisory service actors' perception of pest problems in the focal crop

Soybean pests and diseases – Field. Soybean pests listed by extension agents included FAW (mentioned by 26% of agents), followed by birds and thrips. Other pests included leaf miner, rust, rodents, grasshopper and stalk borer, which were each listed by individual agents (Figure 34).

Soybean pests and diseases – Post-harvest. Extension agents listed weevils as the main soybean post-harvest pests (52%) followed by rodents (Figure 35). Other pests listed by individual agents were moulds, mildew and a black fungus.

Groundnut pests and diseases – Field. Groundnut rosette is the most common field pest on groundnut, listed by 37% (seven out of 19) of extension agents interviewed (Figure 36), followed by aphids (26%). Other pests listed by extension agents included birds, leaf miner, termites, rust, thrips, rodents, caterpillars, grasshoppers, FAW and witch weed (Striga). Witch weed and leaf miner were named by extension agents but were not listed by name in interviews with farmers.

Groundnut – Post-harvest. For extension agents, the main pests of groundnut post-harvest (Figure 37) were rodents (listed by 42% or eight agents), with Aspergillus (aflatoxin) and weevils both listed by 31%. Other minor pests include ants, termites and moulds.

Figure 38 compares the types of groundnut field and storage pests listed by farmers and extension agents. For example, termites were reported as pests by 45% of farmers interviewed but only by 11% of extension agents.

Current crop protection methods

Table 14 lists extension agents' perceptions of management options used by farmers to control field pests in soybean, groundnut and cassava, as well as extension agents' recommendations. As these responses were provided by pest only, they were not able to be differentiated by crop except where crop specific pests and diseases such as groundnut rosette disease (*Groundnut rosette virus*) were described.

The findings show differences in the control methods that extension agents say farmers used and the methods that are recommended by the extension agents.

Table 15 lists extension agents' perceptions of management options used by farmers to control post-harvest pests in soybean, groundnut and cassava, combined with extension agents' own recommendations.

Extension agents' perceptions of pest management practices used by farmers, the percentage of farmers applying each practice and the effectiveness are shown in Figure 39, Figure 40 and Figure 41. The practice most frequently applied is considered to be chemical treatment of seed and planting material (applied by 80% of farmers), but extension agents believe that this is only effective for 61% of farmers. Interventions such as using biological control agents and monitoring using traps were among those least practised and considered the least effective.

Bottlenecks / difficulties / challenges in plant protection, as well as other constraints on production

Extension agents' perceptions of the challenges to implementation of IPM (

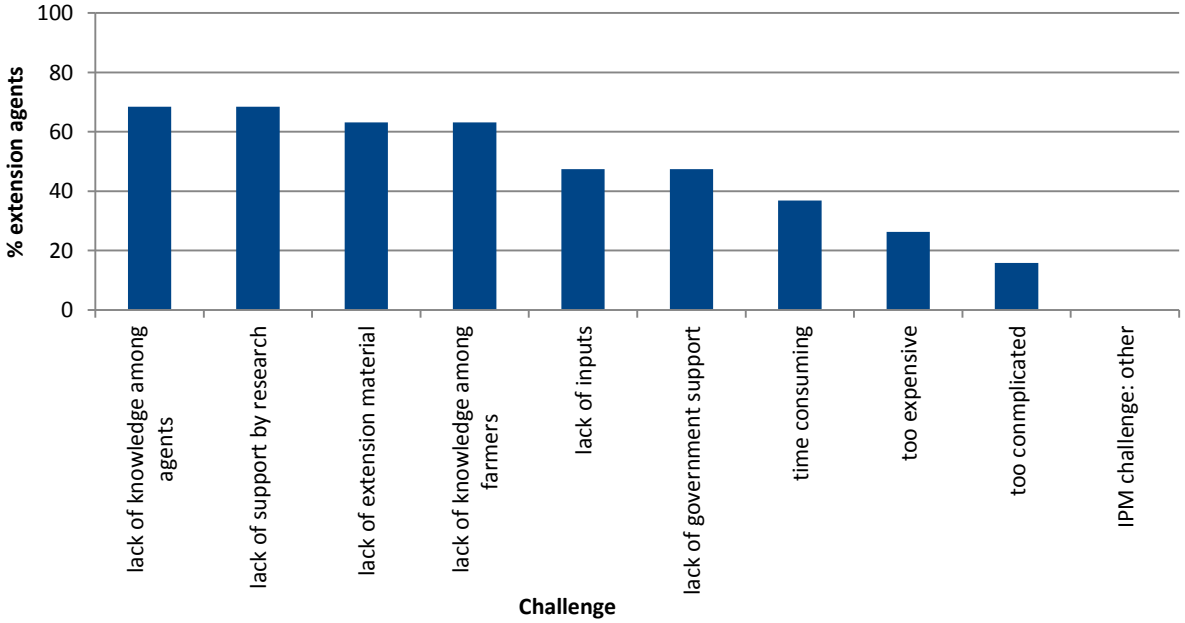

Figure 42) showed that lack of knowledge among extension agents was the greatest challenge, listed by 68% of extension agents. The fact that IPM was too expensive (26% of responses) or too complicated (16%) were the least important.

According to extension agents, farmers face many challenges to the correct application of pesticides (

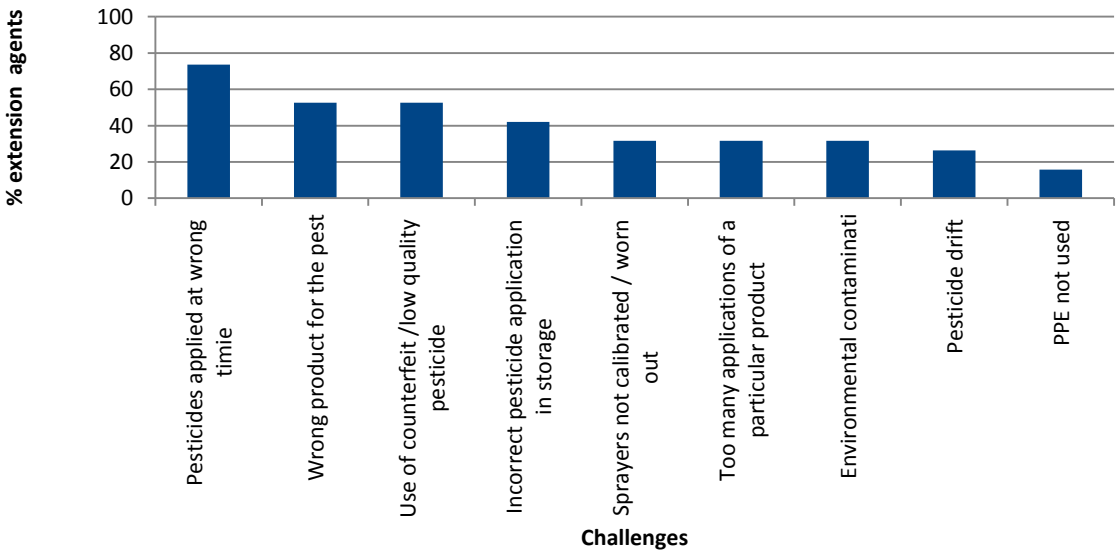

Figure 43 and Figure 44). These include low level of understanding about correct pesticide application in regard dosage, timing, number of sprays, re-entry interval and target pests.

Understanding pesticides

Individual extension agents' level of understanding of common pesticide terms was self-assessed through the questionnaire. The findings (Figure 45) show that extension agents had a good understanding of the concept of pesticide 'residues' (57% of extension agents saying they understood this concept) and 47% saying they had a good understanding of 'resistance'. 'Re-entry interval' and 'pre-harvest interval' were the least understood terms, with 69% and 47% of extension agents respectively saying they had never heard of these terms. The key pesticide term 'active ingredient' was understood by 32% of agents.

Pesticide sources and availability of pesticides, particularly low toxicity products and alternatives to synthetics pesticides

According to all extension agents completing the questionnaire, farmers' main sources of pesticides were retailers (Figure 46), followed by street vendors and then government.

Availability and affordability of inputs is shown in Figure 47. Agricultural inputs such as botanical and chemical pesticides were thought to be available to farmers by over 80% of extension agents, but less than 40% considered them affordable. The greatest disparity between availability and affordability was in spraying equipment, which is generally available, agreed by 84% of extension agents, but only 5% consider it affordable to farmers. For PPE, 42% of agents consider it available and 11% affordable.

Eighty percent of extension agents stated that farmers' planting material came from their agrodealers (89%), with 79% coming from their own household (Figure 48).

Extension agents also provided information on the botanical pesticides that farmers are using. The most common was Tephrosia, mentioned by five extension agents, followed by neem (four), Dalia (three), onions, Dema, marigold, garlic and tobacco. These are shown in Figure 49.

The reason given by one retailer for not stocking biological control agents was that there was no demand from clients and it was not requested by his suppliers. Availability of pesticides is also seasonal, with one retailer only stocking fungicides in the winter season.

Retailers receive some support from extension agents by way of recommending which brands to stock and sell and also in recommending the retailers to farmers seeking inputs (Figure 50).

Health and safety

Use of PPE

Extension agents interviewed suggested that on average 71% of farmers use no specific protective equipment when spaying pesticides. Less than 20% of farmers used rubber gloves and 10% used masks (

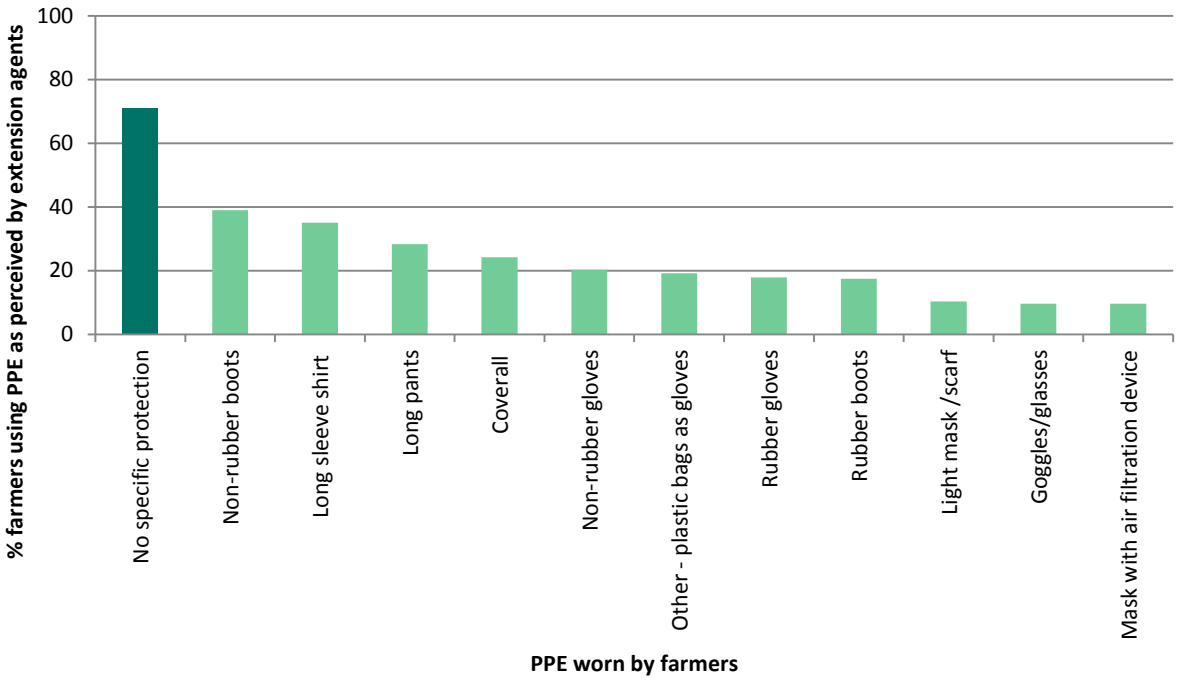

Figure 51). Further, 63% of extension agents believe that farmers do not use PPE because it is too expensive and not available (

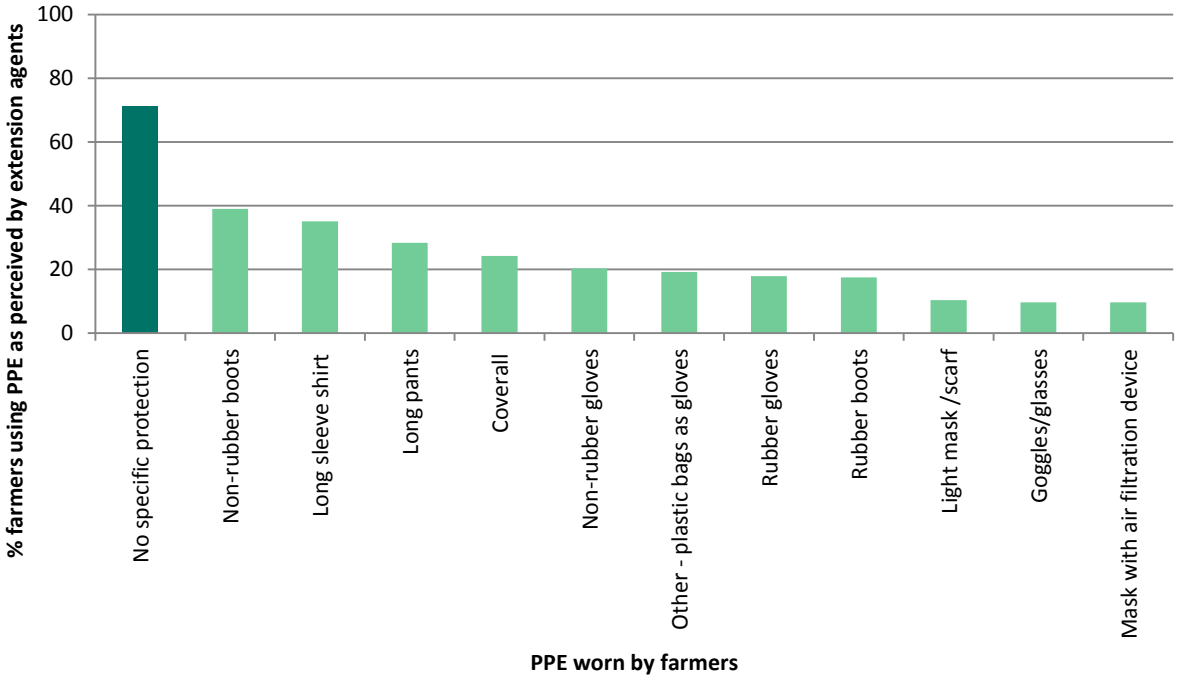

Figure 51)

Understanding pesticide label warning symbols

Questions on extension agents' understanding of standard warning symbols on pesticide labels showed that 63% could correctly identify the symbol for 'use apron' and 42% the symbols for 'wear rubber boots' and 'use coverall'. Only 10% correctly identified the 'harmful/irritant' symbol (Figure 53).

Safe container storage and disposal

Extension agents' perceptions of locations used by farmers to store pesticides (

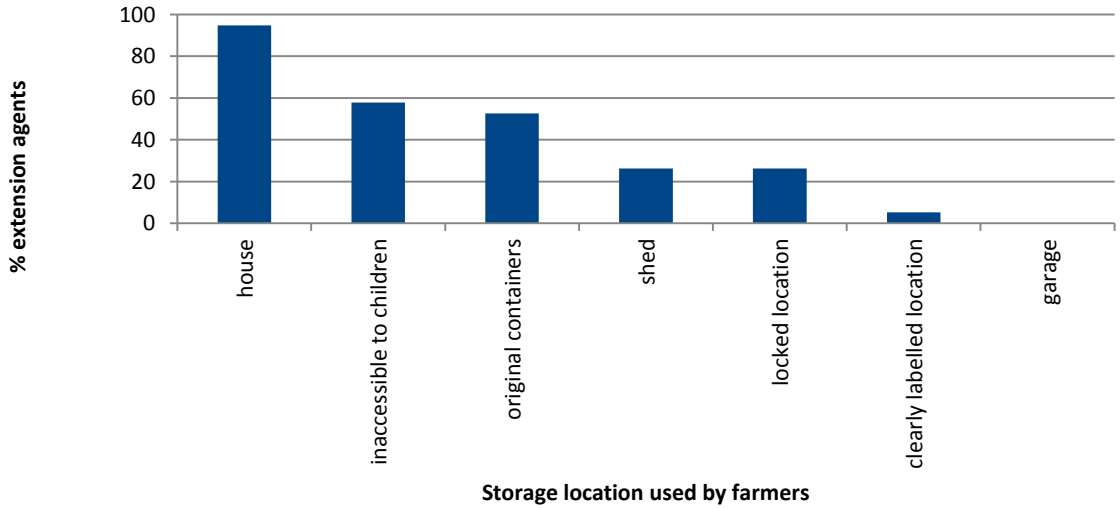

Figure 54) suggest that almost all farmers (95%) store pesticides in their houses, 58% in a location inaccessible to children, and 5% in a clearly labelled location.

Extension agents' responses to questions about which container disposal options they recommended to farmers (see

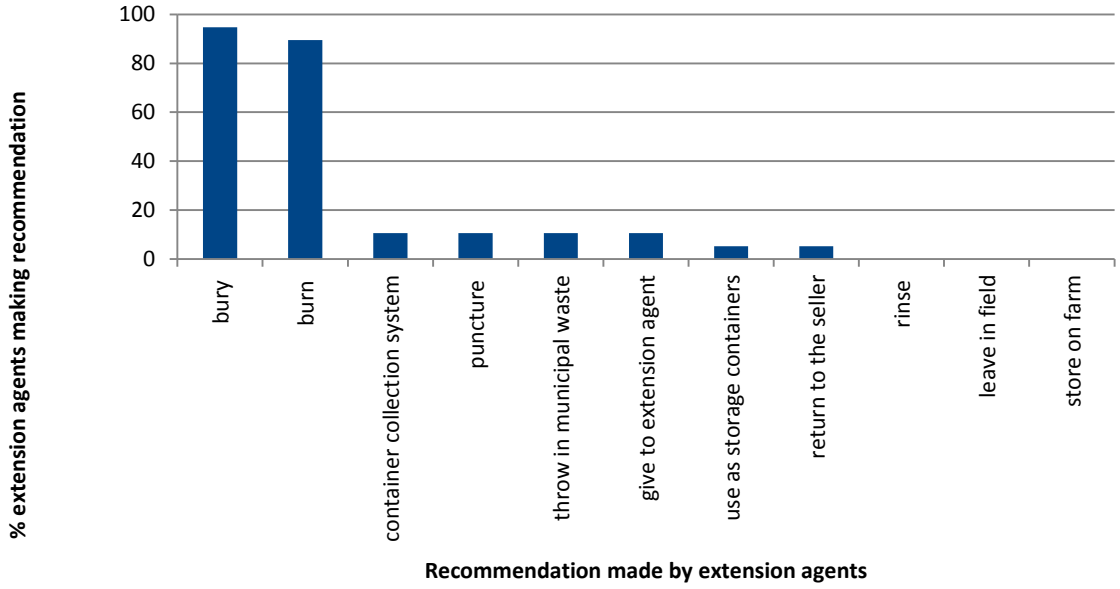

Figure 55) showed that burying containers was recommended by 95% of agents and burning recommended by 90%. One extension agent recommended that farmers reuse containers.

Knowledge of pests, IPM and rational pesticide use

Extension agents provided a list of IPM examples that they were aware of (Figure 56, Figure 57 and Figure 58). The most common example, listed by 42% of extension agents, is early planting as a preventative measure. Hand removing pests was the most common physical measure listed.

Questions on the extension agents' understanding of IPM (Figure 59) showed that although 84% said they had received training in IPM, only 26% (5 out of 19 respondents) felt they had a good understanding of IPM, 67% had a vague idea about IPM and 5% (one extension agent) said they had never heard of IPM.

Training and sources of information

All 19 extension agents have received some form of training over the last two years (i.e. since 2015). Examples include plant doctor training, agri-business management, post-harvest handling, aflatoxin management and use of improved seeds. Training suppliers included the Ministry of Agriculture, CABI and NGOs as examples. Only two extension agents could recall receiving training on IPM specifically.

Sources of advice for extension agents include fellow extension agents, the Department of Information within the Ministry of Agriculture and the internet, including CABI's Plantwise portal.

Sixty-six percent of extension agents stated that they received advice from research colleagues at least a few times a year. Sharing information through field days was the most common exchange mechanism used (90%), followed by direct contact (60%). Other ways included through conferences and staff meetings, which were mentioned by three extension agents.

Pesticide hazards, assessment of risks and documented harmful effects of pesticides

Hazard identification: identification of the HHPs and other hazards associated with pesticides that are registered in the country

The 158 AI registered in Malawi differed in terms of their overall hazard level (Figure 60): 49 of the AI which are allowed for use met one or more of the HHP criteria; 46 AI were categorized as "danger" (one or more of the associated human health hazard statements indicated that the AI is "toxic" or "fatal if inhaled"); 57 AI were categorized as "Warning"; and only 3 AI were categorized as "Low hazard" (there were no known human health hazard statements associated with the AI). The AI which were identified to be HHPs are listed in Table 16.

Of the HHPs identified, 43% were carcinogens, 37% were either extremely or highly acutely toxic, 20% were reproductive toxins and 4% were mutagens (Figure 61). Methyl bromide, the only agricultural ozone depleting substance listed in the Montreal Protocol, is present in the list of registered pesticides (2015) for Malawi. Endosulfan, which is listed as a POP by the Stockholm Convention and requires application of the prior informed consent procedure under the Rotterdam Convention, is also registered. Other AI registered in Malawi which require application of the PIC procedure under the Rotterdam Convention are alachlor, aldicarb, methamidiphos and monocrotophos. For six AI (benomyl, carbendazim, diazinon, epoxiconazole, ethoprop and maneb), more than one of the HHP criteria was met.

In addition to the information on the HHP criteria, the compiled GHS hazard statements identified other human health and environmental hazards. Irritation to the skin, eyes or respiratory tract were frequently listed as potential health effects (45 AI). Other human health effects that were identified included endocrine disruption (16 AI), allergic reactions (32 AI), the potential for serious eye damage (38 AI) and the potential for organ damage (both specific and general, 46 AI). The human health hazard statements covering health effects were included in the determination of hazard category. With respect to environmental hazards, 90 AI were found to be very toxic to aquatic organisms, often with the potential for long lasting effects. Data on pollinator hazards was available

for 57 AI and, of those that were assessed, 14 AI were found to be very toxic or very highly toxic to bees.

None of the AI are listed as candidate POPs. Thirty-two of the identified AI are currently listed in the Rotterdam database of notifications of final regulatory action. Eighty-one AI are included in the Pesticide Action Network (PAN) HHP list (2016). On an AI basis, almost 60% of the AI are allowed for use in the EU (Approved = 93 AI) or pending approval for use in the EU (pending = one AI) whereas the other 40% are not allowed for use in the EU (Not approved = 48 AI) or not listed in EU database at all (15 AI). The EU does not list one of the AI registered in Malawi as a plant protection product (piperonyl butoxide). Table 16 provides more information on the specific AI.

Nine of the identified AI are allowed for use in organic agriculture in that they are listed in Annex V Table 2 of Commission Regulation (EC) 889/2008. Twenty-eight of the AI are classified as U (unlikely to cause acute hazard under conditions of normal use) in the *WHO Recommended Classification of Pesticides by Hazard* (2009). Several (31 AI) of the AI identified through this study are not listed in the 2009 classification. Based on the LD_{50} of the AI, none of the AI that are not listed in the 2009 classification can also be considered to be class U.

In reference to the GIZ procurement policy, 26 AI fall into procurement category A (not allowed), 70 AI fall into procurement category B (only as exception, elaborate verification needed), 20 AI fall into procurement category C (only by authorized staff with strict protection; not for small farmers) and 32 AI fall into procurement category D (appropriate precaution) (

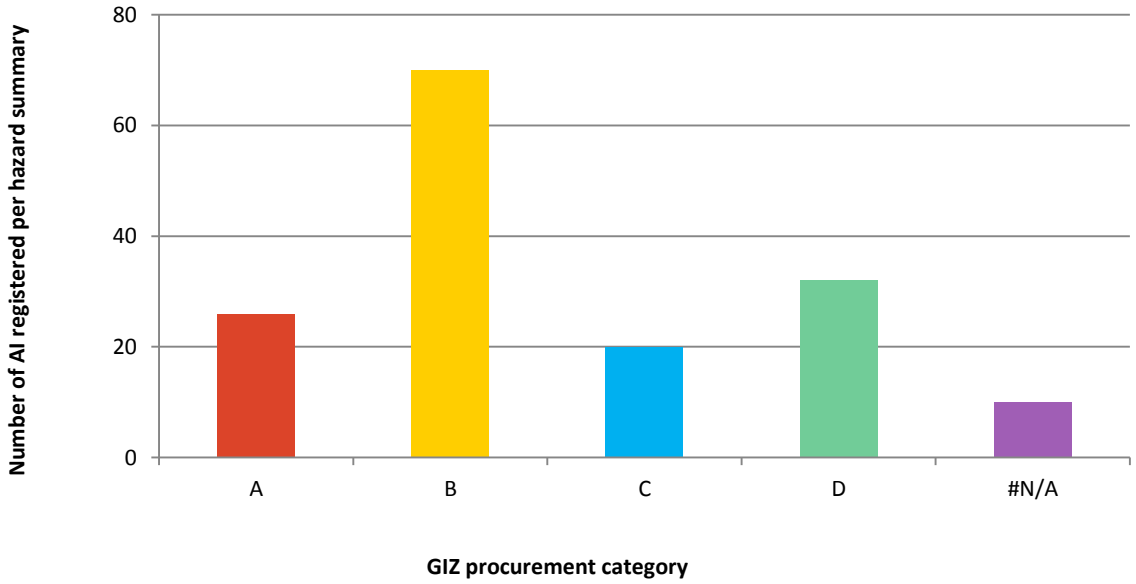

Figure 62). Ten of the AI have not been classified by GIZ.

Out of the 26 and 32 AI which are registered for groundnut and soybean, respectively, nine and seven AI are HHPs. Five out of the 11 pesticides mentioned by farmers or extension agents are HHPs. Agents recommended Carbaryl for aphid control and Abamectin for leaf miner control, while farmers mentioned Permethrin for the control of insect pests during storage. Farmers also mentioned Aldicarb for rodent control. The current study identified 22 non-HHP AI that are also registered to manage key pests for which HHPs are currently used or registered. For the majority of the target pests, at least one non-HHP AI was identified. The full list of pests and the lower toxicity alternative pesticides which are registered to manage them is given in Table 18. The pests for which no HHP alternative AI was identified were rodents as well as frogeye leafspot and purple seed stain in soybean.

Farmers interviewed in FGDs stated that they had not heard of the term ‘highly hazardous pesticide’.

One retailer interviewed for this study stated that he avoided selling products that are likely to cause harm if mishandled, giving the example of aluminium phosphide (HHP, fumigant). However, this product was seen in one other retail premises being sold over the counter as individual tablets taken from the original storage container and therefore sold without an accompanying label.

Counterfeit pesticides are considered by farmers and extension agents to be widespread in Malawi. Indicators for counterfeit products used by farmers include that the lid of the container is not tightly fitted, there is a smell of pesticide or the pesticide having no effect.

Conclusions

Main findings and recommendations for action

The review of the Malawi legislation indicated that although Malawi has made progress on ratifying the main international treaties on pesticide management, several significant gaps in legislation remain. For example, legislation governing the disposal of used pesticide containers and safe pesticide storage are two areas to note. Where legislation exists, implementation and enforcement appear to be weak – two particular areas being in labelling and packaging. Malawi's geographic position also makes it vulnerable to illegal cross border trade, with the consensus being that policing the trade in non-registered or counterfeit pesticides is extremely difficult.

Pesticide use among the farmers interviewed showed reliance on a limited range of products (cypermethrin was the main pesticide used against pests), with a general low level of understanding of safe pesticide management in all areas, including storage, application and recognition of standard hazard symbols. Use of PPE by farmers is extremely low. Farmers and extension agents showed some knowledge of botanical alternatives to synthetic pesticides.

Government structures tasked with implementation and enforcement of Malawian legislation on pesticide management exist in the form of the PCB and the Malawi Bureau of Standards. However, stakeholders met during the study all emphasized that these organizations have limited enforcement capacity due to low staff levels. At the same time, coordination between stakeholders appears to be weak and precise roles and responsibilities unclear.

Recommendations for the implementation of priority innovative measures in crop protection at various levels

Data collected during the study was shared with GIAE partner organizations during a workshop held in Lilongwe on 22–23 November 2017. The following recommendations were made by partners after reviewing the data.

Farmer level

Strengths and opportunities

- Farmers showed awareness and use of non-synthetic chemical options including homemade botanicals and cultural methods. This provides a good basis on which to build a future IPM approach.
- Farmer organizations and identified lead farmers are already established and this presents a good platform on which to build.

Weaknesses

- Identification and understanding of pests and their biology is leading, in some cases, to inappropriate control options being applied.
- Limited use of existing alternatives to synthetic chemicals.
- Misconception of risk when using HHPs, resulting in health impacts for farmers.
- Farmers unable to read and understand labels and hazard symbols.
- PPE is not being used and is generally inaccessible to farmers, being either expensive or unavailable.
- Unsafe pesticide storage being practised by farmers.
- Farmers are not practising proper disposal of empty pesticide containers.
- Lack of knowledge of concepts such as residue, re-entry interval and pre-harvest interval.

Recommendations

- Provide awareness-raising on pesticides and handling to farmers through a range of media and intermediaries, including support to lead farmers, exchange visits, farmer field schools and awareness-raising via television and radio.
- Provide awareness-raising on effective alternatives to synthetic chemicals. This should include promotion of existing IPM practices as well as introduction of new initiatives to increase the range of IPM options that farmers are familiar with and trust.
- Awareness-raising should cover a broad range of areas, including pesticide ingredients and selection, safe handling, appropriate application methods, pesticide storage and container disposal. Awareness-raising on pesticide handling should be accompanied by a programme to increase farmers' access to PPE. This can be done by incentivizing retailers to stock PPE and subsidy schemes to enable farmers' to purchase PPE.

Advisory level

Strengths and opportunities

- Extension agents are aware of and, in some cases, already promoting an IPM approach.
- A wide range of potential 'unofficial' advisers exist in the form of agro-input dealers and retailers from whom farmers can seek advice.

Weaknesses

- Extension agents' low capacity in identification and understanding of pests and their biology is leading, in some cases, to inappropriate control options being recommended to farmers.
- Extension agents and other potential advisers lack training and information on effective alternatives to using synthetic chemicals.
- Low level of awareness and understanding relating to pesticides and their appropriate handling and use.
- Lack of awareness regarding current legislation is preventing advisers from providing adequate advice based on current Malawian law.

Recommendations

- Support those providing advice to farmers to build their knowledge and understanding of a wide range of basic concepts and practices relating to pesticides and pesticide handling, e.g. in the selection of appropriate pesticides for a particular pest and in application procedures, through to safe disposal of unused pesticide. To ensure a holistic approach, the target stakeholders for this support can be broad, to include public and private extension agents, NGOs, churches and value chain intermediaries such as retailers and agro-input providers.
- Raise advisory stakeholders' awareness of legislation in Malawi governing pest and pesticide management. This will enable them to directly conform to legislation and allow them to advise others on implementation of the legislation where appropriate, e.g. in advising farmers on the correct disposal of unused pesticide according to Malawian law.
- Raise advisers' awareness and understanding of IPM practices that are suitable for the Malawian context and of the holistic approach needed to support low-chemical pest management. This support should include demonstrating to advisers the effectiveness of IPM options and building their confidence to prescribe these options to farmers.
- Provide training to agrodealers to enable them to provide appropriate advice to farmers.
- Seek to widen the base of crop protection advisers by providing training on basic pest and pesticide management to private sector stakeholders, including to retailers and other organizations, such as churches.

Policy level

Strengths and opportunities

- Pesticide management is already covered by some sections of legislation.

- The new Pesticides Act (awaiting approval) will include greater emphasis on biopesticides than the previous version.

Weaknesses

- Existing legislation relating to pesticide management has significant gaps and where legislation does exist it is being inadequately implemented and enforced.
- The national agricultural advisory services have been chronically under-resourced.
- Incentives to reduce use of hazardous pesticides are currently weak: HHPs are widely available and relatively cheap. In addition, less hazardous alternatives including some biopesticides are not registered in Malawi (such as neem and Bacillus thuringiensis), not widely available and accessible, or are not being recommended by those advising farmers. Retailers do not stock alternatives due to lack of demand, thus creating a circle of inaccessibility.

Recommendations and priorities for policy action

- Work with the PCB to assess its needs with a view to supporting a review of the pesticide registration process. This should focus on facilitating the registration of biopesticide products.
- Work with the PCB with a view to supporting a reduction in the number of HHPs registered. This can be done by assessing comparative risk and applying a substitution principle for registered pesticides.
- Encourage and support the establishment of incentives to enhance access to non-chemical pest management products and practices.
- Engage all stakeholders in a holistic approach, linking up numerous actors and interventions across existing national structures.
- Improve the sustainability of interventions particularly where inputs are envisaged through support for commercialization via suppliers and agrodealers – create incentives.
- Provide support to the PCB to develop guidance for the registration of biopesticides in Malawi.

Annexes

Annex I Contacts

Table 1 GIAE stakeholder contacts

Organization	Contact details
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	Caseby Banda Environmental Health Officer, Environmental Health Section, Preventative Health Department Tel: 0881743511
	Ganizani Allone Chief Environmental Health Officer, Environmental Health Section, Tel: 0888332954 (or 454?) Ganizaniall@yahoo.com
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Environmental Affairs	**Dr Tananga Nyirenda** Principal Environmental Officer, Department of Environmental Affairs, Ministry of Natural Resources Energy and Mines Lilongwe Tel: +265 991984303 Email: tananganyirenda@yahoo.com
Malawi Bureau of Standards	Malawi Bureau of Standards Regional Office (C) PO Box 156

	Lilongwe Malawi Tel: +265 1 758 341 Email: mbs@mbsmw.org
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Malawi Organic Growers Association	**Stanley Chidaya** Executive Director Malawi Organic Growers Association Stanleychidaya@yahoo.com, mogaorganics@hotmail.com Tel: 0999793179, 0882881993
Croplife Malawi	**Christopher Beya** Currently General Manager, TiL Limited *Previous Crop Life representative and may be able to recommend a current Croplife contact* Mob: +265 (0) 999 962 554 or 888 962 554 Tel: +265 (0) 1 710 377 Email: cbeya@tilmw.com or clbeya@yahoo.com
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IITA	**Akinwale, Gbenga** Programme Manager for Soybean **Sibale, Elizabeth** Activity Manager – Feed the Future

	Contact via – Dr Arega Alene, Country Representative (a.alene@cgiar.org) Tel: +265 1707014/022 Or contact via Mr Davie Botie, Station Administrator (d.botie@cgiar.org)
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Rural Market Development Trust (RUMARK)	**Godfrey Chapola** House 129, Area 14 Lilongwe, Malawi Tel: (265) 1 774 811 Email: info@rumark.org

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GIZ	Sekani Kateta
GIZ/GIAE	Volkmar Engelbrecht

Annex II Overview of agriculture sector performance and contribution to the economy

Table 2 Selected indicators for Malawi agricultural sector

Selected indicators – agriculture sector generally	2007	2010	2013	Latest available	Source
Total area of land under agriculture (% of land)	52.9	60.3	61.4	61.4 (2015)	World Bank
Arable land per person (ha)	0.22	0.24	0.23		FAOSTAT
GDP per capita (current US$)		458	471	481 (2016)	World Bank
Agricultural value added (% of GDP)	30.555	31.923	30.768	28.052 (2016)	World Bank
Agricultural labour force (% of total labour force)	72	70.5	70.0	69.9 (2016)	World Bank
Rural population (% of total)	85.39 (2000)	84.76	84.01	83.54 (2016)	World Bank
Value of total agriculture production (Agricultural production index, PIN) current million US$	3067	6151	6194	4534 (2014)	FAOSTAT

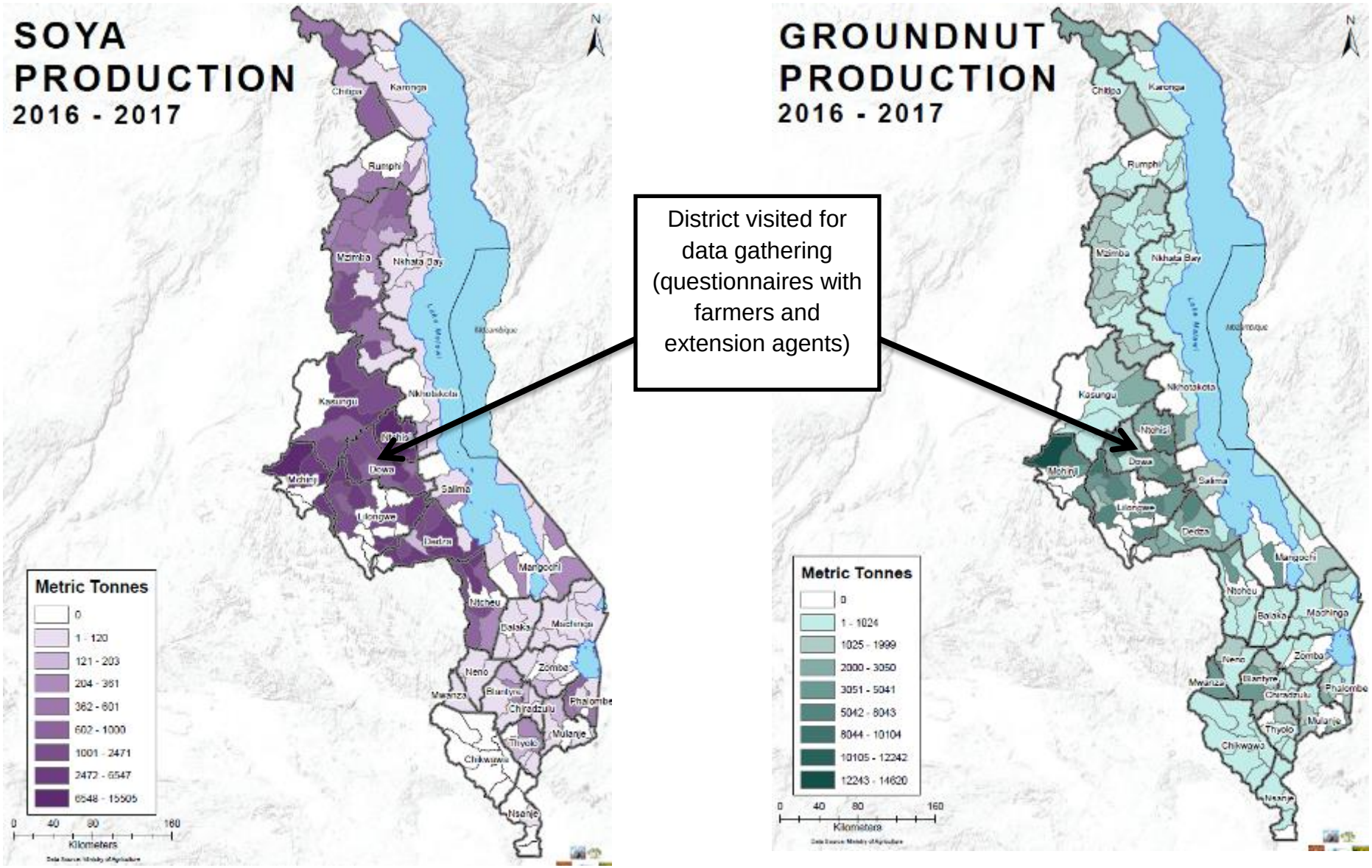

Figure 1 Maps of Soybean, groundnut and cassava production areas and levels

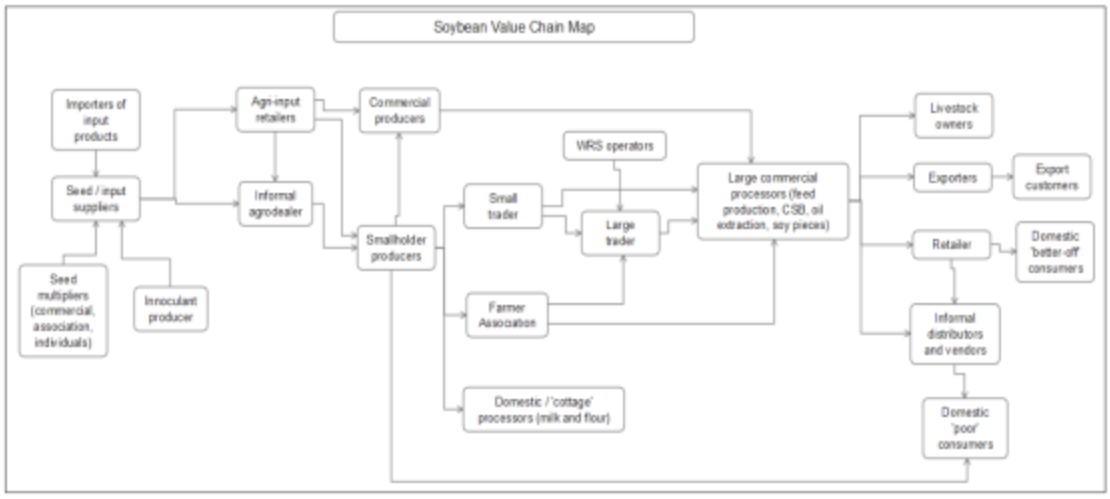

Figure 2 Soybean value chain

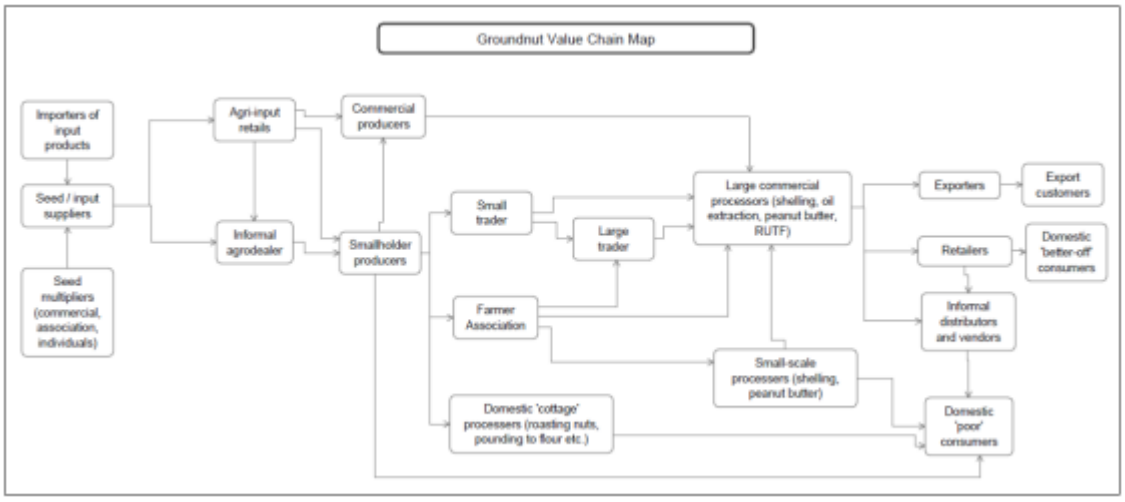

Figure 4 Groundnut value chain

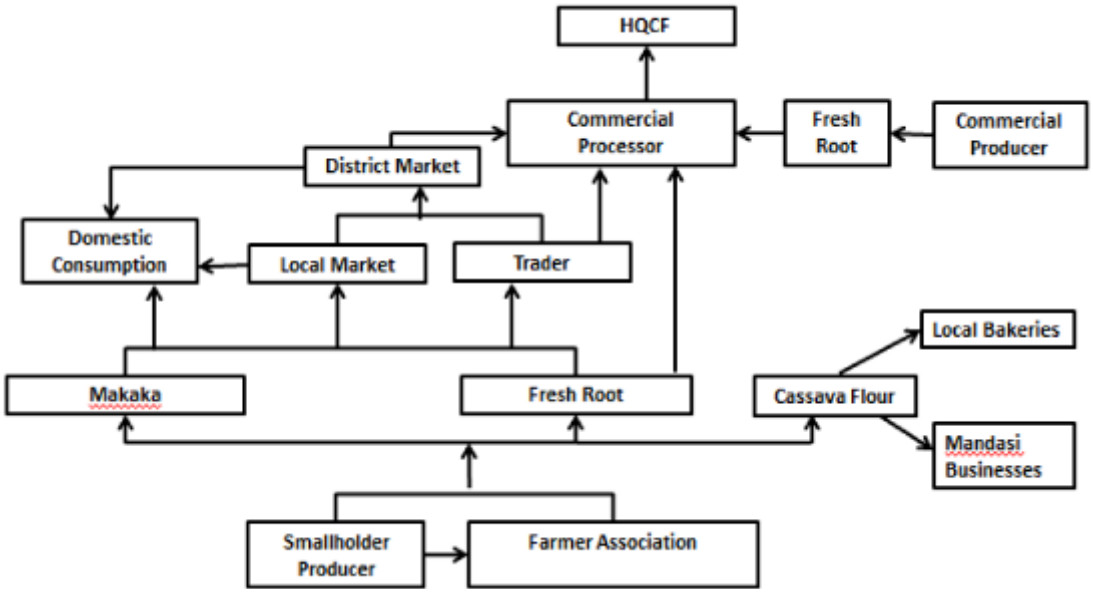

Figure 3 Cassava value chain

Table 3 Production of key crops

Key commodities (general)	Year	Area harvested (ha)	Yield Kg/ha	Production (tonnes)
Maize	2007	1,215,356	2,654	3,226,418
	2010	1,696,270	2,015	3,419,409
	2013	1,676,758	2,170	3,639,866
	2014	1,676,213	1,656	2,776,277
Focal crops				
Cassava (figures at harvest)	2007	172,539	18,772	3,238,943
	2010	195,828	20,431	4,000,986
	2013	211,089	22,804	4,813,699
	2014	222,750	22,504	5,012,763
Groundnuts (with shell)	2007	258,111	1,014	261,810
	2010	295,236	1,007	297,487
	2013	362,824	1,049	380,800
	2014	373925	1,929	296498
Soybean	2007	79,465	897	71,295
	2010	75,186	975	73,356
	2013	114,369	979	111,977
	2014	139,005	869	120,903

Source: FAOSTAT

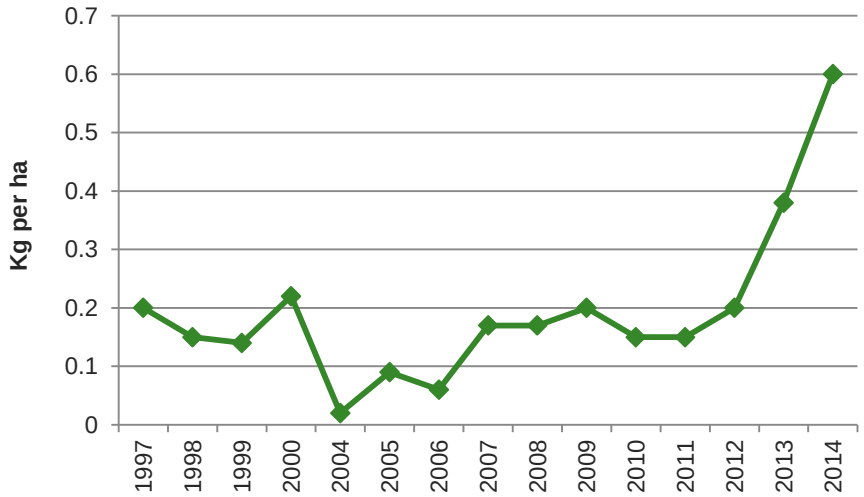

Figure 5 Trend in pesticide use in Malawi

Table 4 Sources of agricultural inputs

Inputs	Company
Seed	RUMARK Agrodealers
Seed	AISL
Seed	Global Seeds
Seed	MUSECO
Seed	Demeter
Seed	Seed Co
Seed	Paneer
Seed	Funwe
Seed	Peacock
Pesticides, seeds, Inoculum, PPE	Agricultural trading company
Inoculum	AISL
Pesticides, Inoculum, PPE	Farmers Association Limited
Pesticides	Osho Chemicals
Pesticide	Afriventure

Table 5 Stakeholders

Extension and advisory services (public and/or private)	
Department of Agriculture Advisory Services	
DCD	
RUMARK	Limited extension advisory
Malawi Organic Growers Association	Organic training and extension Organic group advisory service Organic inspection Control systems
Farmers' Organization Ltd	Extension services
NASFAM	Extension and advisory services
MET/Weather	Data on forecasting and early warning
Trading and processing – soybean and groundnut	
Afrinut	Processing of groundnut and soybean
SUNSEED	Processing soybean
Mount Meru	Processing soybean
Grain Legumes Development and Marketing	Enhance production and marketing of legumes
Seed Co – Malawi (private seed company)	Production and marketing of seeds
Soybean Association of Malawi (SOYAMA)	Address soybean trading and marketing issues as well as lobby financing institutions to support the soybean industry
Central Poultry Feeds (CP-Feeds) and Rab Processors	Buy soybean grain from farmers, process soybeans into human food and animal feed
Collectives and associations	
National Smallholder Farmer's Association of Malawi (NASFAM)	Promotion of farmer associations Production of quality declared seeds Linking farmers to markets
Association of Smallholder Seed Multiplication Action Group	Farmer owned and controlled rural seed production and marketing organization
Farmers Union of Malawi	Farmer representative
RUMARC AGRO dealer Association	Input supply, output marketing
Sunseed	Organization of producers
Malawi Organic Growers Association	Organization of producers
Permaculture Network	Organization of producers
Certification organizations	
Malawi Bureau of Standards	Inspection and certification
Control Union	Inspection and certification
Afrisco (African Standard Certification	Inspection and certification
IMO/ Ecocert	Inspection and certification
Malawi Organic Growers Association	Development of internal control system for organic certification Quality assurance

Table 6 Other key stakeholders and roles

NGOs	
United Purpose	Promotion of GAP and markets
CARE	Collective marketing
CISANET	Policy and advocacy
RUMARK	Input supply, output marketing
Legume Development Trust (LDT)	Policy, marketing of groundnuts, advisory and training services
MoGA	Organic agriculture
FUM	Policy and advocacy
Research	
IITA-Malawi	Soybean breeding, variety development, technical backstopping and training Integrated soil fertility management Aflatoxin level research and farmer training
ICRISAT	Groundnut breeding Seed systems
DARS	Groundnut breeding
FiBC	Organic research and documentation

Table 7 Organizational arrangements within the national governments for pest and pesticide management

Role	Ministry name	Department/agency responsible	Specific functions	Number of staff per function, level and location (national, district)
Registration of pesticides	MOAIWD	Pesticides Control Board	Implements the Pesticides Act, Plant Protection Act	Head Office: Bvumbwe, Email: pesticideboard@malawi.net
Enforcement of pesticide regulations	MOAIWD	Pesticides Control Board		
National Plant Protection Organization	MOAIWD – DCD and Department of Fisheries	Plant Protection Unit, Seed Services Unit,	Implements the Plant Protection Act (1969)	
Food safety	Ministry of Health	Research institutions	Malawi Biosafety Act 2002, Biosafety Regulations 2007 and Malawi Biotechnology Guidelines 2009; to the National Biosafety Regulatory Committee through the Biosafety Registrar	
	Ministry of Industry and Trade			
	Malawi Bureau of Standards		Mandate to promote metrology, standardization and quality assurance of commodities and of the manufacture, production, processing and treatment thereof; and further to provide for matters incidental to or connected with standardization	
Public health issues related to pesticides	Ministry of Health	Public Health Institute of Malawi	Implement international health regulations; conduct investigations on chemical events, both local and international, to eliminate the dangers arising from such occurrences to protect human health and the environment	

Role	Ministry name	Department/agency responsible	Specific functions	Number of staff per function, level and location (national, district)
		The Directorate of Preventive Health Services via the Department of Environmental Health Services	Responsible for implementing the environmental health policy in Malawi. This covers: safety handling and disposal of harmful chemical substances and the control of environmental pollution.	
	Ministry of Labour	Occupational Safety and Health	Ensure that institutions that handle chemicals follow necessary precautions and implement safeguards Enhance knowledge for quick identification of potential health hazards for health workers and ensure safety of workers through, for example, ensuring correct use of PPE Handling incidences of chemical poisoning Advocating for issues of occupational safety and health Collaborating with Environment Affairs Department to ensure sound management of chemicals and associated waste Collaborating with border control agents to prevent import of banned chemical products in the country	
Plant variety registration	MOAIWD	Department of Crops Development (crop production), Seed Services Unit, Bunda College of Agriculture at the University of Malawi	To promote the production of different crops and facilitate producers' access to improved and appropriate crop production and agro-processing technologies for increased productivity. Provide guidance in crop production	
Occupational health and safety related to pesticides	Malawi Congress of Trade Unions (MCTU)		Defending workers' rights to ensure decent work conditions and occupational safety and health in the chemicals sector	

Role	Ministry name	Department/agency responsible	Specific functions	Number of staff per function, level and location (national, district)
	Ministry of Labour	Department of Occupational Safety and Health	Conduct inspections of workplaces Conduct investigations of accidents and poisoning Making recommendations for compensation Implementation of the Occupational Safety, Health and Welfare Act, 1997 (No. 21 of 1997)	
	Malawi Congress of Trade Unions (MCTU)		Defending workers' rights to ensure decent work conditions and occupational safety and health in the chemicals sector	
Environment	Ministry of Natural Resources, Energy and Environment	Department of Environmental Affairs	Promote sustainable management of land and natural resources	
		The Directorate of Preventive Health Services via the Department of Environmental Health Services	Responsible for implementing the environmental health policy in Malawi. This covers: safety handling and disposal of harmful chemical substances and the control of environmental pollution.	
Agricultural research	MOAIWD	Department of Agriculture Research (DARS)	Conduct studies on efficacy of various pesticides and their impact on human health and the environment Monitor chemical imports and export in collaboration with MRA and PCB Conduct awareness on safe use of pesticides among smallholder farmers in collaboration with other agents	
		Department for Crops Development	To promote the production of different crops and facilitate producers' access to improved and appropriate crop production and agro-processing technologies for increased productivity	

Role	Ministry name	Department/agency responsible	Specific functions	Number of staff per function, level and location (national, district)
	National Commission for Science and Technology (NCST)		Promote and coordinate research in the country and initiate research and investigations through experiments on the effects of chemicals, i.e. initiate chemical safety research	
Extension	MOAIWD	Department of Agriculture Extension Services (DAES)	Extension of technologies to farmers	Ratio of extension agents to farmers is either 1:2,352 or 1:3,274, depending on source (i.e. Agricultural Census or Agricultural Production Estimates Survey)
Commodity boards	MOAIWD	ADMARC WFRA		
Setting and overseeing policies relating to IPM, GAP, organic agriculture and/or sustainable agriculture	Ministry of Industry and Trade Malawi Bureau of Standards National Commission for Science and Technology (NCST) Genetic modification of crops (cotton)		Role is to: • Facilitate foreign direct investment • Identify new export markets and promote Malawian agricultural products • Facilitate agribusiness licensing and improve the ease of doing business in agriculture • Facilitate the establishment and enforcement of quality standards for agricultural products, particularly through the Malawi	
Setting and overseeing financial instruments such as subsidies, incentive programmes, taxes on inputs, etc.	Ministry of Industry and Trade		Border control: enforce import and export requirements of industrial chemicals; work in collaboration with Ministry of Agriculture, Medicines and Poisons Board, Ministry of Health, EAD	

Role	Ministry name	Department/agency responsible	Specific functions	Number of staff per function, level and location (national, district)
	Ministry of Finance	Treasury	Provide funding and financing for programmes on management of industrial chemicals including support for programmes of the Environmental Affairs Department	
	Malawi Revenue Authority (MRA)			

Official contact points / designated national authorities for multilateral environmental agreements	Victoria Kachimera Chief Environmental Officer (Legal) Ministry of Natural Resources, Energy and Mining Environmental Affairs Department Lingadzi House – Robert Mugabe Crescent, City Centre Private Bag 394 Lilongwe 3 Malawi +265 1 771 111 +265 1 773 379 kachimera_7(at)yahoo.com Ms. Tawonga Mbale-Luka Director Environmental Affairs Department Lingadzi House Private Bag 394 Lilongwe Malawi +265 1 771 111 +265 1 773 379 tawongam(at)yahoo.com Mr Misheck Soko Acting Registrar of Pesticides Pesticides Control Board PO Box 51300 Limbe Malawi +265 1 471 419 +265 1 471 312 m.soko(at)pesticidesboard.mw.com Ms Caroline Theka Environmental Officer Ministry of Natural Resources, Energy and Mining Legal Department Private Bag 394 Lilongwe 3 Malawi +265 1 771 111 +265 1 773 379 caroltheka(at)yahoo.com

Annex III Overview of the legal framework

Table 8 Overview of the legal framework for pest and pesticide management in Malawi

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
The country is a party to the Montreal Protocol	✓
The country has enacted provisions relating to the implementation of the Montreal Protocol	✓
The country is a party to the Rotterdam Convention	✓
The country has enacted provisions relating to the implementation of the Rotterdam Convention	✓
The country is a party to the Stockholm Convention	✓
The country has enacted provisions relating to the implementation of the Stockholm Convention	✓
The country is a party to the Basel Convention	✓
The country has enacted provisions relating to the implementation of the Basel Convention	✓
The country is a party of the ILO Safety and Health in Agriculture Convention (C184)	X
The country has enacted provisions relating to the implementation of the ILO Safety and Health in Agriculture Convention (C184)	✓
Policies to promote reductions in unnecessary pesticide use such as policies on IPM, GAP, organic production and sustainable agriculture	
A policy is in place to develop and promote the use of IPM	✓
A policy is in place to promote the adoption of GAP, organic production and/or sustainable agriculture standards	X
A policy is in place to facilitate access to information on matters including pesticide hazards and risks, residues in food, IPM/IVM, alternatives to HHPs and related regulatory and policy actions	X
The country's policies to achieve the sustainable use of pesticides include quantitative objectives, targets, measures, timetables or indicators to reduce risks and impacts in parallel with the requirements of the EU directive 2009/128/EC (National Action Plan for the Sustainable Use of Plant Protection Products/Biocides (NAPS)).	X
Research	
A policy is in place to encourage and promote research on alternatives to existing pesticides that pose fewer risks, such as non-chemical preventive and direct control measures	X
Regulations related to the manufacture of pesticides	
A regulation addressing the manufacture and packaging of pesticides exists:	✓
• It defines appropriate engineering standards and operating practices, including quality assurance procedures	X
• It defines necessary precautions to protect workers	X
• It ensures the proper siting of plants and stores, monitoring and control of waste, emissions and effluents	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
• It ensures that packaging or repackaging is carried out only on licensed premises that comply with safety standards	X
• It contains provisions for poisoning cases	X
• It ensures that lists of banned pesticides for manufacture are in harmony with the country's international obligations	?
Legal framework for non-chemical preventive and direct control measures	
Registration is required for non-chemical preventive and direct control measures	X
A subsidy scheme for non-chemical preventative and curative control methods is in place	X
Price and trade policy, including subsidies	
Distribution and trade is a market-driven supply process / there is no government purchasing	X
A subsidy scheme for pesticides is in place:	X
• The subsidy scheme could potentially lead to excessive or unjustified pesticide use and may divert interest from more sustainable alternative measures	X
• There are subsidies for pesticides for field applications	X
• There are subsidies for pesticides for treatment of seed/planting material	X
• There are subsidies for pesticides for treatment of seed/planting material and/or for post-harvest applications	X
• The subsidy scheme is restricted to lower risk alternatives	X
A subsidy scheme for PPE is in place	X
Registration (synthetic pesticides and biopesticides)	
The legislation establishes a mandatory registration system for pesticides, tailored to national needs	✓
The registration process involves the risk-based evaluation of comprehensive scientific data demonstrating that the product is effective for its intended purposes and does not pose an unacceptable risk to human or animal health or the environment	X
The legislation identifies the body responsible for registration	✓
The legislation sets out the powers and functions of the registration body	✓
There is a mechanism in place for regional coordination / harmonization for the registration of pesticides	X
The legislation indicates how the registration body will make its registration decisions	✓
The legislation lists the types of final decisions the registration body can take	✓
The registration procedures indicate that the decision must be communicated to the applicant, within a certain time period, and must include a justification based on the decision criteria	X
The legislation clearly defines the activities and types of pesticides requiring registration (e.g. all pesticide uses or a subset):	X
• There are special requirements for products used on seed / plant material	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
• There are special requirements for products used for post-harvest application	X
• There are special requirements for non-chemical preventative and curative control methods	X
• There are provisions for experimental permits for the importation of limited quantities of unregistered pesticides for research, education or registration purposes	✓
• There are provisions for use of unregistered pesticides in emergency situations	✓
Low toxicity / low risk pesticides are defined	X
The regulation provides a definition for what biopesticides/biocontrol agents are	X
The legislation addressing registration contains a system designed to encourage the use of fewer or less toxic pesticides	X
• Fewer data requirements for less toxic alternatives	X
• Special process for biopesticides (or an equivalent grouping for pesticides of natural origin under a different name, e.g. “biocontrol agents”)	X
• Accelerated process or lower fees for registration of less toxic products	X
• New pesticides can only be registered if they replace more toxic pesticide products used for the same purpose	X
The legislation provides for distinct registration pathways for biopesticides or biological control agents and chemical pesticides	
• The data requirements for biopesticides / biological control agents include:	X
○ Identity, biology and ecology of the agent	X
○ Information for assessment of safety and effects on human health	X
○ Information for assessment of environmental risks	X
○ Information for assessment of efficacy, quality control and benefits of use	X
○ Toxicity for humans and the environments of additives (for microbial biological control agents only)	X
The legislation contains other provision which aims at facilitating the registration of biopesticides / biological control agents	X
The legislation indicates the validity period for registrations	X
The legislation describes procedures for denial of registration and appeal	X
The legislation describes requirements for label extension	X
The legislation provides for review of registered pesticides and empowers the registration body to impose new conditions in view of new information	X
The legislation describes requires mandatory re-registration at specified intervals	X
The legislation assigns responsibility for keeping records	X
The legislation includes provisions ensuring confidentiality of trade secrets	X
A pesticide register compiling all registered products is made publicly available by the responsible authority. It contains the following information:	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
• Trade names of the products	X
• Registration numbers	X
• Name(s) of the active ingredient(s)	X
• Concentration of the active ingredient(s)	X
• Formulation type	X
• Authorized uses including crops and target pests	X
• The name of the registrant	?
• The period of registration	?
• User groups (e.g. use of some pesticides is restricted to certified professionals);	X
A separate list containing the pesticide products that are banned or severely restricted is published by the national authority. Likewise, biopesticides are identified in a separate list	X
Analysis of registered pesticide list for HHPs and alternatives	
List the time of last update	last date available 2015
The number of AI registered	158
The number of products registered	405
The number of registrants	Not known
For the banned list, the last time it was updated, the number (and identity) of the banned pesticides	Not known
Biocontrol agents that are not covered by the national authority which handles registration of pesticides, e.g. macro-organisms	
The legislation contains provisions addressing export, shipment, import and release of biological control agents and other beneficial organisms. It contains the following requirements:	X
• To carry out pest risk analysis of biological control agents	X
• To obtain, provide and assess documentation as appropriate, relevant to the export, shipment, import or release of biological control agents and other beneficial organisms	X
• To ensure that biological control agents and other beneficial organisms are taken either directly to designated quarantine facilities or mass-rearing facilities or, if appropriate, passed directly for release into the environment	X
• To encourage monitoring of release of biological control agents or beneficial organisms in order to assess impact on target and non-target organisms	X
Packaging and labelling	

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
The legislation specifies the products to which the packaging and labelling requirements apply (e.g. equally to imported and domestically manufacturer products)	X
The legislation specifies the technical requirements for packaging and repackaging	X
The legislation incorporates requirements for packaging and labelling into the registration process	✓
The legislation requires that packaging is safe	✓
The legislation requires packaging that will not degrade under normal conditions (e.g. the packaging material should be impermeable to its contents)	X
The legislation requires packaging that does not resemble common packaging of consumable goods	X
The legislation requires that packaging or repackaging only take place on licensed premises where staff are adequately protected	X
The legislation bans repackaging when effective controls are not possible in the national context	X
The legislation prohibits the repackaging or decanting of pesticide into food or drink or other inappropriate containers	✓
The legislation prohibits reuse of containers except under exceptional circumstances (e.g. where there is a programme in place to refill containers)	✓
The legislation requires that an officially approved label is a mandatory part of the product package	✓
The legislation lists the information which is required on the label	✓
• Product name	✓
• Use type	✓
• Type of formulation	✓
• AI name	✓
• AI concentration	✓
• Co-formulants	✓
• Net content	✓
• Name of supplier	✓
• Manufacturer	✓
• Batch number	✓
• Registration number	✓
• Hazard and safety information following the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)	X
• Directions for use	✓
• Warning against container reuse, instructions for storage and disposal	X
• Legal requirement that pesticides be used in a way that is consistent with the label	✓

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
The legislation lists how the information in the label should be communicated (languages, system of weights and measures, etc.)	X
The legislation outlines physical requirements of the label, e.g. minimum size of packaging, use of a durable material, fade resistant ink	X
A handbook or manual is available to guide label design and/or review	X
Marketing	
The legislation contains provisions specifically addressing pesticide advertising	✓
• It defines pesticide advertising broadly to cover all forms	✓
• It prohibits the advertising of unregistered or illegal pesticides	✓
• It prohibits false or misleading advertising of pesticides	✓
• It prohibits advertising contrary to approved uses or label instructions	✓
• It designates the authority responsible for enforcement	x
Transport	
Regulation addressing the transport of pesticides is in place	✓ ?
• It sets out requirements for vehicles and containers	X
• It prohibits the transport of pesticides in the same vehicle as passengers, animals, food or feed	X
• It requires physical separation in cases where joint transport or storage is unavoidable	X
Import and export	
The legislation contains provisions specifically addressing the import and export of pesticides	✓
• It prohibits the import / export of pesticides that have not been registered	✓
• It prohibits import / export of counterfeit, substandard or outdated pesticides, or of pesticides otherwise not meeting the prescribed requirements	✓
• It establishes application procedures for a pesticide import permit	✓
• It develops procedures and criteria for decisions on import permits	✓
• It requires inspection of pesticides at the point of entry	X
• It fosters collaboration between the competent national authority and the customs department at points of entry	X
• It establishes exceptions for donations or imports by public entities for specific purposes	✓
• It requires that exported pesticides meet the same quality standards as comparable domestic ones	✓
• It requires the use of Harmonized System customs codes on shipping documents	X
Requirements for sale	

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
The legislation contains provision specifically addressing the sale of pesticides	
• It sets requirements so that only those with competency and training may be licensed to sell pesticides	X
• It includes among the decision-making criteria for the granting of a licence issues such as storage, display, training, knowledge, record keeping, safety equipment and emergency plans	X
• It prescribes the separation of pesticide from food and medicine	X
• It prescribes that pesticides may only be sold in their undamaged original container	X
• It prescribes that pesticides may only be sold with a readable label	✓
• It prescribes that pesticides must not be sold to minors	X
• It prescribes that shops that sell pesticides must have firefighting equipment	X
• It prescribes that shops that sell pesticides must have a warning board	X
Licensing	
The legislation contains provisions to identify which pesticide-related activities are permitted only to operators that hold a valid licence	✓
• It prescribes the holding of a valid licence for manufacture and packaging	X
• It prescribes the holding of a valid licence for sales	✓
• It prescribes the holding of a valid licence for transportation, import and export	X
• It prescribes the holding of a valid license for special applications	✓
• It imposes specific and more restrictive requirements for severely restricted pesticides	X
• It provides for back up inspections	X
• It establishes a system to receive and evaluate applications, in order to assess risk	?
• It sets out clear criteria for the granting or denial of the licence, as well as provisions for imposition of conditions, suspension and revocation	✓
• It establishes the term of validity and the procedures for renewal of the licence	✓
• It enables the authority to impose fees for services associated with licensing	✓
• It sets out an appeal process linked to the licensing scheme	✓
Availability	
The legislation contains provisions to regulate the availability and use of pesticides in accordance with the hazards involved and the existing levels of user training	X
• It takes into account the type of formulation, method of application and its uses when determining the risk and degree of restriction appropriate to the product	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
• It contains provision to limit the availability of pesticides that are sold to the general public through non-specialized outlets	X
• It contains restrictions specifically targeting products used on seed/planting material	x
• It contains restrictions specifically targeting products used for post-harvest applications	X
Handling and use, including regulations on application equipment	**X**
The legislation contains provisions to prohibit the use of pesticides for a purpose, or in a manner, other than that prescribed on the label	✓
Responsibilities of pesticide operators (farmers and farmer workers) are identified in national regulations, e.g. to follow safety and hygiene norms, to follow recommendations relating to PPE use, to take reasonable precautions, to report risks, etc.	X
The legislation requires employers to take the necessary measures to protect the health of workers and the environment	X
• The required measures include provision of training	✓
• The required measures include provision of protective equipment	✓
• The required measures include health monitoring of the workers	✓
The legislation ensures that all workers, including those in agriculture, are protected under the legal framework	?
The legislation contains provisions to promote the use of pesticide application methods and/or equipment that minimize the risks	X
The legislation contains provisions to permit pesticide application equipment and PPE to be marketed only if they comply with established standards	X
The legislation contains provisions to prescribe the use of proper application equipment	X
• Respect for the recommended application process	X
• Appropriate calibration of the spraying equipment for the pesticides to be applied	X
The legislation contains provisions to prescribe the responsible cleaning of application equipment	X
• To rinse the content of the tank with fresh water and to apply the remaining liquid on the treated field	X
• Application equipment must be rinsed externally in the field	X
The legislation contains any other provision to prohibit the use of pesticides in an unsafe manner that poses a threat to human health or the environment	✓
Requirements for training	
A policy is in place to produce and disseminate relevant and clear educational materials on pesticide use and management	?
The legislation requires pest control operators to hold a licence or permit	✓
• For all products and application methods	?
• Only for specific products' application methods	X
• The content of the mandatory trainings is described in the law	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
Restrictions related to vulnerable groups	
The legislation contains provision to prevent the use of pesticides by and sale of pesticides to children or pregnant and nursing women	X
The legislation requires employers to take the necessary measures to prevent use by children and other vulnerable groups	X
Requirements for PPE	
A policy is in place to promote the use of suitable PPE	✓
The legislation prescribes the use of PPE for the application of pesticides	✓
• Operator risk and exposure is assessed at the time of registration in order to determine the PPE performance requirements	X
• Application of international standards (e.g. ISO 27065) or national standards for the classification of PPE by performance requirements (level of chemical resistance or some other measure to differentiate the level of protection provided by PPE)	X
• Only PPE which has met national standards may be marketed	X
• The label is required to list the elements of PPE (e.g. gloves, protective footwear, face protection, apron) and their performance requirements	X
• Responsibilities of pesticide operators (farmers and farm workers) are identified in national regulations, e.g. to follow safety and hygiene norms, to follow recommendations relating to PPE use, to take reasonable precautions, to report risks, etc.	✓
Storage	
The legislation makes provisions for safe storage of pesticides	X
• It differentiates between private, end-user or home storage and bulk or commercial storage	X
• It imposes record keeping requirements on those storing pesticides	X
• It prohibits the reuse of a pesticide container for any non-pesticide storage reason	✓
• It indicates the type of containers required	X
• The legislation specifies how and where pesticide products may be stored	X
○ Plant protection products are stored in their original containers and packs	X
○ Plant protection products are stored according to label storage requirements	X
○ Plant protection products that are liquid formulations are stored on shelving that is never above those products that are powder or granular formulations	X
○ Plant protection product storage facilities are built in a manner that is structurally sound and robust	X
○ Plant protection product storage facilities have sufficient and constant ventilation of fresh air to avoid a build-up of harmful vapours	X
○ Plant protection product storage facilities have or are located in areas with sufficient illumination by natural or artificial lighting to ensure that all product labels can be easily read while on the shelves	X
○ Plant protection product storage facilities are equipped with shelving that is not absorbent in case of spillage	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
○ Plant protection product storage facilities have retaining tanks or products are bundled according to 110% of the volume of the largest container of stored liquid, to ensure that there cannot be any leakage, seepage or contamination to the exterior of the facility	X
○ Plant protection product storage facilities and all designated fixed filling/mixing areas are equipped with a container of absorbent inert material such as sand, floor brush and dustpan and plastic bags that must be in a fixed location to be used exclusively in the case of training of plant protection products	X
○ An accident procedure including emergency contact telephone numbers shall visually display the basic steps of primary accident care and be accessible by all persons within 10 metres of the plant protection product/chemical storage facilities and designated mixing areas	X
○ All plant protection product/chemical storage facilities and all filling/mixing areas have eye washing amenities, a source of clean water at a distance no farther than 10 metres, and a first aid kit containing the relevant aid material	X
Disposal of unused pesticides	
A policy is in place to prevent the accumulation of obsolete pesticides and used containers	✓
A policy is in place to inventory obsolete or unusable stocks of pesticides and used containers, and establish and implement an action plan for their disposal	✓
The legislation contains provisions to ensure that disposal of hazardous pesticide waste is carried out in an environmentally sound manner	✓
The legislation bans certain types of activities in relation to pesticide waste (e.g. pouring it down drains or into water sources, burying it in unapproved sites and burning it in unapproved incinerators)	X
The legislation places affirmative duties on industry to assist in proper disposal	X
The legislation requires any person or entity seeking to dispose of pesticides or pesticide waste to seek authorization from the competent authority	✓
The legislation contains provisions for the implementation of a toxic waste collection scheme	X
The legislation contains provisions for the establishment of facilities for the management of bulk quantities of toxic waste	X
Disposal of empty pesticide containers	
The regulation addresses the disposal of pesticide containers	x
• The regulation governing disposal of empty pesticide containers is the same across the country	?
• Appropriate PPE is required when handling empty pesticide containers	X
• Cleaning the container before final disposal is the responsibility of the person disposing of the container	X
• When a metal, plastic or glass pesticide container is empty, it should be immediately triple rinsed (or pressure washed) with the resulting residue from the pesticide container being added to the spray tank for application	X
• After rinsing, the container should be rendered unusable by puncturing, crushing or breaking	X
• The regulation contains specifications for the storage conditions of empty pesticide containers (e.g. bagged, stored in a secure, ventilated location)	X
• The regulation bans the reuse of empty pesticide containers	✓

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
• Burying empty pesticide containers is prohibited. Or, if burying is allowed, specifications are provided for how the empty containers should be buried	X
• Burning empty pesticide containers is prohibited. Or, if burning is allowed, specifications are provided for how the empty containers should be burned (e.g. to stay out of smoke, information on what should be done with the ash, etc.)	X
• Empty containers are classified as hazardous waste regardless of whether they have been decontaminated	X
• Empty containers must be transported in specially licensed vehicles	X
• Empty containers may not be transported with food, beverages, medicines, feed, animals and people	X
• Users must return containers to the manufacturer, to the place of purchase or to the place indicated on the invoice issued at the time of purchase	X
• Final disposal of empty pesticide containers must be carried out by authorized companies / Containers must be destroyed at a specialized facility	X
• The procedure for disposal is described in legislation (recycling (if available), in a sanitary landfill, by incineration, etc.)	X
• Pesticide waste generators (= pesticide users) are required to establish waste management plans for harm reduction	X
The legislation contains dispositions to establish a container management system	X
Post-registration monitoring	
A policy is in place to collect reliable data and maintain statistics on the health effects of pesticides and pesticide poisoning incidents / on environmental contamination and adverse effects, including the monitoring of pesticide residues in feed, drinking water and/or the environment	X
• The policy assigns responsibility for mandatory monitoring and data collection with respect to pesticides	X
• The policy sets out the powers and responsibilities of the responsible body and the inspection corps with regard to information-gathering	X
• The policy imposes reporting requirements on manufacturers, importers, distributors and sellers of pesticides	✓
• The policy requires reporting of pesticide-related incidents to the competent authority	x
Residue monitoring in food and MRLs	
The legislation contains provisions to regulate and/or monitor pesticide residues in food	✓
• It defines which authority is in charge of the monitoring	✓
• It defines which authority is in charge of setting the MRLs	✓
• It applies for domestic production for national consumption as well as for imports / exports	✓
• It applies only for a limited number of export crops	X
• It prescribes following the MRLs set by the *Codex Alimentarius*	X
Other relevant human health and environmental protection regulations	
A policy is in place to raise awareness among users about the importance and ways of protecting health and the environment	X

Adherence to and implementation of international agreements relating to pesticides	Present or absent in legislation
A policy is in place to carry out health surveillance programmes of those who are occupationally exposed to pesticides	✓
A policy is in place to provide guidance and instructions to health workers on the diagnosis and treatment of suspected pesticide poisonings	X
A policy is in place to establish national or regional poisoning information centres	X
Compliance and enforcement	
The legislation contains provisions to prohibit the import, packaging, repackaging, transportation, distribution or sale of a pesticide unless it is packaged in accordance with criteria provided in the law	✓
The legislation contains provisions to detect and control counterfeiting and illegal trade in pesticides	X
The legislation contains provisions to facilitate the exchange of information (e.g. actions taken to ban or severely restrict a pesticide; scientific, technical, economic, regulatory and legal information; the availability of resources and expertise; cases of counterfeit and illegal pesticides being traded; poisoning and environmental contamination incidents data) between regulatory and implementing authorities	X
The legislation designates the national authority responsible for inspection	✓
• It defines the powers of the inspectors	✓
The legislation provides procedures and criteria for inspections	✓
• It provides procedures and requirements for sample taking	✓
• It contains provisions for the designation of official laboratories for analysis of samples	✓
• It provides clear and effective procedures for intervention if irregularities are found during inspections	✓
• It defines the actions that will be considered as offences, including special offences for public officials	✓
• It determines which offences will be criminal and which administrative	X
• It determines proportional and deterrent fines and includes mechanisms to adapt the fines if their value declines	✓
• It defines other consequences of the infringement, such as the revocation of a licence or forfeiture of materials used in connection with the commission of the offence	✓

Table 9 Legislation in Malawi relating to pest and pesticide management

Pesticides Act (Cap. 35:03). 2012 (2000)	The Pesticide Act provides for the life-cycle management of pesticides, regulating manufacture, formulation, importation into and exportation from the country, transport, storage, distribution, sale, use and disposal of pesticides and other matters connected thereto. This Act establishes the PCB, which is responsible for monitoring the trade and use of pesticides, and collecting statistical and other information concerning the import, export, manufacture, distribution, sale and use of pesticides, about pesticide residues and safe use
The Pesticides Regulations Regulation 2012 (2002)	The Pesticide Regulations were put in place to guide on the implementation of the provisions of the Pesticide Act. These Regulations implement provisions of the Pesticides Act in respect to applications for registration of a pesticide, registration of a pesticide and relevant certificate, labelling of pesticides, application for a permit to manufacture or trade in pesticides, limitation on use of imported pesticides, commercial applicator's licence, and determination or WHO hazard classification
Environmental Management Act, 2017 (No. 19 of 2017)	This Act covers the conservation and management of the environment in Malawi and prescribes environmental standards. It also concerns the conservation and management of biological (genetic) resources.
National Agriculture Policy 2016	The NAP identifies a set of priority actions, including irrigation development, mechanization of agriculture, agricultural market development, agro-processing and value addition, improved management of agricultural resources, increased agricultural exports and incomes, improved food and nutrition security, empowerment of youth, women and vulnerable groups in agriculture, and institutional development, coordination and capacity strengthening
National Seed Policy (Revised)	The major focus of the revised seed policy is the availability of adequate high quality seed and planting materials to the farming community. It therefore addresses the challenges in the seed industry in the areas of research, production and quality control, imports and exports, marketing and distribution, while also underscoring the important role both the public and private sectors could play in accelerating agricultural and forestry development through the seed industry. The policy also provides for the building up of strategic seed reserves
Plant Protection Act 1969 (No. 11 of 1969).	This Act makes provisions for the consolidation of plant protection to prevent the introduction and spread of harmful organisms, to ensure sustainable plant and environmental protection, to control the importation and use of plant protection substances, to regulate export and imports of plant and plant products and ensure fulfilment of international commitments
Plant Protection (Fumigation) Regulations (Cap. 64:01). 2012 (1973)	These Regulations, made under Section 12 of the Plant Protection Act, 1969, contain rules concerning fumigation of plants and materials in contact with plants for the purpose of destroying injurious organisms. The First Schedule lists essential and compulsory fumigation equipment.
National Environmental Policy (2004)	The overall policy goal is the promotion of sustainable social and economic development through the sound management of the environment.
World Bank Environmental Safeguard Policies Operational Policy 4:09 (Pest Management)	Guides the IPM plan for projects that trigger pesticide usage. The approaches include biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest
Biosafety Act (Cap. 60:03). 2012 (2002)	The Act makes provision for the control of genetic modification of organisms and related activities so as to prevent danger and damage to public health and the environment. The Act shall apply to: (a) the genetic modification of organisms; (b) the importation, development, production, testing, release, use and application of genetically modified organisms; and (c) the use of gene therapy in animals, including human beings.

Biosafety (Management of Genetically Modified Organisms) Regulations (Cap. 60:03). Malawi | 2012 (2007)	Implements the Biosafety Act
Control of Goods Act, 1968 (Cap. 18:08)	Covers the distribution, disposal, purchase, sale, retail prices and imports into and exports from Malawi of any manufactured or unmanufactured commodity.
Control of Goods (Control of Distribution of Commodities) Regulations (Cap. 18:08). 2012 (1994)	These Regulations, made under Section 3 of the Control of Goods Act, 1968, provide that the Minister of Trade and Industry may make orders for the control of the distribution of any commodity in Malawi
Control of Goods (Registration) Regulations (Cap. 18:08). 2012 (1968)	Supports the Control of Goods Act by providing procedures for the registration of importers or exporters
The Water Resource Act (2013)	The Act provides a plan for sustainable management and development of water resources. It outlines the principles for water resources management and for the prevention and control of water pollution
Malawi revenue Authority Customs & Excise Division Customs & Excise Act Customs and Excise Cap. 42:01 1	An Act providing for the administration, management and control of customs and excise, the imposition and collection of customs, excise and other duties and for matters connected therewith
Occupational Safety, Health and Welfare Act, 1997 (No. 21 of 1997)	The Act regulates conditions of employment in workplaces with regard to the safety, health and welfare of employees. The Act imposes duties on employers, the self-employed, other persons in control of premises, manufacturers and suppliers
Employment Act (Act 6 of 2000)	Regulates minimum standards of employment
Labour Inspection (Agriculture) Convention, 1969 (No. 129)	The Labour Inspection (Agriculture) Convention, 1969 (No. 129) is a supplement to the ILO Labour Inspection Convention, 1947 (No. 81) and enforces legislation relating to conditions of work and the protection of workers specifically in the agriculture sector, covering aspects such as safety, health and welfare and the employment of children and young persons.

Annex IV Farm characteristics and production practices in focal crops – data from farmer surveys

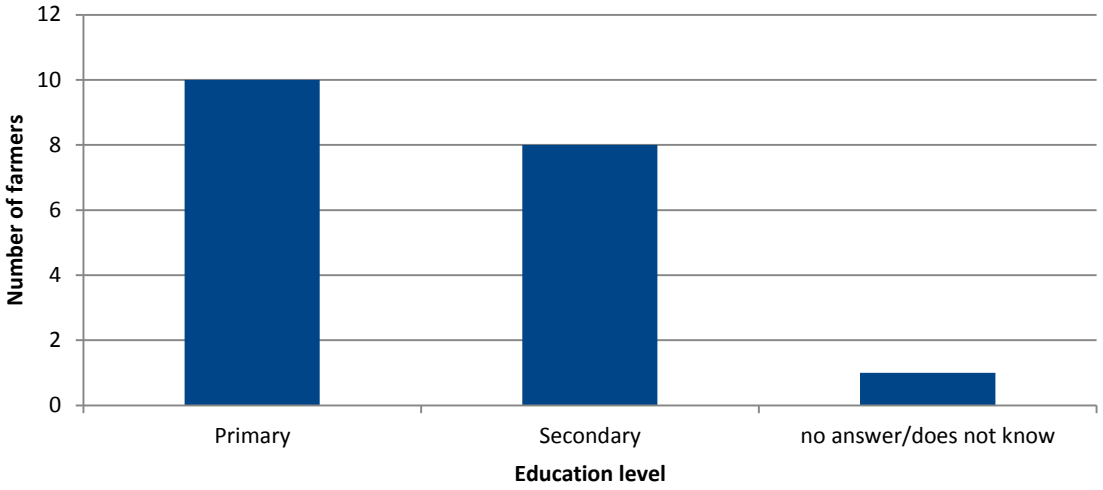

Figure 6 Farmer education level

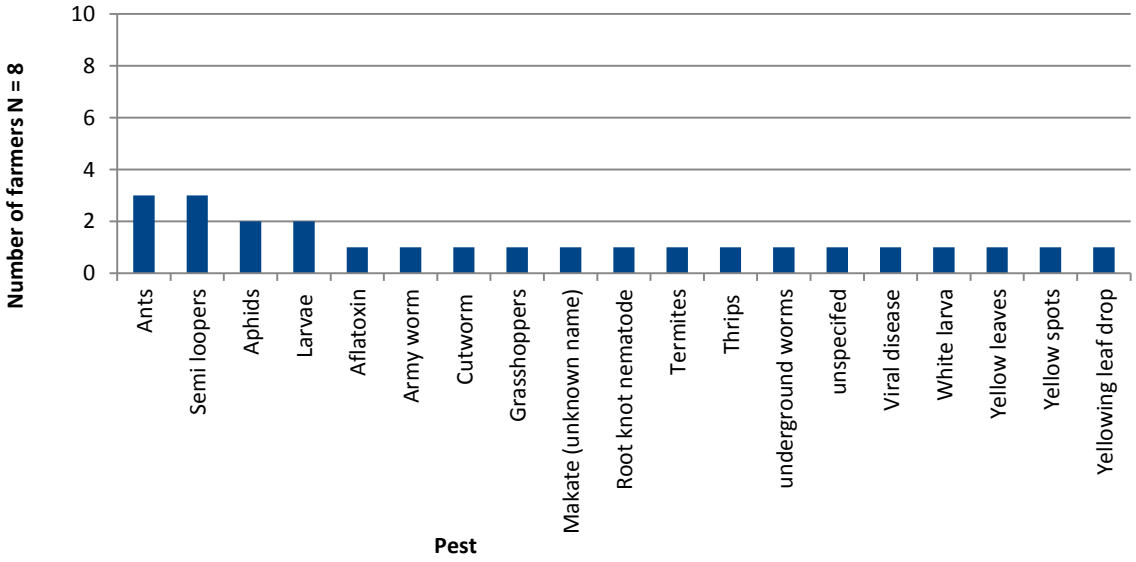

Figure 7 Soybean field pests mentioned by farmers

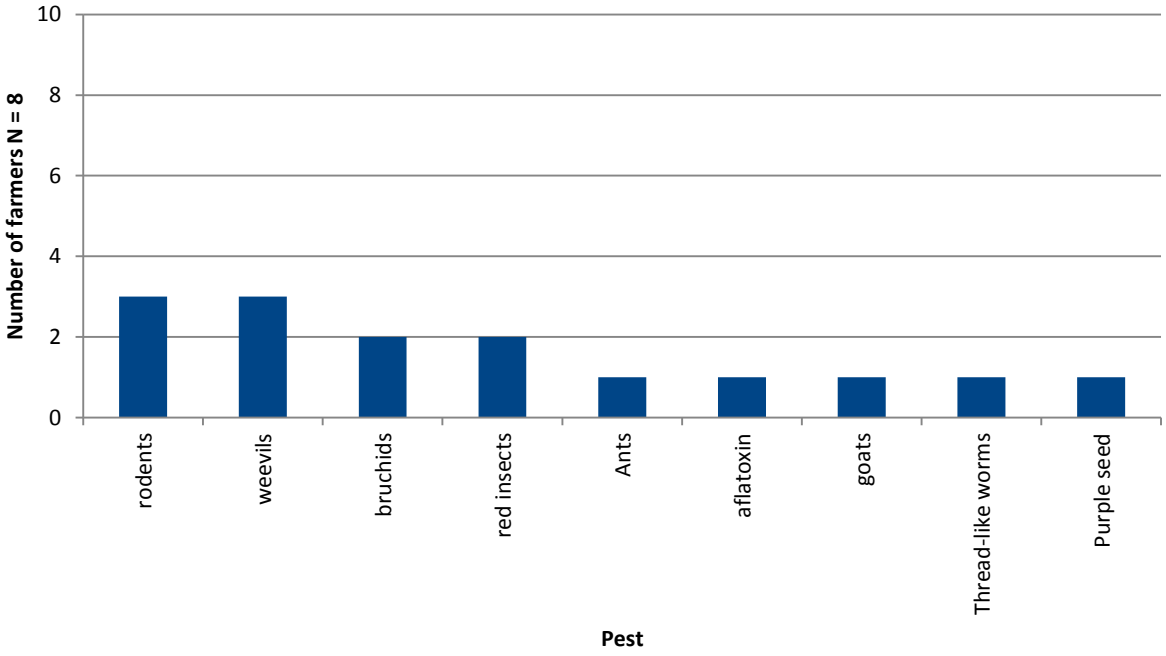

Figure 8 Soybean post-harvest pests mentioned by farmers

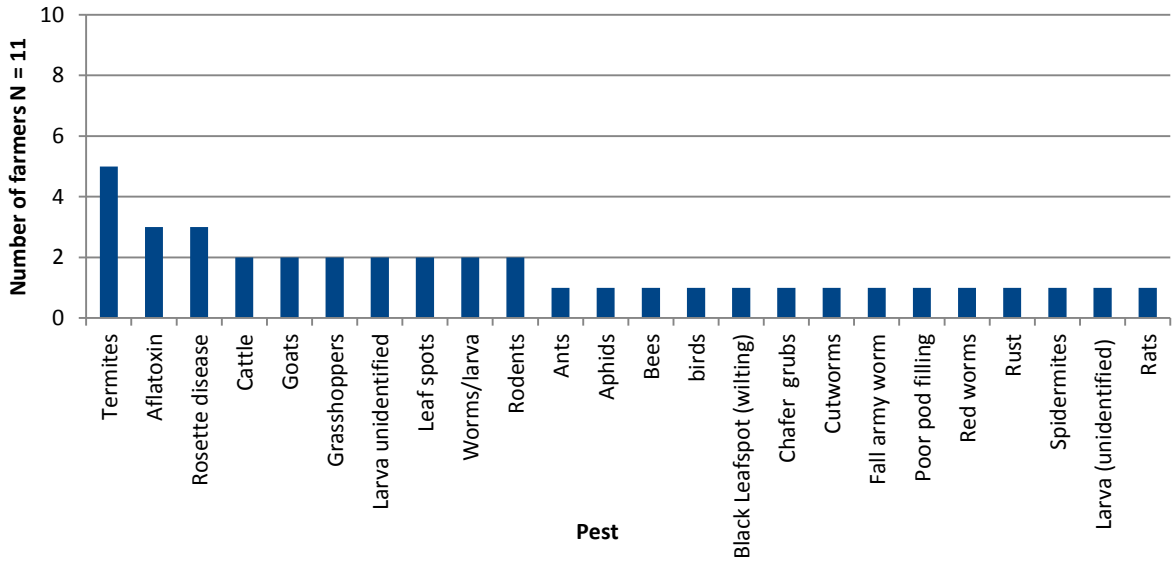

Figure 9 Groundnut field pests and diseases mentioned by farmers

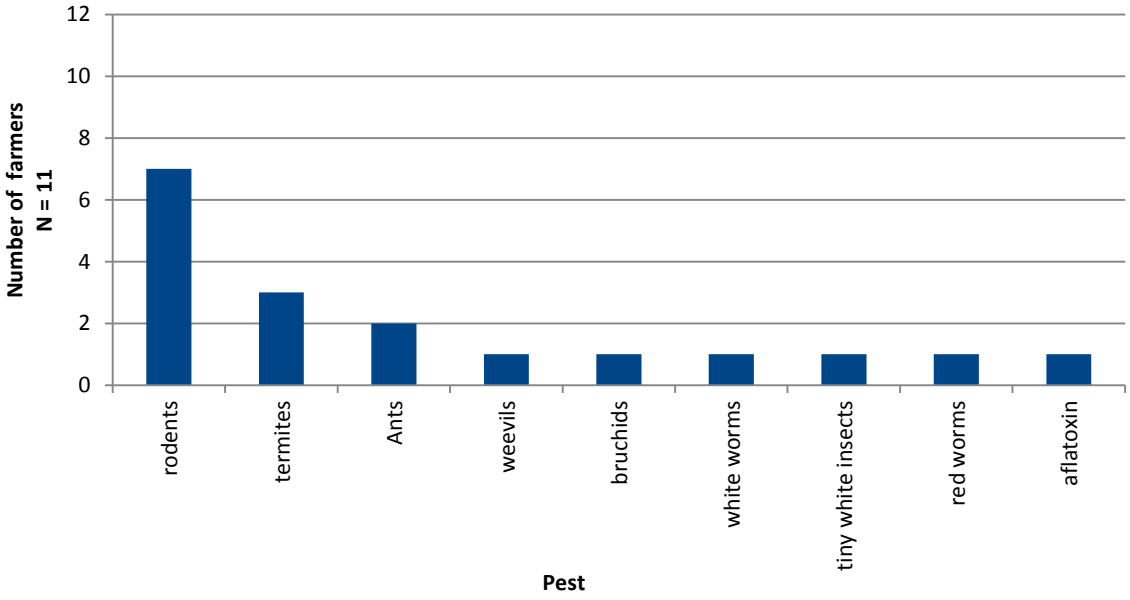

Figure 10 Groundnut post-harvest pests and diseases mentioned by farmers

Table 10 Soybean field pest and disease management options listed by farmers

Pest name	Number of farmers reporting pest (N=8)	Chemical product name	AI	Botanical	Cultural	None
Ants	3		cypermethrin	tobacco		
Semi-loopers	3		cypermethrin (3 farmers)	Tephrosia (2 farmers)	Handpicking	
		Phoskil (2 farmers)	Monocrotophos		Ashes	
Aphids	2				Change seeds	
					Manure	
Larvae	2				Uprooting	
Aflatoxin (caused by contamination with Aspergillus fungus species)	1					
Armyworm	1		cypermethrin	Tephrosia		
Cutworm	1		cypermethrin	Tephrosia		
Grasshoppers	1		cypermethrin		Handpicking	
Makate (unknown name)	1					
Root knot nematode	1			Tephrosia		
Termites	1	Dursban	Chlorpyrifos		Planting Ichadze	
		Solignum	cypermethrin		Placing old grass near the termites to attract them to feed on instead of on crop	
Thrips	1					None
Underground worms	1	Cypha	cypermethrin		Ashes	
Viral disease	1					
White larva	1					
Yellow leaves	1				Remove leaves	
Yellow spots	1				Ashes	
Yellowing leaf drop	1					None

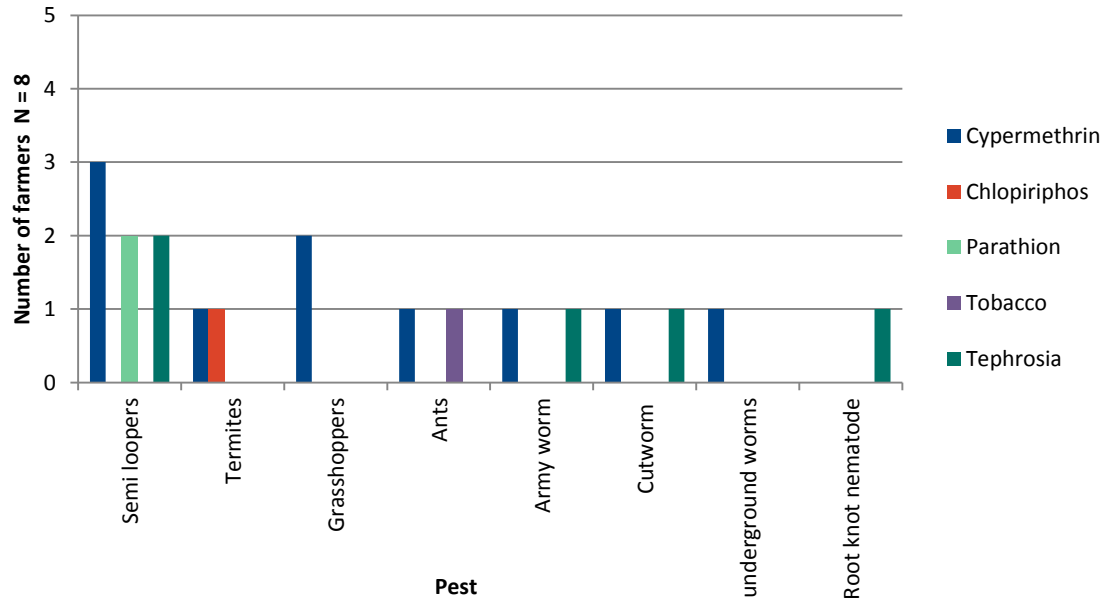

Figure 11 Soybean field pest and disease management options mentioned by farmers

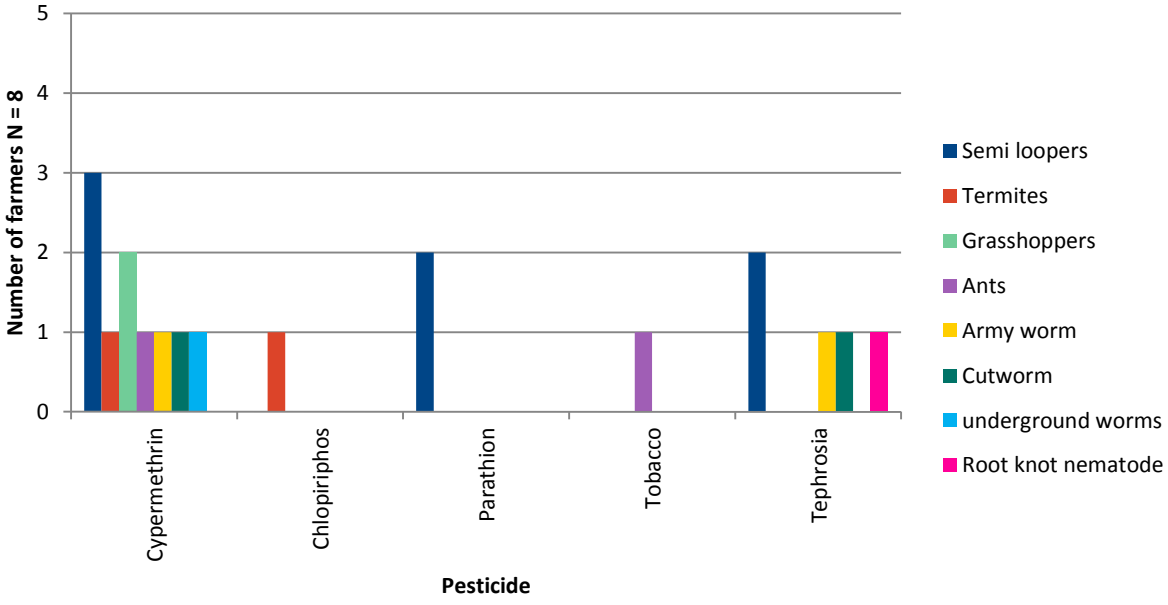

Figure 12 Soybean field pest and disease management options mentioned by farmers

Table 11 Soybean post-harvest pest management options listed by farmers

Pest name	Number of farmers reporting pest (N=9)	Chemical product name	AI	Botanical	Cultural	Non-chemical
Rodents	3	Temik	Aldicarb			Cats
		Indocide				
Weevils	3	Super Guard	Dithane	Tobacco leaves		Ash
						Paraffin
Bruchids	2	Actellic		Tephrosia		
				Tobacco leaves		
Ants	1		Cypermethrin		Sun drying	Ash
Aflatoxin (caused by contamination with Aspergillus fungus species)	1					

Table 12 Groundnut field pest management options as listed by farmers

Pest name	Number of farmers reporting	Synthetic name	AI	Botanical	Cultural
Aflatoxin (caused by contamination with Aspergillus fungus species)	4	Dyphin			Covering with soil
					double planting of groundnuts per line
Ants	1				
Aphids	1				Hand picking
Bees	1				
Birds	1				
Black Leafspot (wilting)	1				Uprooting
Chafer grubs	1				Hand picking and crushing
Cutworms	1		Cypermethrin	Tephrosia	
FAW	1		Cypermethrin		
Grasshoppers	2		Cypermethrin		

Pest name	Number of farmers reporting	Synthetic name	AI	Botanical	Cultural
Larva (White hairy, unidentified)	1			Gliricidia plant extract spray	
Larva unidentified	2	Dyphin			Hand picking and crushing,
					uprooting infect plants
Leaf spots	2				Uproot and burn or dry infected crops
Poor pod filling	1				
Rats	2	Temik	Aldicarb		
Red worms	1				
Rosette disease	3				Uprooting
					Uproot and burn or bury infected plants
					Crop rotation
Rust	1				
Spider mites	1				Hand Picking
Termites	5		Cypermethrin		Hand picking
					Early harvesting
					Planting muhandze
					Putting grass out for the termites to eat

Table 13 Groundnut post-harvest pest management as listed by farmers

Pest name	Number of farmers reporting	Synthetic name	AI	Botanical	Cultural
Rodents	7	Indocide (4)			Cats
		Temik (4)	Aldicarb		Hand killing
Ants	2				Sun drying
Weevils	1	Actellic super			Sun drying
Termites	3	Solignum			Ash
Bruchids	1	No pesticide used			Sun drying and ash
White worms	1	No pesticide used			
Tiny white insects	1	No pesticide used			Sun drying
Red worms	1				Sun drying and ash
Aflatoxin (caused by contamination with Aspergillus fungus species)	1				Drying with Mandela cork

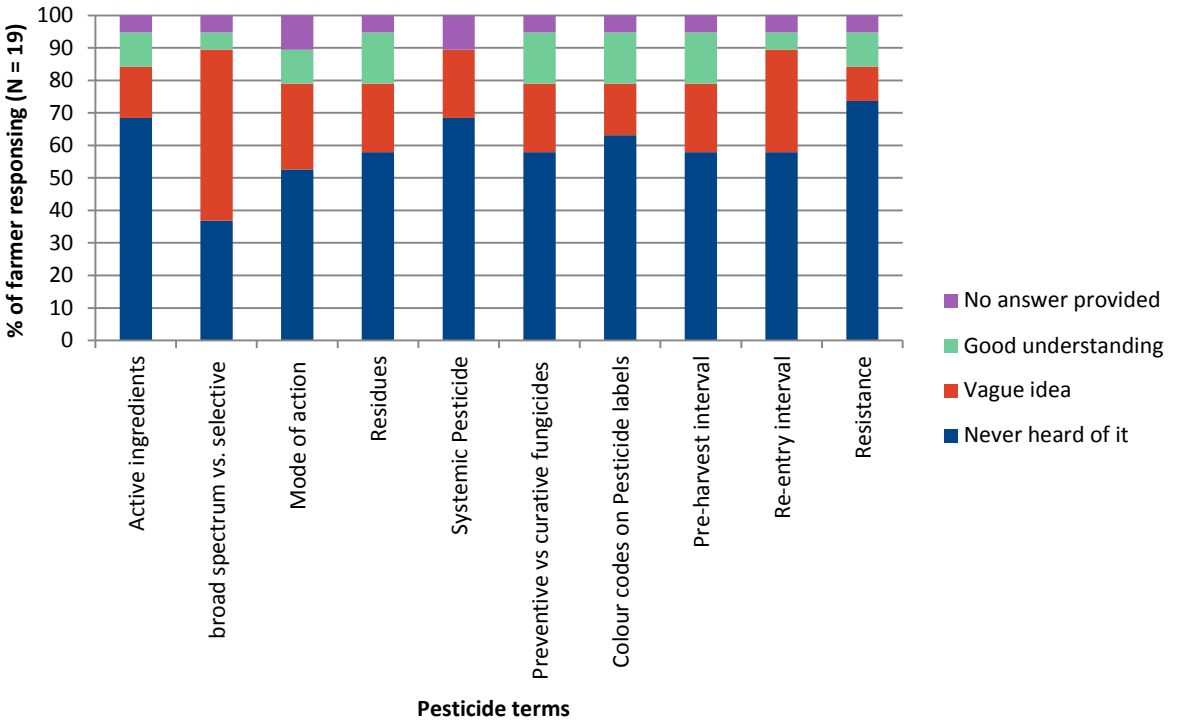

Figure 13 Farmers' level of understanding of pesticide terminology

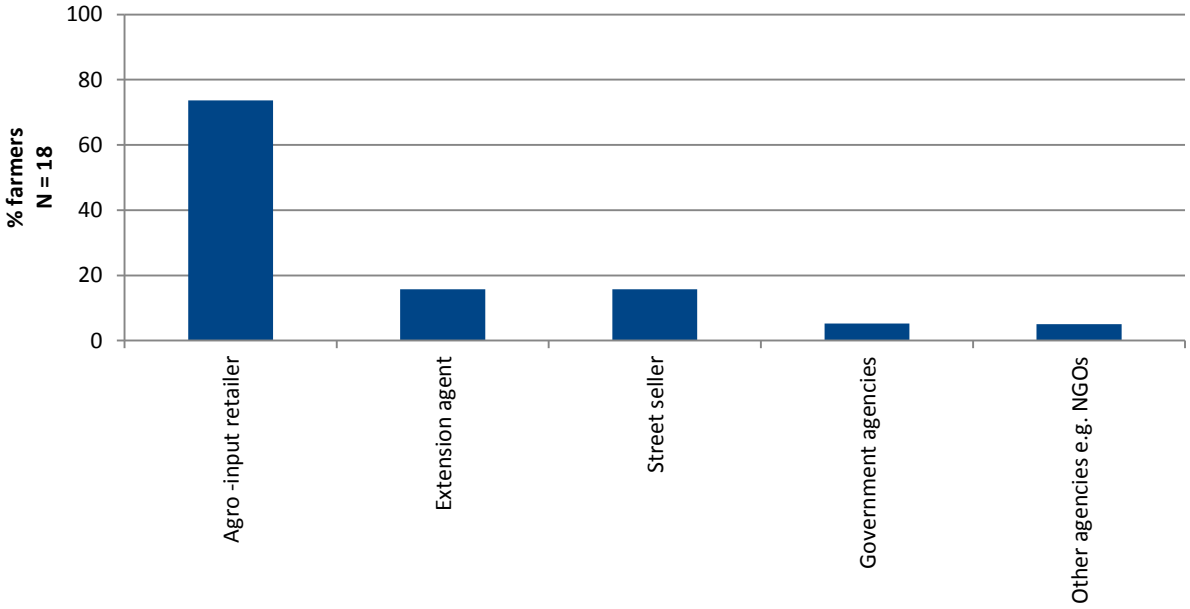

Figure 14 Farmers' sources of pesticides

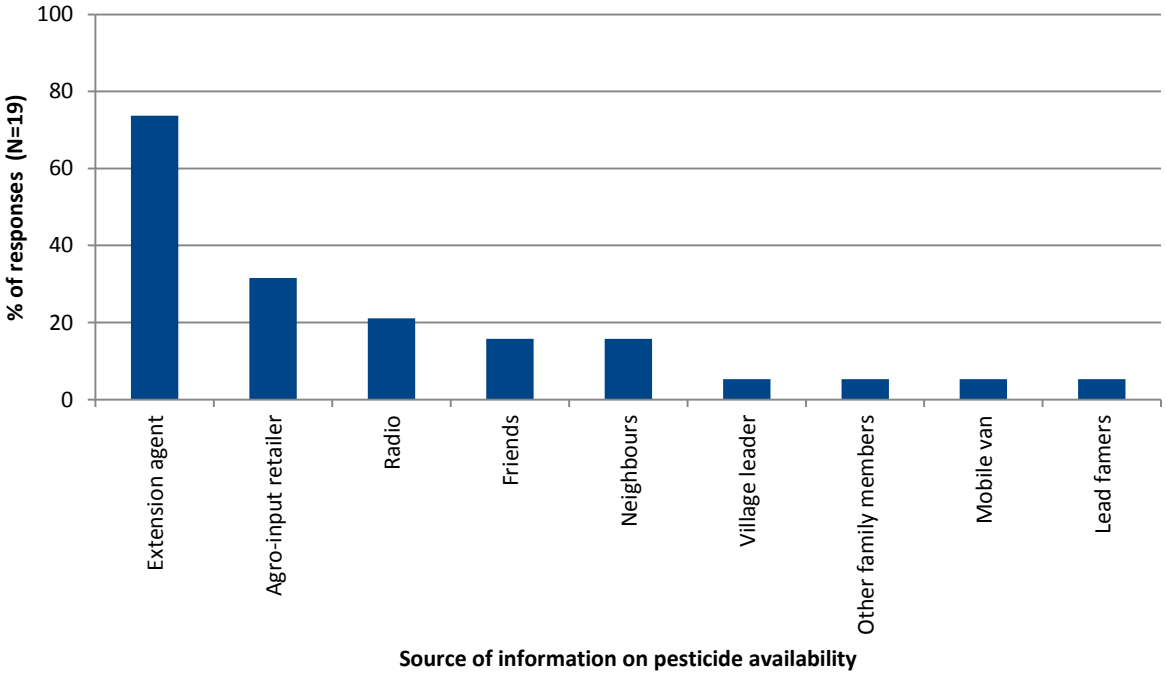

Figure 15 Farmers' sources of information on pesticide availability

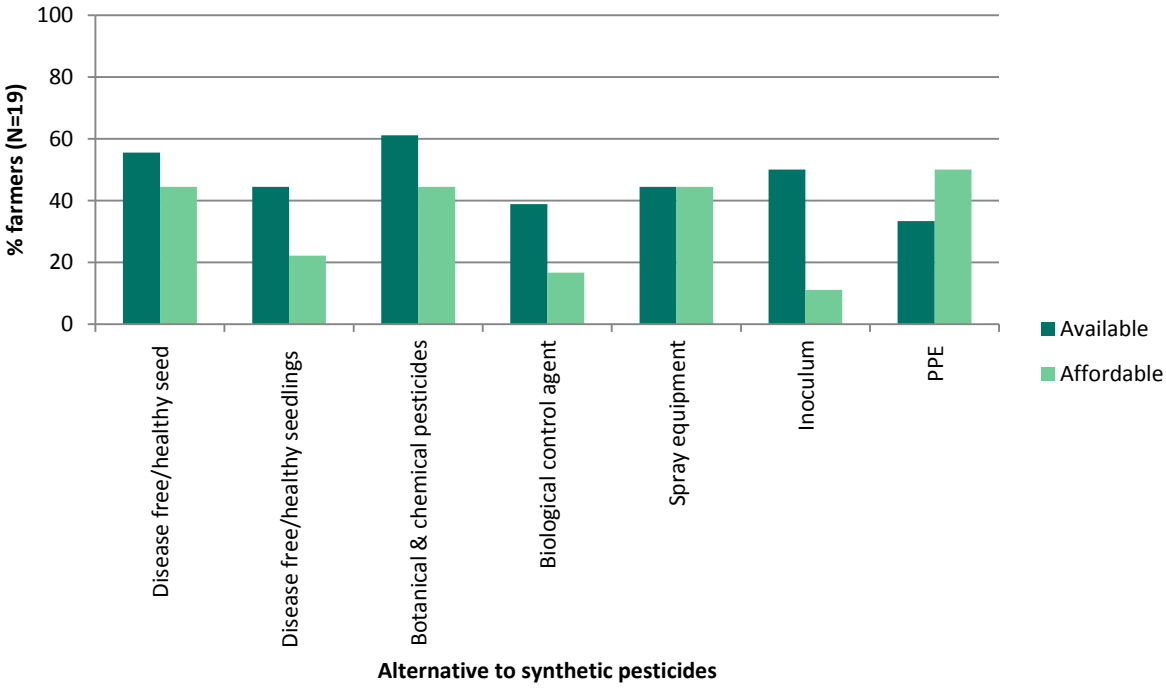

Figure 16 Farmers' views on the availability and affordability of inputs

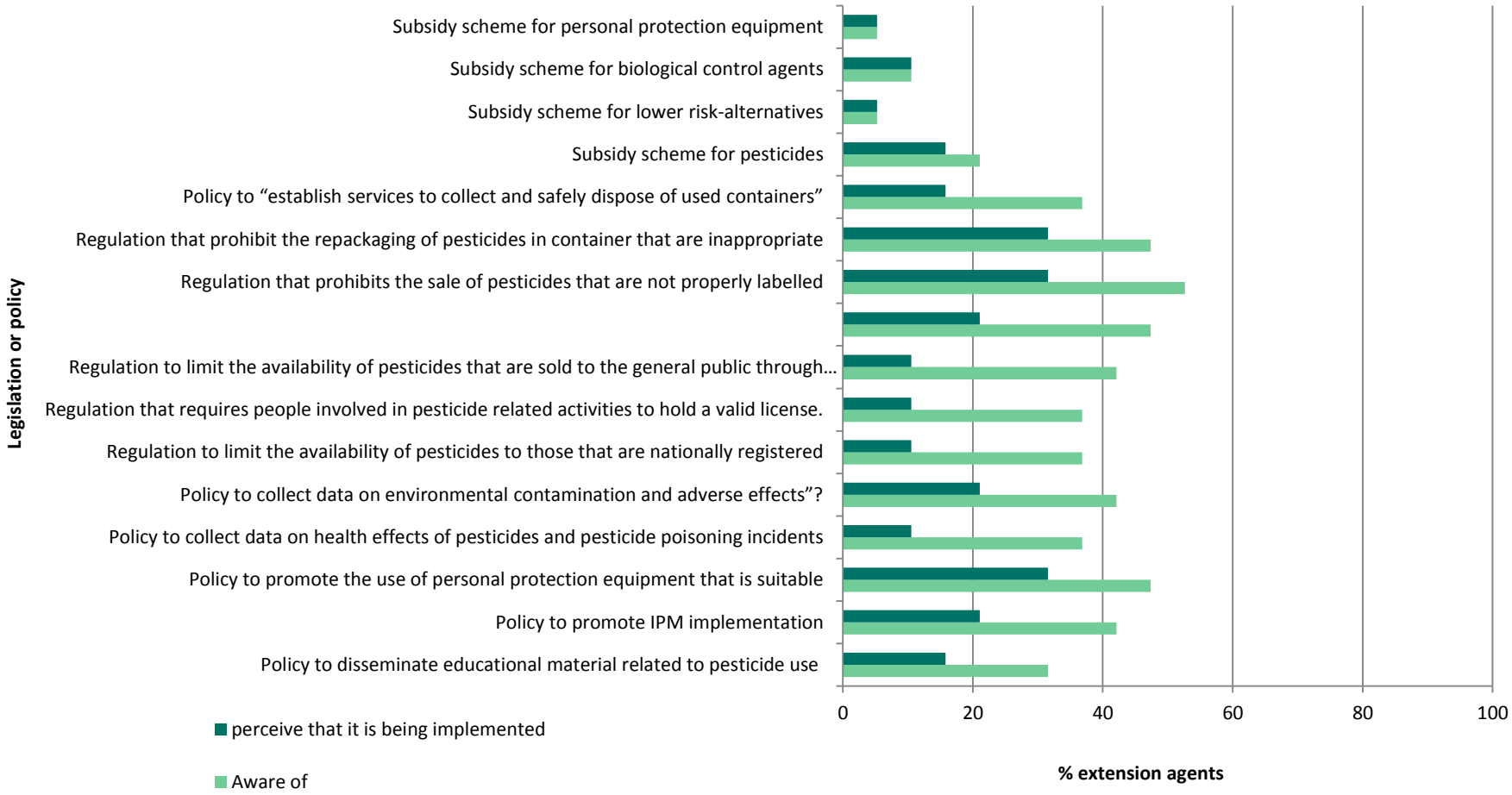

Figure 17 Extension agents' awareness of selected areas of Malawi legislation relating to pesticide management

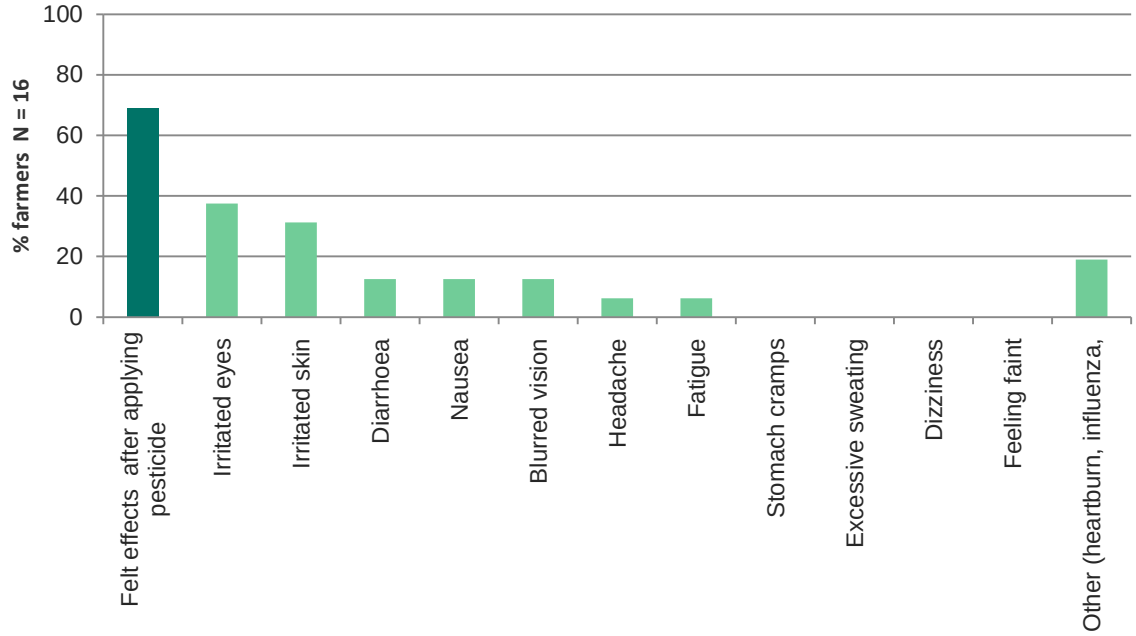

Figure 18 Farmers who stated they had experienced health effects after applying pesticides and type of effect

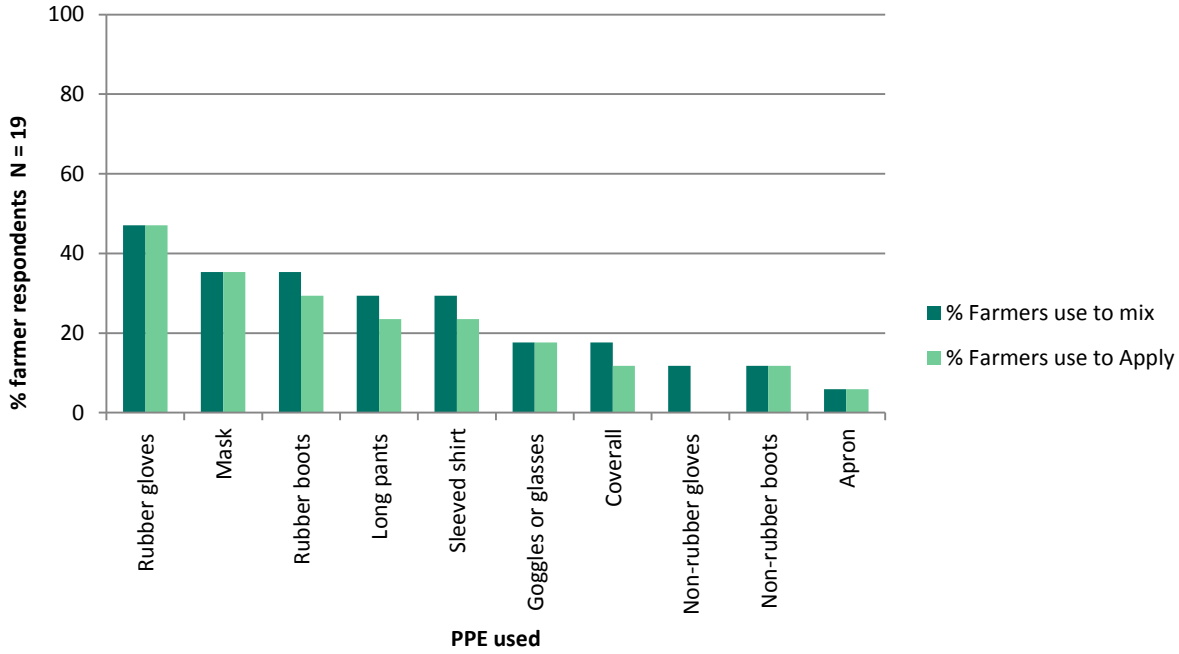

Figure 19 Use of PPE by farmers to mix and apply pesticides

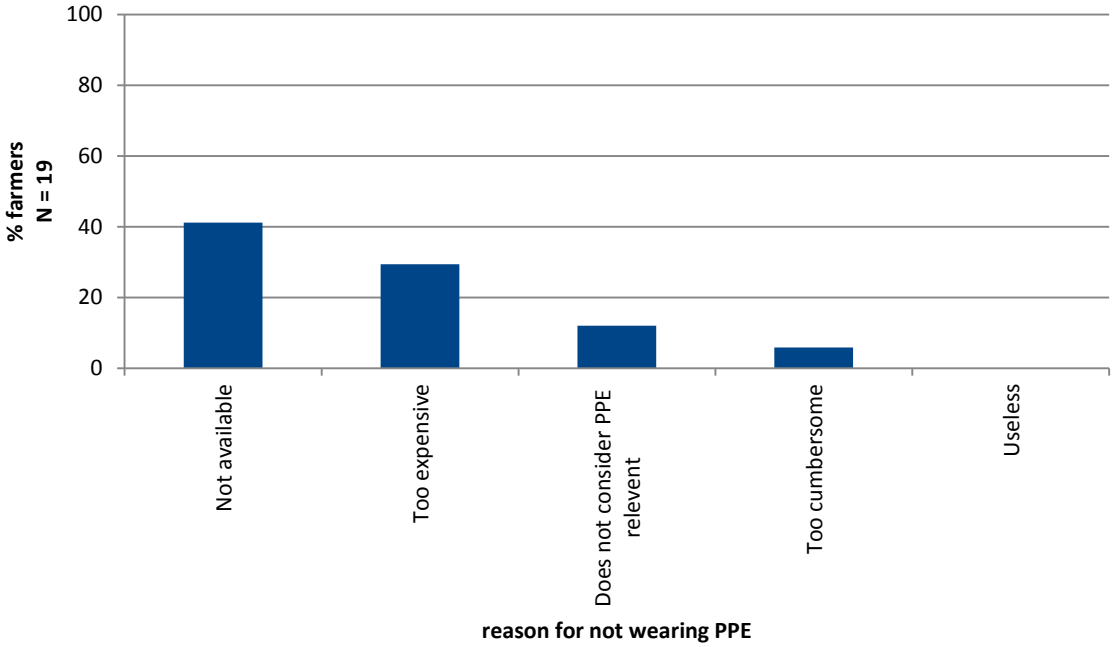

Figure 20 Reasons given by farmers for non-use of PPE

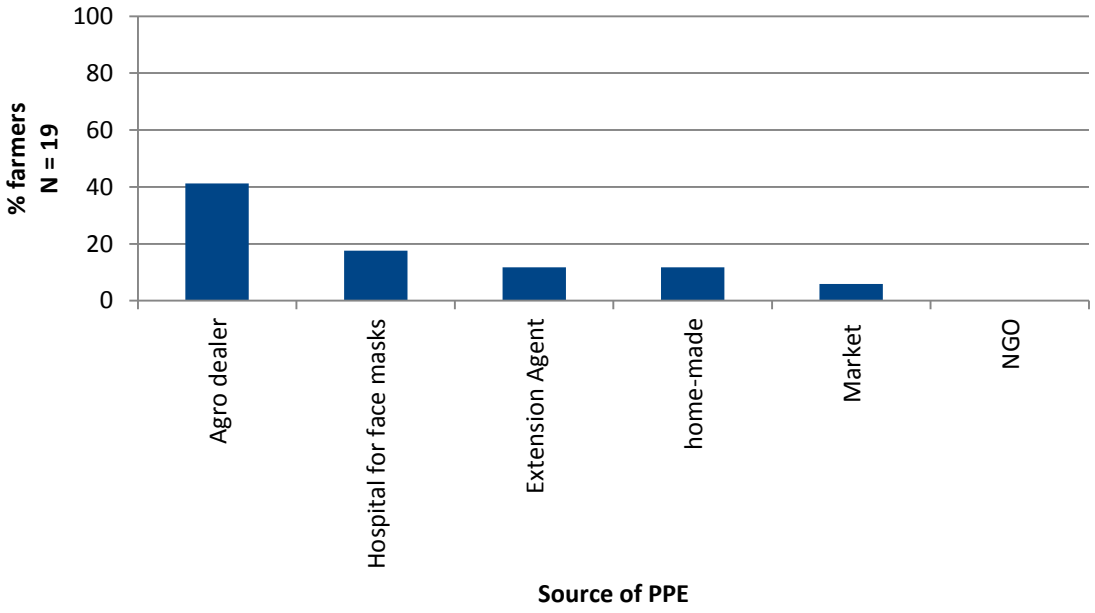

Figure 21 Farmers' sources of PPE

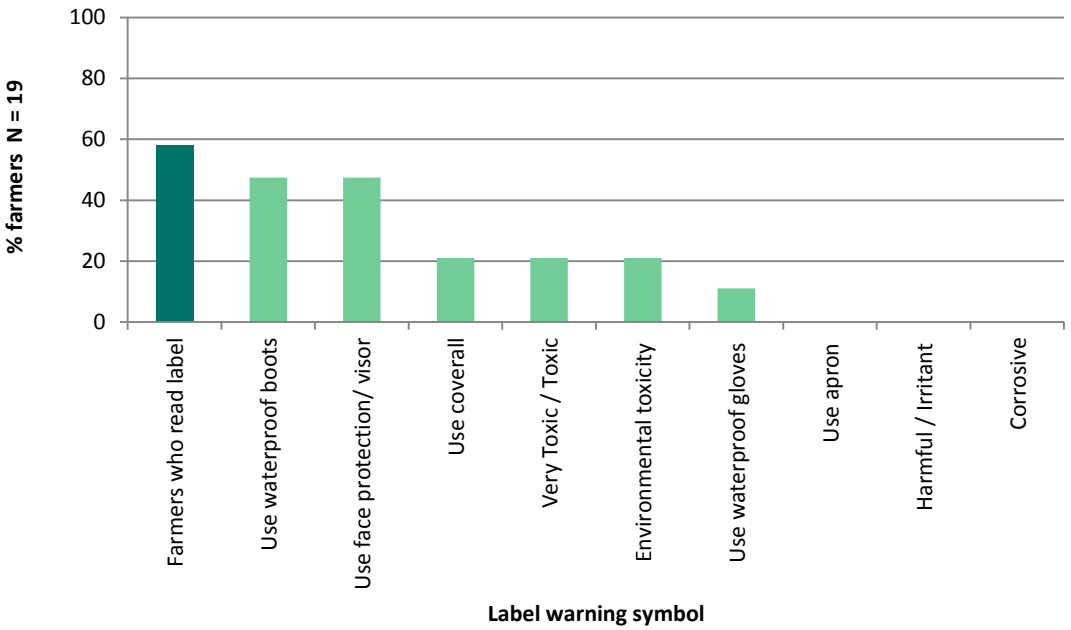

Figure 22 Farmers who read and can correctly identify warning symbols on pesticide labels

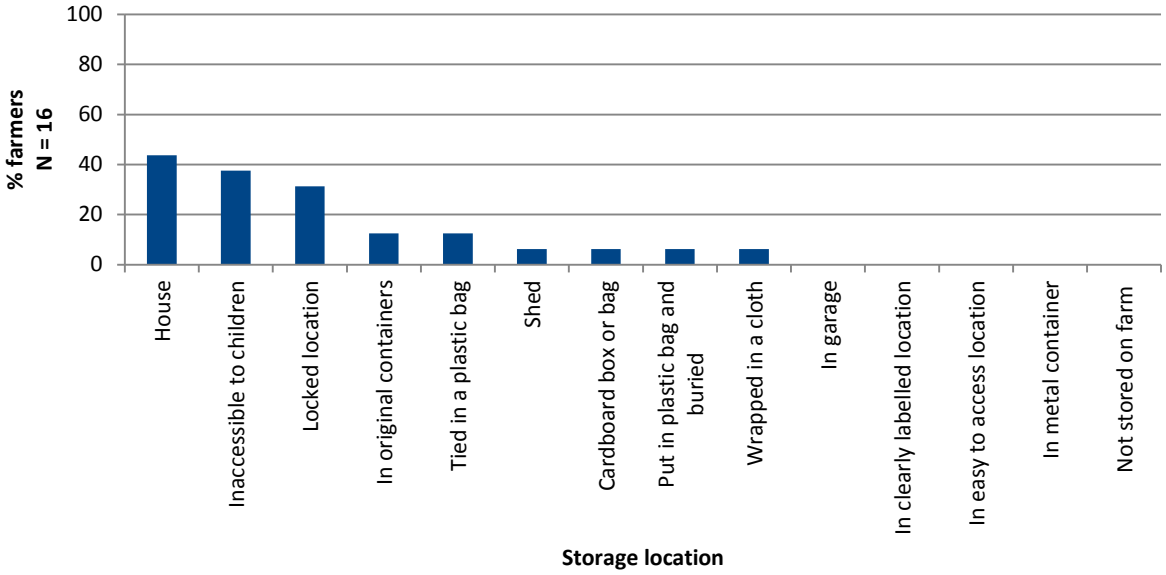

Figure 23 Locations used by farmers to store pesticides

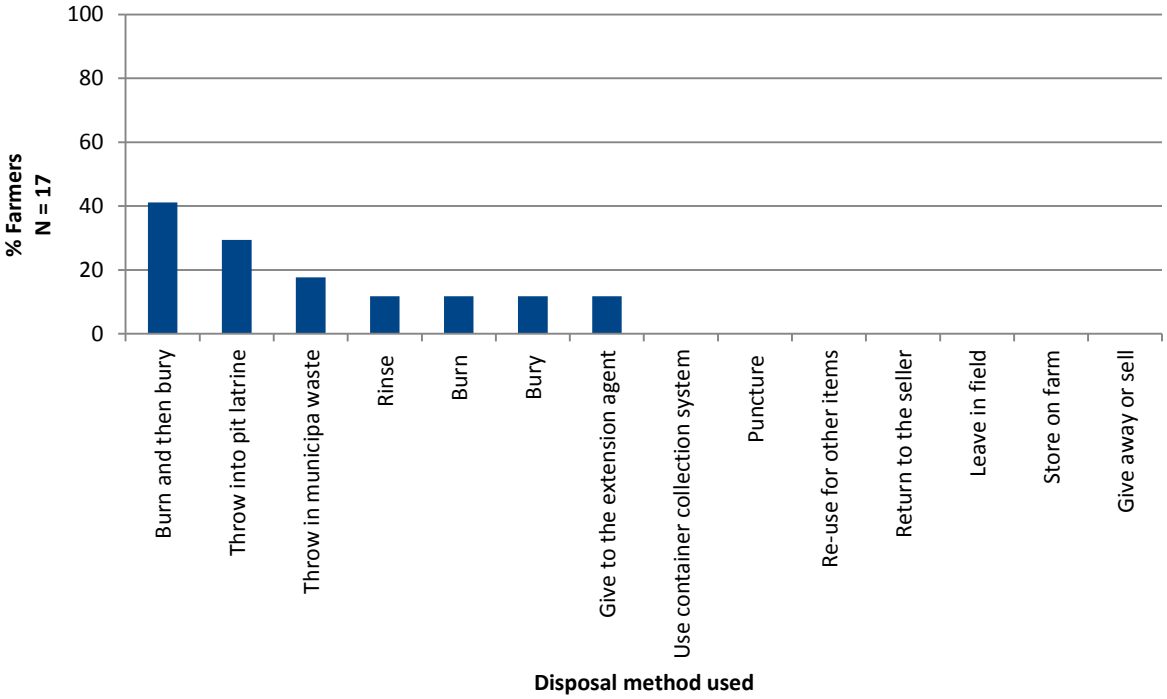

Figure 24 Farmers' practices for pesticide container disposal

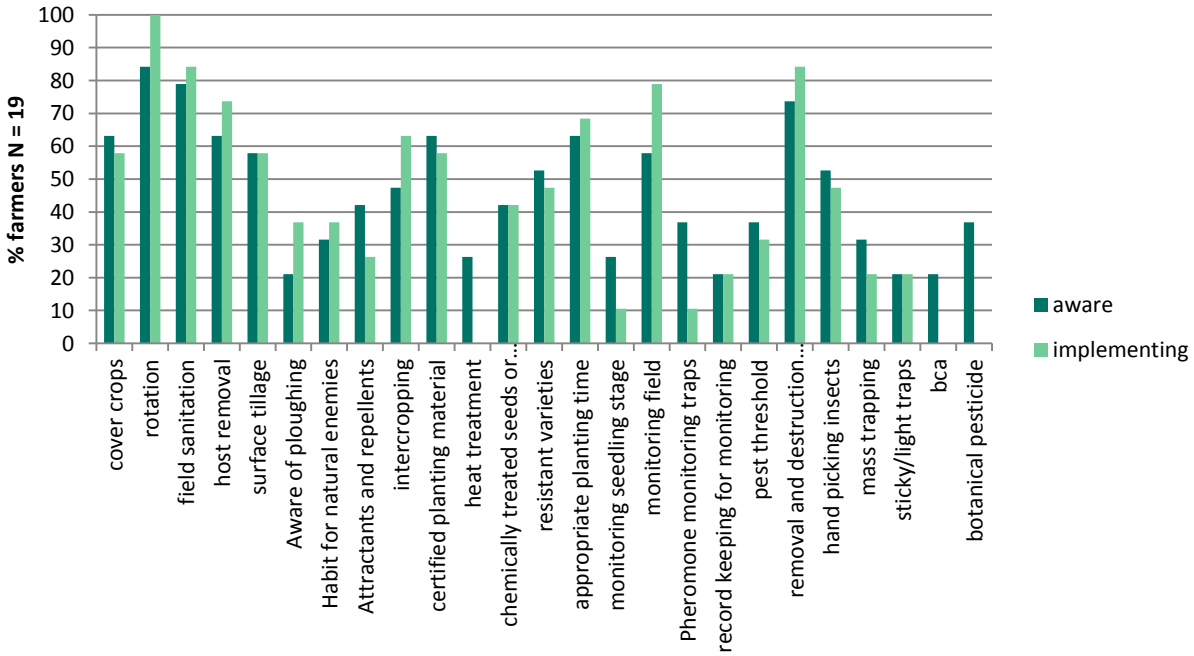

Figure 25 Farmers' awareness and implementation of various IPM practices

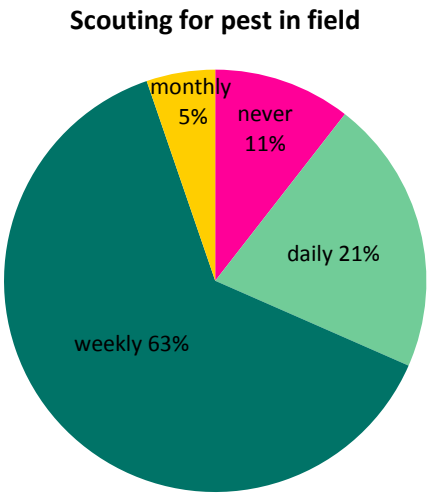

Figure 26 Frequency of scouting by farmers for field pests for soybean and groundnut

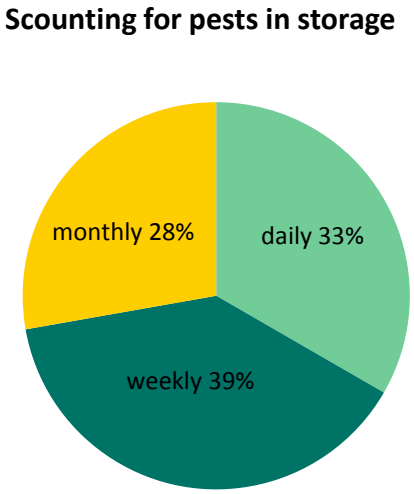

Figure 27 Frequency of scouting by farmers for pests in storage for soybean and groundnut

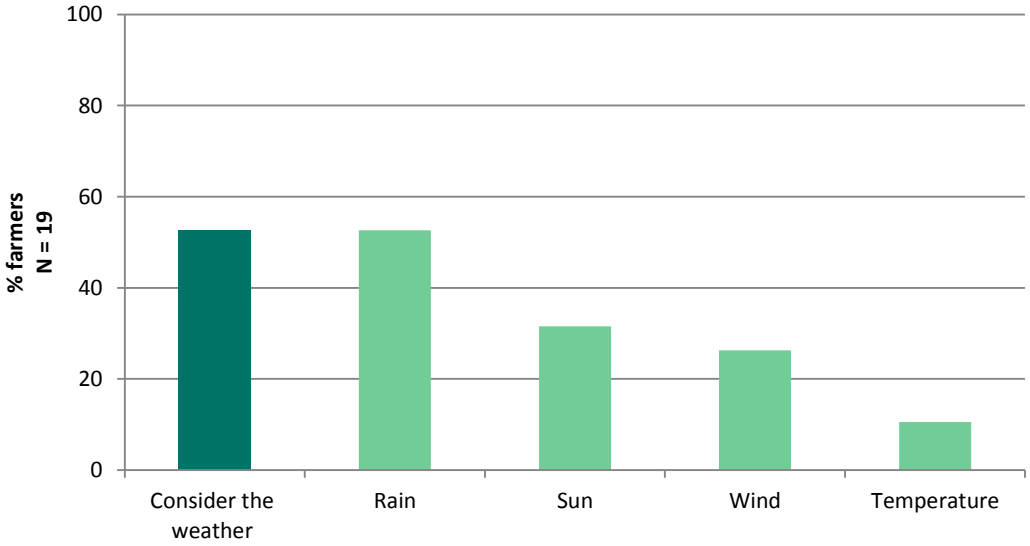

Figure 28 Farmers who consider weather before spraying

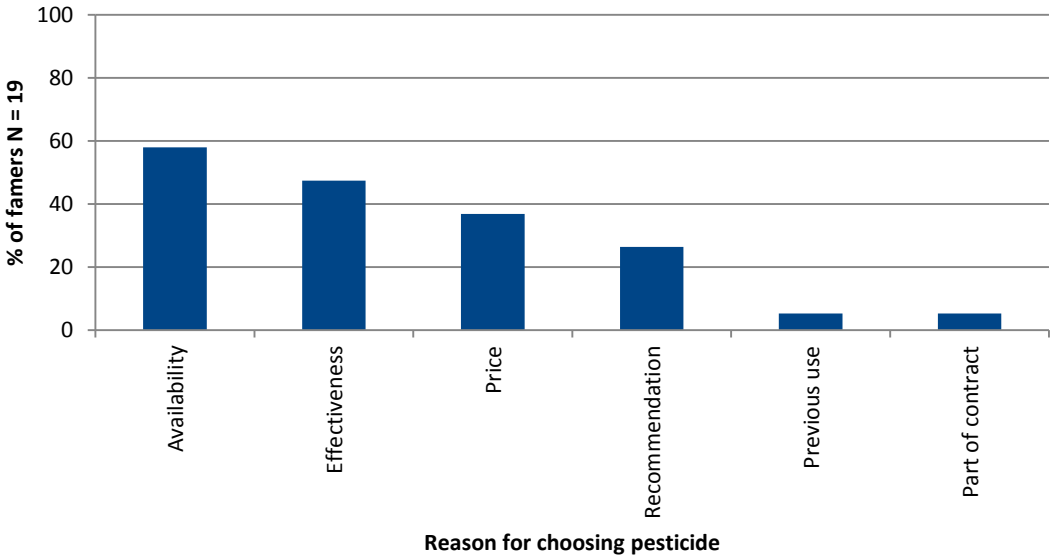

Figure 29 Farmers' reasons for choosing pesticides

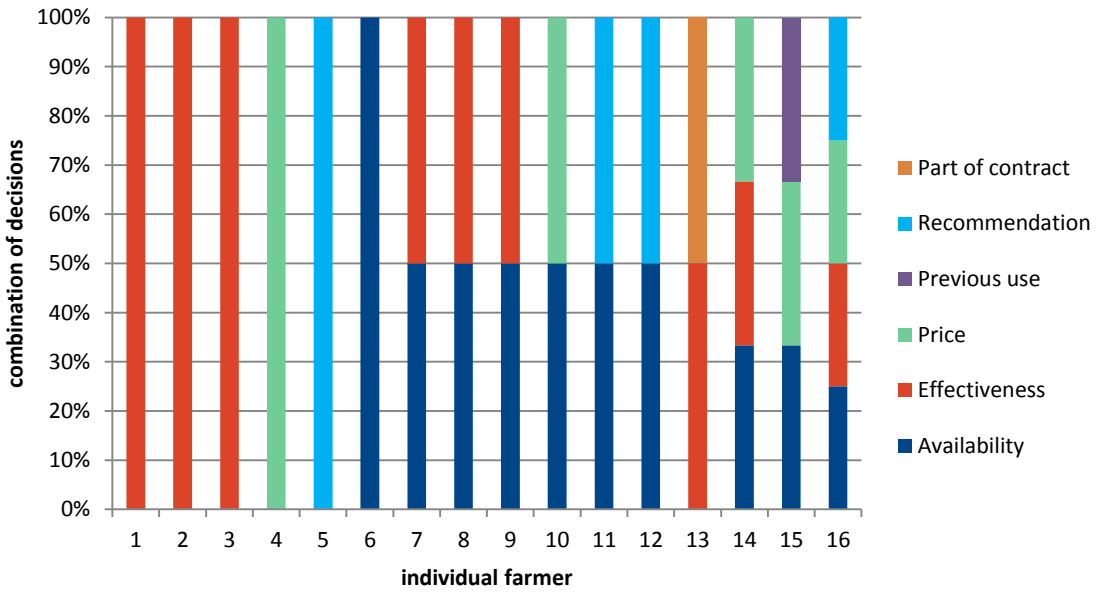

Figure 30 Factors individual farmers take into consideration when choosing a pesticide

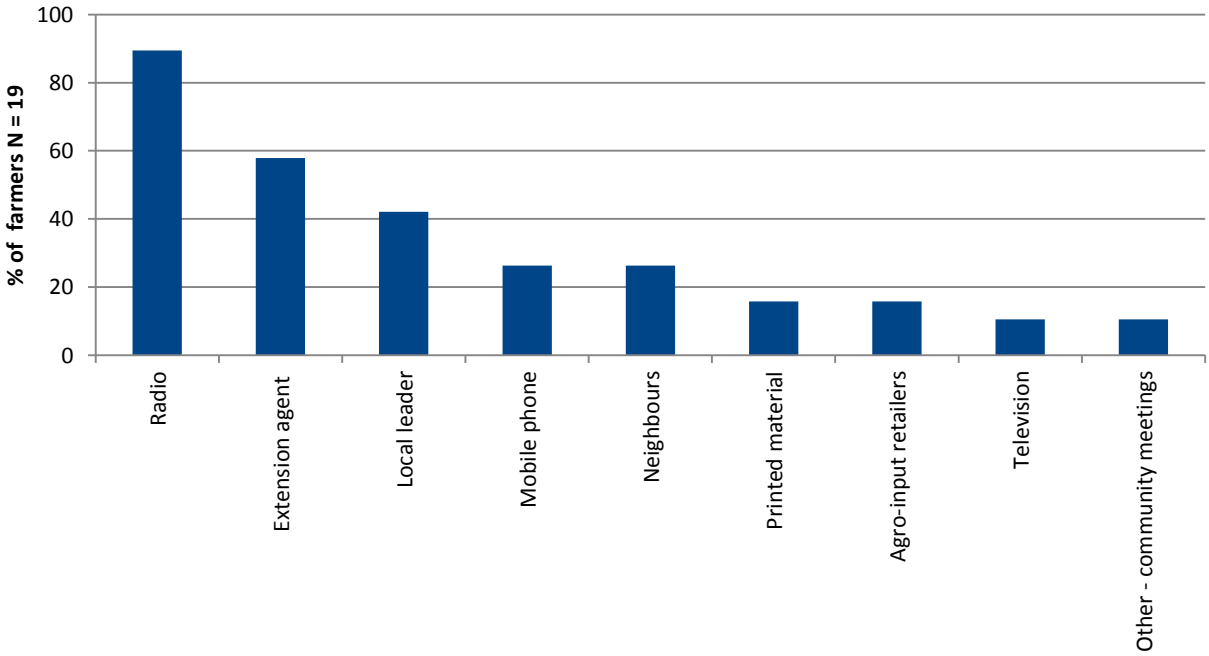

Figure 31 Farmers' sources of information on pest management

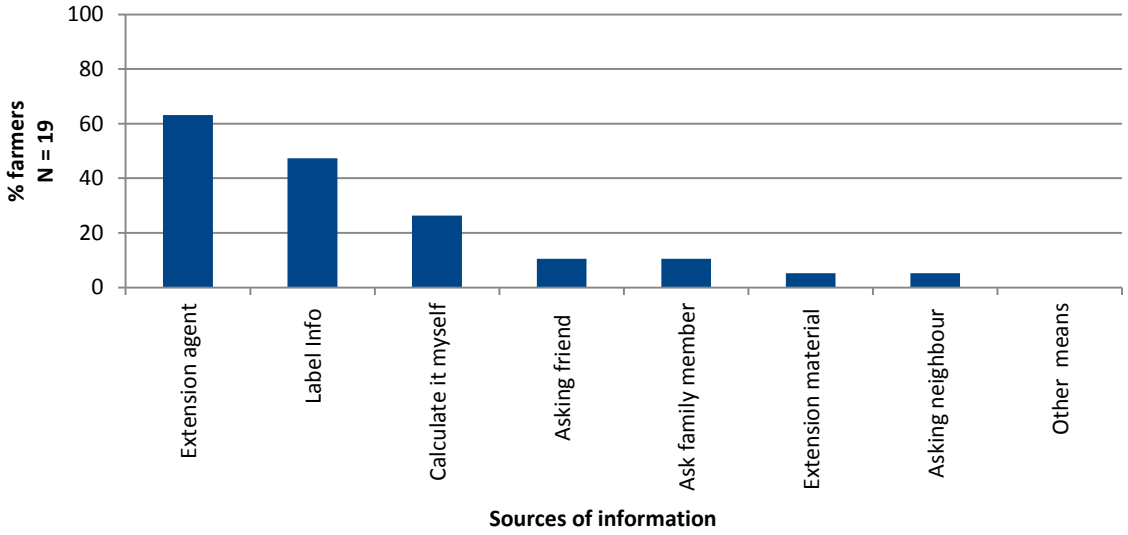

Figure 32 Farmers' sources of information on pesticide dosage

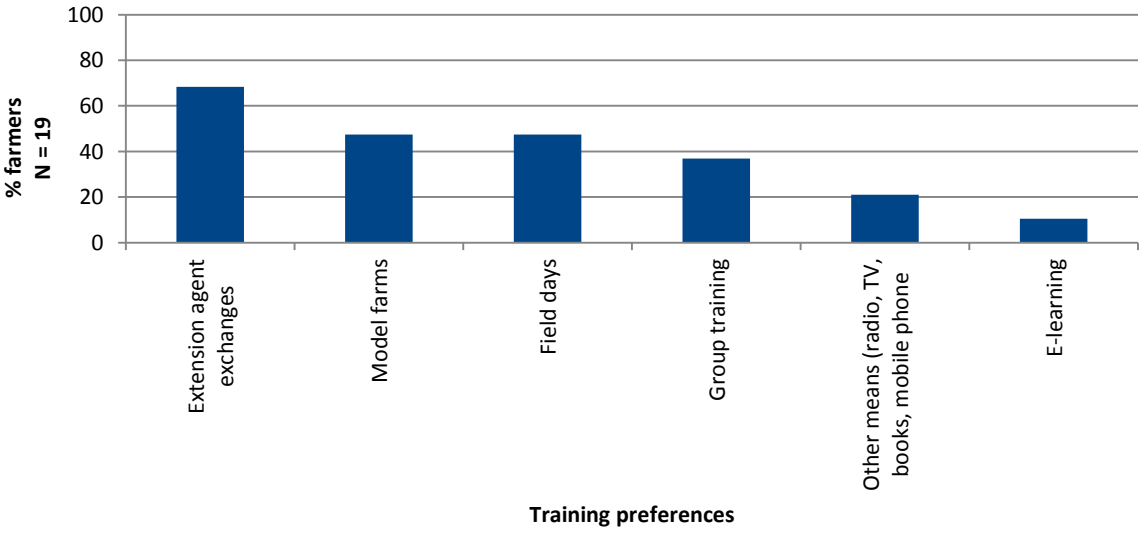

Figure 33 Farmers' preferred ways to receive training

Annex V State of science in pest management in soybean and groundnut

Soybean

Soybean Rust (*Phakopsora pachyrhizi*)

First reported in Malawi (CABI/EPPO 2015; Murithi et al. 2015)

Prevention

- Plant varieties that are tolerant to rust. TGx1740-2F, or “Tikolore”, is an early maturing variety, resistant to soybean rust (IITA 2015)
- Rotate soybeans with cereals such as maize to break disease life cycle
- Use plant spacing of no more than 20 plants / 10 metre row to aid field ventilation (CABI 2015)
- Plant soybeans early to enable the crop to grow before build-up of the disease in the environment and to enable the plant to exceed the most susceptible growth stage of disease at 4–6 leaf stage (CABI 2015)
- Avoid transferring disease via infected equipment and clothing from one field to another

Monitoring

- Scout weekly from two weeks after germination onwards. Look for rust spots on underside of leaves. Take action when: 1–3 plants per metre row are infected with spots during seedling stage. 2–4 leaves per 40–50 out of 100–150 plants show symptoms, between vegetative to early maturity stage (disease spreads seven days after infection) (CABI 2015)

Control – chemical

- Apply appropriate fungicides as protectants before incidence is over 5%.
  Effective fungicides include: chlorothalonil, strobirulins, triazoles. Rotation of fungicide AI is recommended by the Fungicide Resistance Action Committee's (FRAC) (Juliatti et al. 2017)
- Spray penetration into mid to lower canopy and complete plant coverage is essential to achieve rust control

Frogeye Leafspot (fungus: *Cercospora sojina*)

Prevention

- Plant clean, pathogen-free seed
- Use varieties tolerant to frogeye such as Solitaire and Soprano (Emmanuel and Gowda 2014)
- Rotating out of infected soybean for at least two years will help reduce the frogeye leaf spot risk
- Burying infected soybean residue will help reduce the inoculum in a field
- Plant resistant soybean varieties if fields had frogeye leafspot in recent years (Iowa State University 2017c)
- Plant certified seeds treated with a fungicide if the disease is expected or known from the area (Chisunka 2015)
- Plant early to ensure good crop stand (Chisunka 2015)
- Deep-ploughing of crop residues if infected (Chisunka 2015)
- Rotate soybean with maize and other cereals after a maximum of three years’ continuous cultivation with soybeans and in any case when fungal disease infection was experienced (Chisunka 2015)
- Disease survives and overwinters in soybean residue and seeds (UF 2001)

Monitoring

- Inspect the crop weekly from germination onwards (Chisunka 2015)

- Lesions start as tiny dark spots on leaves, but can be mistaken for other diseases. Later, lesions become circular to irregular with brown to reddish margins with a grey light centre (Chisunka 2015)
- Take action when 5–7 plants in 10 show early infection (Chisunka 2015)

Control – cultural
- Early tillage of soybean residues directly after harvest is effective in reducing the pathogen population (Iowa State University 2017b)
- At early infection remove infected leaves or branches and bury deep (Chisunka 2015)

Control – chemical
- Fungicide seed treatments can reduce the risk of infection. Spraying applications of fungicides after growth stage R1 can reduce disease severity. However, applications made at stage R3 are considered most effective fungicides include: DMI Triazoles MBC Thiophanates. Reference should be made to the Fungicide Resistance Action Committee (FRAC) guidelines for resistance management when using fungicides.
- Seed dressing with systemic fungicides
- Fungicides are mostly protective against new infections. They can usually not cure already infected plants. Fungicides are applied to soybeans at the R1–R4 growth stages and only if justified by thresholds and only during humid weather (Chisunka 2015)

Purple seed stain (fungus: *Cercospora kikuchii*)
The causal fungus for this disease is a very close relative of the one that causes frogeye leafspot (*Cercospora sojina*). Like frogeye leafspot, it is seed borne (Iowa State University 2017a).

Prevention
- Varieties resistant to Cercospora are available. However, there are no known sources of resistance for purple seed stain (Iowa State University 2017c)
- Soybean varieties vary in their response to Cercospora but a high level of resistance is not currently available. Nevertheless, many commercial varieties demonstrate at least some degree of tolerance (DuPont Pioneer Agronomy Sciences 2013)
- Tillage (to around 25cm depth) – Rapid decay of infested residue prevents a build-up of the pathogen and potentially greater infection in the next soybean crop (Chisunka 2015)
- In no-till or reduced-till systems, longer crop rotations and shredding soybean straw with a combine-mounted shredder are effective (NCSRP 2018)
- Crop rotation with non-legume crops like maize, sorghum, wheat and finger millet
- Field location and plant spacing that allow for good air flow (NCSRP 2018)
- Field location with good soil drainage (NCSRP 2018)
- Avoid overhead irrigation (Infonet-biovision 2017b)

Monitoring
- The best time to scout for this disease is R3 through R6 (Iowa State University 2017c).

Control
- Foliar fungicides are registered for Cercospora leaf blight. Application made during pod filling stages can reduce the incidence of purple seed stain (Iowa State University 2017c)
- Seed lots with a high percentage of infected seed can be treated with a seed treatment fungicide (NCSRP 2018)

Pod borer (*Helicoverpa)*

Prevention

Varieties: TGx1937-1F has vigorous seedling establishment. It is medium to late maturing and has high biomass production and nodulation. It is tolerant and/or resistant to pod borer (IITA 2015).

Natural enemies
The number of natural enemies or beneficial organisms varies with crop age, from crop to crop, region to region, and from season to season. The combined action of a number of beneficial species is often required to have a significant impact on potentially damaging helicoverpa populations. It is therefore desirable to conserve as many beneficial organisms as possible. Various natural enemies and beneficial organisms exist:

- Wasps of the families: Tachinidae, Ichneumonidae Braconidae and Trichogrammidae parasitize helicoverpa larvae (van den Berg et al 1988))
- Ants and spiders will also attack helicoverpa larvae (van den Berg et al 1988)
- Other predators such as wild birds and chickens also prey on larvae (Infonet Biovision 2017c)
- To conserve beneficial organisms, adopt the "go soft early" IPM strategy of only using biopesticides against caterpillars in vegetative crops

Intercropping
- Intercrop soybean with plants that are attractive to natural enemies (Infonet Biovision 2017c)

Monitoring
- Soybeans should be scouted for eggs and moths to pinpoint the start of infestations and increase the chance of successful control
- Inspect twice weekly from early budding until late podding (Infonet Biovision 2017c)
- Monitor crops at least weekly during the vegetative stage and twice weekly from flowering onwards (Infonet Biovision 2017c) African Bollworm http://www.infonet-biovision.org/PlantHealth/Pests/African-bollworm#simple-table-of-contents-6
- Look for helicoverpa eggs and for damage, including leaf chewing, terminal damage and damage to pods, and any natural enemies of helicoverpa (Infonet Biovision 2017c)
- Open vegetative terminals to check for small larvae feeding inside (Infonet Biovision 2017c)
- Beat sheet sampling is the preferred sampling method for medium to large helicoverpa larvae. Small larvae should be scouted for by opening vegetative terminals and flowers
- Inspect crops weekly during the vegetative stage – damage to vegetative terminals is often the first visual clue that helicoverpa larvae are present
- Soybeans should be scouted for eggs and moths to pinpoint the start of infestations and increase the chance of successful control
- Inspect twice weekly from early budding until late podding

Control
Thresholds
Approximate economic threshold of approximately 7–8 helicoverpa larvae per square metre in vegetative soybeans (Rogers & Brier, 2010).
Helicoverpa thresholds for podding soybeans currently range from 1–2 larvae/m^2 (depending on crop value and pesticide cost) (Rogers & Brier, 2010).

Biopesticides
- Prior to flowering, biopesticides, particularly helicoverpa nucleopolyhedrovirus (NPV) are recommended in preference to chemical insecticides. This helps conserve beneficial insects to

buffer crops against helicoverpa attack during the susceptible reproductive stages, and avoids flaring of other pests such as silverleaf whitefly and mites
- For best results, all ingestion type products require thorough plant coverage. For biopesticides, addition of Amino Feed or an equivalent product is recommended
- Selective insecticides are the preferred options to preserve beneficial organisms (IPM 2017)

Cultural control
- Where possible, avoid successive plantings of summer legumes
- Good agronomy and soil moisture are crucial as large, vigorously growing plants suffer less defoliation for a given helicoverpa population and have less risk of terminal damage
- In water-stressed crops, terminals are more attractive to larvae than wilted leaves. Vigorously growing plants with adequate available moisture are better able to replace damaged leaves and compensate for flower and pod damage

Groundnut

Groundnut Rust (Puccinia arachidis)

Prevention
- Use resistant cultivars (CABI 2017; Nigam 2014)
- Seed can be purchased from ICRISAT-Lilongwe, Department of Agricultural Research Services (DARs), and other reputable seed sources including Seed Traders Association of Malawi (STAM) (AICC 2015)
- ICRISAT has identified the following resistant cultivars or breeding lines: ICGs 1697, 2716, 4746, 7296, 7893, 7899, ICGV 87354, ICGV 92267 (Suvendu and Badigannavar 2015)
- There are varieties with different tolerance to rust that have been bred at ICRISAT. Since the mid-1980s, over 60 ICRISAT improved varieties have been released in 22 African countries, with some combining tolerance to rust and leaf spots. Check if these are available from local seed suppliers (Africa Soil Health 2014)
- Adjust times of sowing to avoid favourable environmental conditions for rust outbreak (20-25 °C, < 85% HR) (CABI 2017)
- Early planting at correct spacing controls the diseases (rosette, early and late leaf spots and rust) (AICC 2015)
- Eradicate volunteer groundnut plants since they can host the fungus (CABI 2017; Tsatsia and Jackson 2012; UF 2000; Africa Soil Health, 2014; Nigam 2014)
- Practice crop rotation with two cereal crops, one after the other (e.g. maize, sorghum, rice, sugarcane) (CABI 2017; Tsatsia and Jackson 2012; UF 2000; AICC 2015; Nigam 2014)
- Practice intercropping with cereals (maize, sorghum, pearl millet) (Nigam 2014)
- Control weeds as the disease may be favoured by the high humidity in a dense crop canopy (CABI 2017; AICC 2015)
- Ensure a sufficiently long break of at least four weeks between successive groundnut crops where the disease is present (CABI 2017)
- Plant new crops as far as possible from infested fields. If not possible, do not plant downwind of them (CABI 2017; Tsatsia and Jackson 2012)
- At an early stage of the disease development, remove affected plants and carry them away from the field in a plastic bag and burn the debris to prevent the spores from spreading. Plant debris can also be used as fodder (CABI 2017)

Monitoring
- Monitor twice a week for symptoms on leaves, starting 30 days after germination (CABI 2017)
- Look out for (CABI 2017):
    - Orange-coloured pustules appear primarily on the undersides of the leaves, and turn reddish-brown. Pustules may later appear on the upper surfaces opposing the pustules

of the lower surfaces. Rust-damaged leaves become necrotic and dry up, but remain attached to the plant. In severe damage, the crop has a burnt appearance

- Infected plants tend to mature 2–3 weeks earlier than those that remain healthy (CABI 2017)
- Symptoms may first be noticed within patches of a field (CABI 2017)
- Monitor carefully for rust development during favourable conditions (20–25 °C, free water on the leaf surface and high relative humidity) (CABI 2017)
- Consider applying control measures as soon as rust spots are seen, even if only on a few plants (CABI 2017; Nigam 2014)

Control – chemical

- Begin to spray as soon as rust spots are seen. Spray at regular intervals: 10–14 days until 14 days before harvest (Tsatsia and Jackson 2012; UF 2000; Africa Soil Health, 2014; Nigam 2014)
- In most cases, spraying should begin no later than 30–35 days after planting (Tsatsia and Jackson 2012; Nigam 2014)

Early leaf spot (Cercospora arachidicola)

Prevention

- The best way to manage the disease is by growing resistant varieties and by selecting those that produce yields early (Africa Soil Health 2015)
- Check whether these varieties and others are available locally (ICGV-SM 86715, ICGV 91225, ICGV-SM 93535) (Africa Soil Health 2015). Other options include: Bafia, A65, ICGM281 (Mandia et al. 2014)
- Early maturing cultivars (95–100 days) may be nearly mature before M. berkeleyi (Late leaf spot) can build up and thus escape major disease problems (McDonald 1985)
- Keep weeds under control to prevent high humidity within groundnut crops (Africa soil health 2015)
- Sow early, just before first rains, to reduce the severity of leaf spot (Kasunga et al. 2014)
- Temperatures of 25–30°C and 6–8 hours of high humidity are needed for infection and disease development (Africa Soil Health 2015)
- In Malawi an experiment showed that lesion intensity caused by *M.arachidis* infection was greatest in the December plantings compared with those in Jan/Feb (Farrell et al. 1968)
- Where possible, there should be a distinct break in time between successive groundnut crops. As the diseases are largely soil borne, rotation with other crops is very important (McDonald et al. 1985)
- Rotate with cereals or pasture. Break for 3–4 years between successive bean crops (Kasunga et al. 2014)
- Intercrop with millet, maize, cotton, sorghum and soy bean to reduce spread of spores (Moses et al. 2016). For example, five rows of groundnuts with two rows of maize (Mandia et al. 2014)
- Plant debris should be removed from the field after harvest, burned in situ, fed to animals, or deep-buried (McDonald et al. 1985)
- Volunteer groundnut plants and 'ground-keepers' should be eradicated (McDonald et al. 1985)
- Avoid mechanical damage to plant stems and roots as fungus can enter plants though wounds (Mandia et al. 2014)

Monitoring

- Inspect the crop at least once a week (Africa Soil Health, 2015)
- Normal stages of attack are the vegetative, flowering and pod filling stages (Kasunga et al. 2014)
- Action should be taken immediately if 2 to 3 spots are observed on several plants per field (Kasunga et al. 2014)

Look out for:

- Oval spots on leaves, particularly the older leaves (this is the first symptom that appears, usually 45–60 days after sowing) (CABI, 2016)
- Early leaf spots are reddish-brown on the upper surface surrounded by a yellow halo and brown on the lower leaf surface (CABI, 2016)
- Late leaf spots are dark brown to black, usually with a smaller halo or without one (CABI, 2016)
- Dense spores form ring patterns on the undersurface (CABI, 2016)
- Spots also appear on the stems and petioles (CABI, 2016)
- Leaf and pod loss (CABI, 2016)

Control – cultural

- Before sowing, plan to plant the new crops as far away as possible from older ones, especially if they are infected by leaf spots (Africa Soil Health, 2015)
- If it is not possible to avoid planting near old crops, do not plant downwind from them, otherwise spores will easily spread to the new crop in wind and rain (Africa Soil Health, 2015)
- If plants are infected, remove and bury deep in the soil, burn or feed to animals. Do not compost (CABI, 2016; Mandia et al. 2014)

Control – chemical

- If growing the crop for sale, and fungicides are affordable and available, spray with as soon as leaf spots are seen, even if they appear only on one or a few plants (Africa Soil Health, 2015)
- To obtain effective control of leaf spots, fungicides are first applied before or just after the appearance of symptoms

Helicoverpa (*H. armigera*)

Prevention

- Use insect resistant or tolerant varieties (DGR 2015)
- Deep tillage (5–10cm) to reduce the overwintering pupae as tillage damages pupae, expose them to sunlight and natural enemies (CABI 2015; Africa Soil Health Consortium 2014)
- Remove and destroy crop residues immediately after harvest (Africa Soil Health Consortium 2014)
- Intercrop with maize or sorghum that enhance natural enemy populations and thus reduce pest infestation levels (van denBerg 1993)
- Intercropping with flowering sunflower, flowering sorghum and maize may distract ovipositing moths (van den Berg 1993)
- Increasing crop diversity often reduces pest infestation (Berg 1993)
- Crop rotation with sorghum, maize, pearl millet and sugarcane minimizes the infestation (Jat and Tetarwal 2013)
- Organic manure induces the production of phenols and tannins in groundnut plant, which plays an important role in groundnut insect pest management (Rao 2013)
- Reductions in the use of hazardous insecticides and early season substitution of broad spectrum insecticides with softer biological alternatives such as Bt, NPV and botanical insecticides may permit early establishment of natural enemies and contribute to pest suppression (Cherry et al. 2003)
- It is easy for cotton bollworm to develop resistance to insecticides, meaning it is essential to switch between pesticide groups to avoid resistance development (CABI 2015)

Monitoring

- Use light traps to attract and monitor the adults (DGR 2015; CABI 2015) or pheromone traps (DGR 2015)

- Set up pheromone traps at 5/ha to monitor helicoverpa armigera / Spodoptera litura (NCIPM 2014)

Economic thresholds – helicoverpa ground nut
- Four larvae / m^2 of groundnut plants (Brier et al 2014)
- Two larvae/plant or 20–25% defoliation at 40 days (NCIPM 2014)

Control – biological
- 119 parasitoids have been recorded in southern Africa (Botswana, South Africa, Zimbabwe), 59 diptera larval/pupal parasitoids, 26 hymenoptera egg parasitoids, and 34 hymenoptera parasitoids (van den Berg 1993)
- Trichogrammatoidea spp egg parasitoids and *Linnaemya longirostris* (Macquart), a late-larval parasitoid, are the most common parasitoid species, but their impact is rather low (van den Berg 1993)
- Conserve the natural bio control population of spiders, long horned grasshoppers, praying mantis, robar fly, ants, green lace wing, damsel flies/dragon flies, flower bugs, shield bugs, lady bird beetles, ground beetle, predatory cricket, earwig, braconids, trichogrammatids, NPV, and green muscular fungus (Jat and Tetarwal 2013)
- Conserve natural enemies like coccinellids, spiders, hymenopteran and dipteran parasitoids (DGR 2015)
- Use high frequency oscillation pest-killing lamp traps in the field to kill the adults; two lamps/mu (CABI 2015)
- For small plots, it is possible to hand pick and destroy the eggs and young caterpillars (Africa Soil Health Consortium 2014)

Biopesticides
- Neem extracts, made from neem seeds and leaves, and neem oil are also reported to be effective against the larvae and eggs (Africa Soil Health Consortium 2014; DGR 2015)
- Apply H-NPV or B.t (Bacillus thuringiensis) when large number of eggs and early instar larvae are noticed (DGR 2015; Jat and Tetarwal, 2013; NCIPM 2014)
- Two microbial pesticides, *Bacillus thuringiensis* subspecies kurstaki and *Bt aizawai*, and Helicoverpa armigera nuclear polyhedrosis virus can be used to control the young caterpillars with minimal harm to natural enemies (Africa Soil Health Consortium 2014)

Control – chemical
- The decision to use a pesticide needs to be based on the severity of the problem, the presence of natural enemies and the economic value of the crop (Africa Soil Health Consortium 2014)
- The cotton bollworm has developed resistance to several pesticides, notably synthetic pyrethroids (Africa Soil Health Consortium 2014)

Groundnut Aphid (*Aphis craccivora*)

Sap removal and physiological reactions of plants to aphid feeding cause direct damage.

Prevention
- Use of varieties with resistance to insect pests (NCIPM 2014)
- Sow early in the rainy season to take advantage of the low aphid population (ICRISAT 2013; Mansaray et al. 2013; Haraman 2013; Naidu et al. 1999)
- Plant at correct plant spacing to reduce disease spread, since aphids prefer landing where plants are widely spaced (Mansaray et al. 2013)
- Do not grow groundnut in the same soil for more than one year; rotate with maize, millet, sorghum or other cereals (Mansaray et al. 2013)

- Intercrop with beans, maize, millet, sorghum or other cereals (Mansaray et al. 2013; Nigam 2014)
- Varieties which are densely hairy and with stiff leaves that deter aphids (Jasani 2009)
- Handpicking and destruction of various insect stages and the affected plant parts (Jasani 2009)

Monitoring
- Examine the undersides of the leaves and the bud areas for groups or colonies of aphids (Infonet-biovision 2017a)
- Yellow traps are useful for monitoring the arrival of winged aphids to the crop (Infonet-biovision 2017a)
- Look for shiny black or dark brown aphids, about 2mm in length, and for the sooty mould that grows on the honeydew they produce. Aphids prefer feeding on young and soft tissue, including leaves, flowers and pegs (Mansaray et al. 2013)
- Use yellow sticky traps to attract and monitor winged aphids. Use at least three stickers per acre (Mansaray et al. 2013)
- Consider controlling aphids as soon as you see them, or when you see the rosette virus symptoms (Mansaray et al. 2013)

Economic threshold level
- 5–10 aphids/terminal at seedling stage (NCIPM 2014)

Biopesticides
- Use trap crop. Grow flowering plants (carrots, sunflower, marigold, buckwheat, dill, maize, etc.) on the internal bunds inside the field (NCIPM 2014; DGR 2015)
- Release aphids' natural enemies such as parasitic wasps (e.g. *Entomophthora* sp.) or predators (e.g. syrphid larvae or coccinellid) (Mansaray et al. 2013; NCIPM 2014; Jasani 2009)
- The most important aphid predators are predatory bugs (e.g. Anthocoridae, Miridae, Nabidae), carabid beetles (Carabidae), soldier beetles (Cantharidae), predatory gall midges (Cecidomyiidae), lacewings (Chrysopidae), ladybird beetles (Coccinellidae) and hoverflies (Syrphidae) (Infonet-biovision 2017a)
- To control aphids, mix 1 tablespoon of dishwashing soap with 4 litres of water. Spray early in the morning or late afternoon, 2–3 times at 3–4 day intervals (Mansaray et al. 2013)
- Dust ash evenly onto infested parts of the plant (Mansaray et al. 2013)
- Spray using Azadirachtin (Neem) based products such as Achook at a rate of 20 ml/20 L of water (Mansaray et al. 2013)
- Seed treatment with *Trichoderma viride* at 4 gm/kg seed (Jasani 2009)
- Apply NSKE 5% (neem seed kernel extract) to control sucking pests (Jasani 2009)
- Formulations of neem (*Azadirachta indica*) have been shown to be effective against *A. craccivora* and can be used as an alternative to chemical insecticides (Baidoo et al. 2012; Chaudhari et al. 2015)

Groundnut rosette virus

The main vector for groundnut rosette virus is the groundnut aphid (*Aphis craccivora*).

Prevention
- Plant resistant varieties such as "Nsinjilo", "Chalimbana 2005", "Chitala" and "Baka" (Mansaray et al. 2013; Haraman 2013)
- Resistance to groundnut rosette disease ICGV-SM 90704 (a medium-duration Virginia bunch type) and ICGs 12988 and 12991 (short-duration, Spanish type) have agronomic characteristics that are desired by Malawian farmers (Naidu et al. 1999)

- Control the aphids in the field (Mansaray et al. 2013)
- Destroy sources of the virus, e.g. remove infected plants, volunteer plants or other plants that harbour aphids (ICRISAT 2013; Mansaray et al. 2013; Haraman 2013; Nigam 2014)
- Sow early in the rainy season to take advantage of the low aphid population (ICRISAT 2013; Mansaray et al. 2013; Haraman 2013; Nigam 2014; Naidu et al. 1999)
- Plant at correct plant spacing as aphids prefer landing where plants are widely spaced (Mansaray et al. 2013)
- Do not grow groundnut in the same soil for more than one year; rotate with maize, millet, sorghum or other cereals. This hampers the spread of the aphid vector (Mansaray et al. 2013)
- Intercrop with beans, maize, millet, sorghum or other cereals (Mansaray et al. 2013; Nigam 2014)
- Intercropping and border cropping act as barrier to the vector (Nigam 2014)

Monitoring

- Look for symptoms and aphid vectors regularly, starting five days after germination to 50% flowering. Symptoms vary depending on the infection (Mansaray et al. 2013):
    - Leaves: yellowing, mottling and mosaic, smaller leaves, green older leaves. Younger leaves are only slightly mottled. Older leaves can be chlorotic with green veins and show downward rolling of leaf margins
    - Branches: stunting, and bushy appearance of young plants while in older plants a few branches are affected
    - Shoots: distortion
    - Pods: none produced
- Look for shiny black or dark brown aphids, about 2mm in length, and for the sooty mould that grows on the honeydew they produce. Aphids prefer feeding on young and soft tissue, including leaves, flowers and pegs (Mansaray et al. 2013)
- Use yellow sticky traps to attract and monitor winged aphids. Use at least three stickers per acre (Mansaray et al. 2013)
- Consider controlling aphids as soon as you see them, or when you see the virus symptom (Mansaray et al. 2013)

Control – chemical

- Seed treatment with imidacloprid offers protection against sucking pests

Varieties available

TGx1740-2F, or “Tikolore”, is an early maturing variety, tolerant of drought and resistant to a number of diseases and pests such as bacterial pustules, soybean rust, soybean mosaic virus, frogeye leaf spot, Witch’s broom, purple seed stain, common soybean fly, thrips, pod sucking bug, and the pod borer (IITA 2015).

TGx1937-1F or “Kafue” has vigorous seedling establishment. It is medium to late maturing and has high biomass production and nodulation. It is tolerant and/or resistant to purple seed stain, common soybean fly, thrips, pod sucking bug, and the pod borer (IITA 2015).

Annex VI Advisory service characteristics and the advice they provide – Data from extension agent interviews

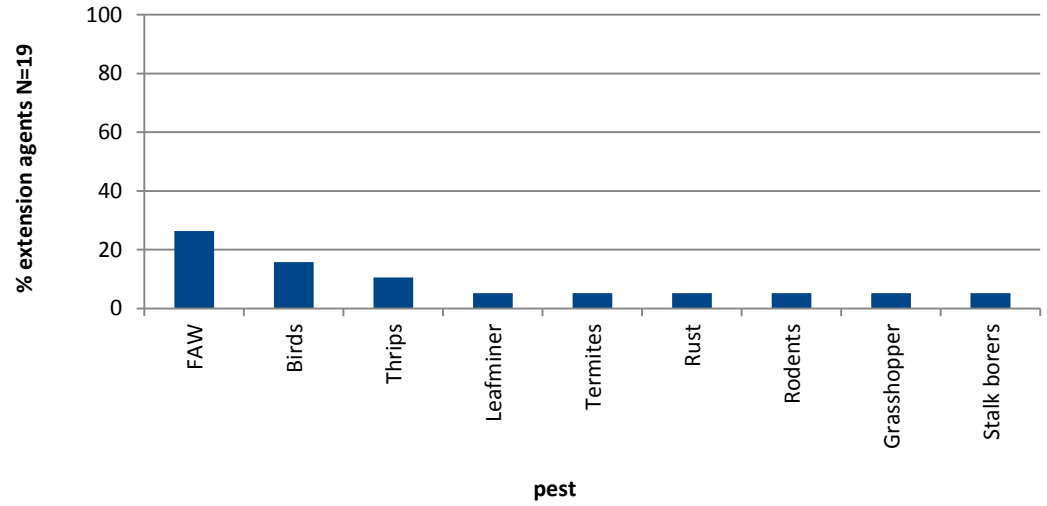

Figure 34 Soybean field pests mentioned by extension agents

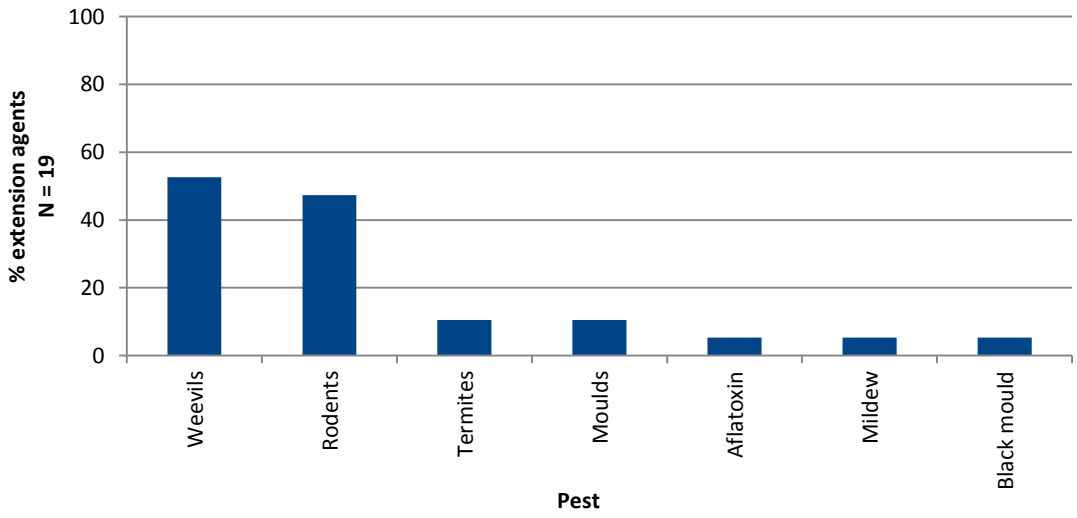

Figure 35 Soybean post-harvest pests mentioned by extension agents

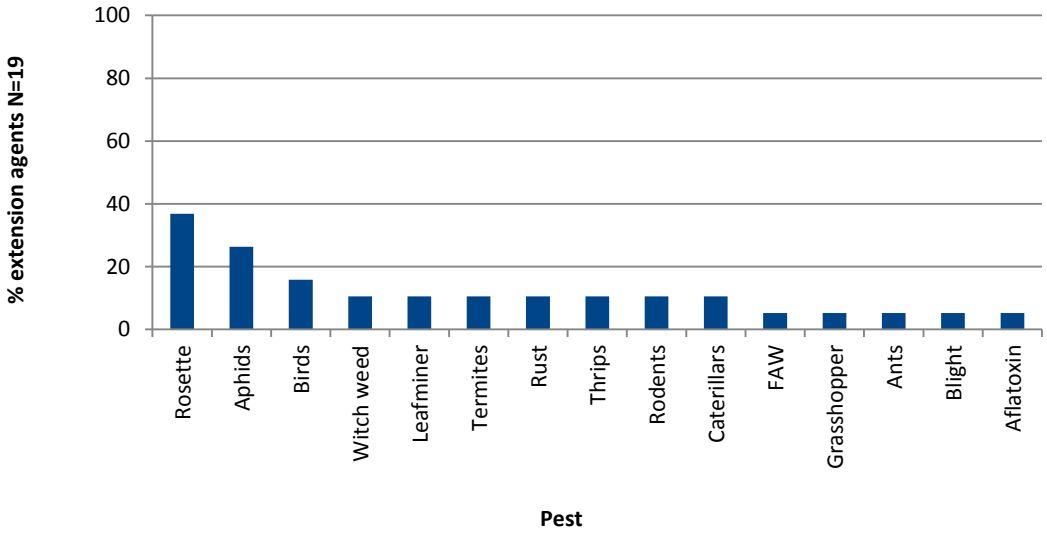

Figure 36 Groundnut field pests and diseases mentioned by extension agents

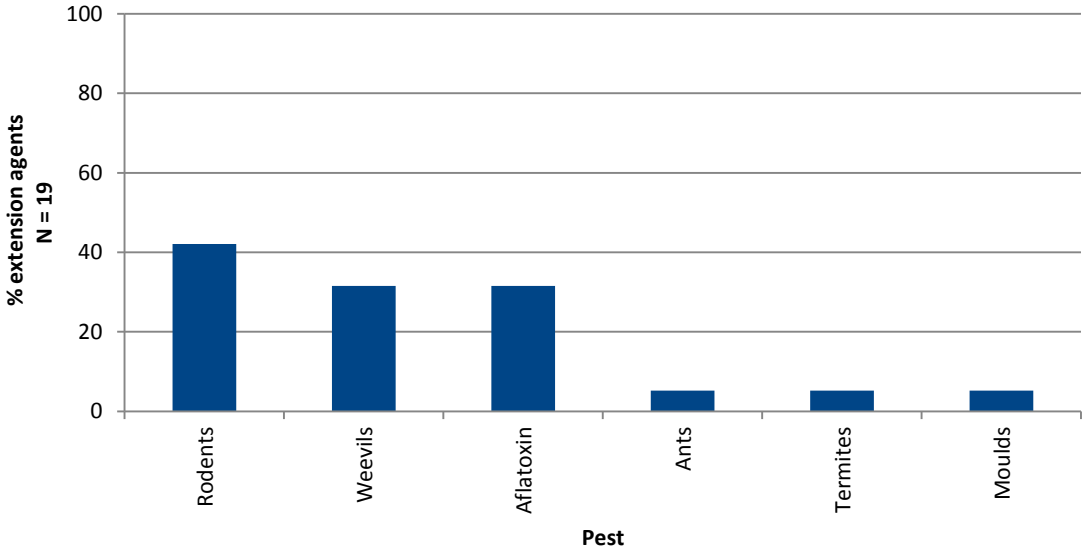

Figure 37 Groundnut post-harvest pest and diseases mentioned by extension agents

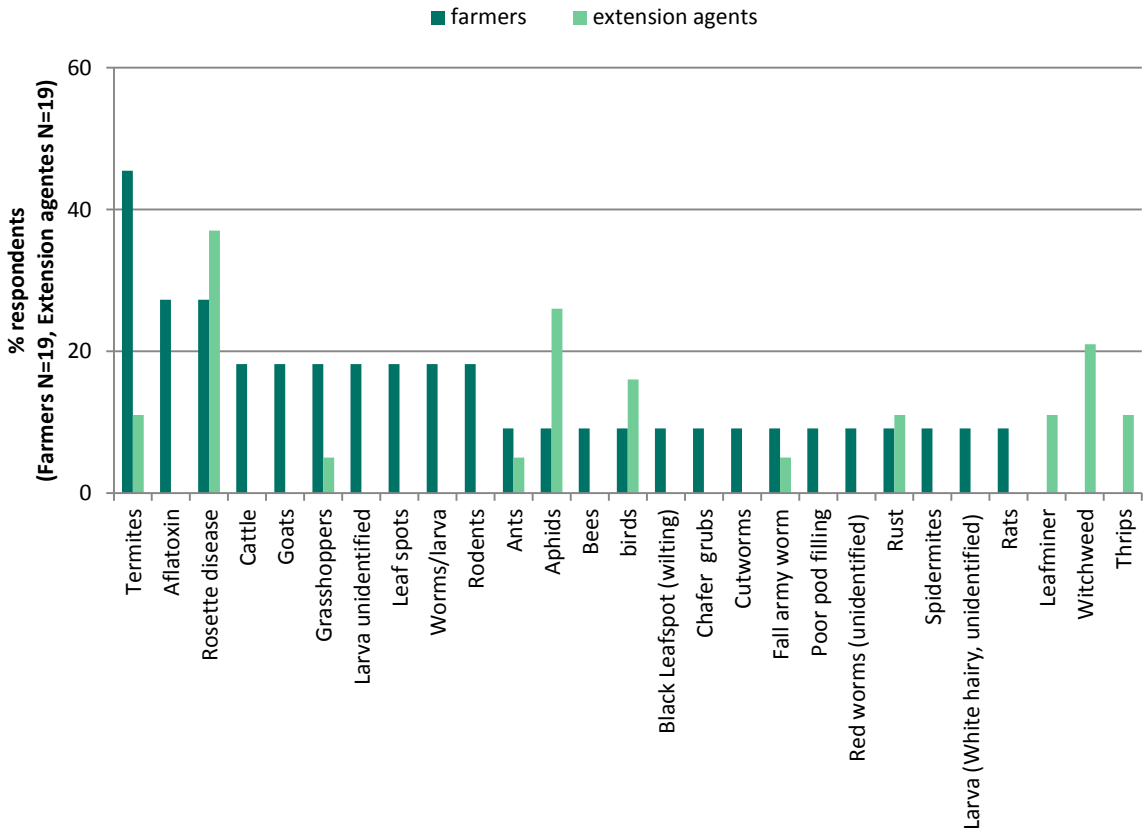

Figure 38 Main pests and diseases in field and storage for groundnut and comparison of responses from farmers and extension agents

Table 14 Extension agents' perceptions of management options used by farmers to control field pests in soybean, groundnut and cassava, and extension agents' recommendations

Pest	Chemical products used by farmers	AI	Chemical products recommended by extension agents	AI	Botanicals used by farmers	Botanicals recommended by extension agents	Non-chemical control used by farmers	Non-chemical recommended by extension agents
Ants	Solignum	Cypermethrin		Cypermethrin			Suffocating with soil	Burning
Aphids		Carbaryl	Actellic	Pirimphos-methyl		Soap solutions	None	
		Cypermethrin 20 EC				Pepper solution	Introducing ants	
Beetles		Cypermethrin					Handpicking	Hand picking and physical killing
Birds							Hunting	Use of plastics to scare them
							Chasing them using plastic sheet	Fliers, chasing
							Bird traps	Bird traps
							Fencing with fliers	
Blight			Dithane	Mancozeb				
Cassava mosaic	Confidor	Imidacloprid					Uprooting	Uprooting
							Field hygiene	
Caterpillars		Cypermethrin					Handpicking	Handpicking
		Carbaryl					Trapping	
		cypermethrin						
Drying in soybean			Foliqode					
FAW		Cypermethrin		Cypermethrin 20 EC		Soap and Tephrosia	Early planting	Early planting
	Snowcron	Profenofos		Alpha-Cypermethrin		Tephrosia Spray	Hand picking	Physical killing, early planting

Pest	Chemical products used by farmers	AI	Chemical products recommended by extension agents	AI	Botanicals used by farmers	Botanicals recommended by extension agents	Non-chemical control used by farmers	Non-chemical recommended by extension agents
				Cypermethrin			Ash	Ash
				Deltamethrin 2.5			Sand and ashes	
			Snowcron	Profenofos			Physical killing	
			Sevin	Carbaryl			Soap	
							Application of Usipa	
Grasshoppers		cypermethrin	Cypermethrin				Hand killing	Hand picking and physical killing
			Actellic	Pirimphos-methyl				
Ground beetles							None	
Larva					Neem leaves		Hand killing	Early planting
					Aloe vera		Burning	Weeding
							Pulling of plant	
Leaf eaters		Cypermethrin	Cypermethrin				Use wasps	Cleaning field by burning before planting
	Snowcron	Profenofos						Crop rotation
								Hand picking
Leaf miner	Abamectin	Avermectin B1a and avermectin B1b	Abamectin	Avermectin B1a and avermectin B1b	Tephrosia volgelli		None	
		Cypermethrin					handpicking	None
	Deltamethrin	Deltamethrin						
Mandolo	None						uproot plants	early planting
							Crop rotation	Crop rotation
							Resistant varieties	

Pest	Chemical products used by farmers	AI	Chemical products recommended by extension agents	AI	Botanicals used by farmers	Botanicals recommended by extension agents	Non-chemical control used by farmers	Non-chemical recommended by extension agents
Mildews (fungi)							Field hygiene	
Nsabwe		Cypermethrin						
Red spider mite		Cypermethrin						
Rodents, mice							Digging and killing	Digging and killing physically
Groundnut Rosette	None						Uprooting	Crop rotation
Semi-loopers		Cypermethrin						
Spider mites		Cypermethrin		Cypermethrin			Deria extract	Deria extract
Stalk borer		Cypermethrin					Crop rotation	
							Hand picking	
Rust								Uprooting and burning
								field hygiene
Termites	Actellic	Pirimphos-methyl	Confidor	Imidacloprid			No banking	No banking
	Confidor	Imidacloprid					Dragging with hoe	
	Solignum	Permethrin					Spraying with water fish	
							Early planting	
Thrips		Cypermethrin	Daconil	Chlorothalonil/Acibenzolar-Smethyl		Neem leaves	Biological	
			Cypermethrin					
Weevils			Actellic spray	Pirimphos-methyl				Ash
White grubs		Cypermethrin		Cypermethrin			handpicking	
	Cofidor	Imidacloprid						

Pest	Chemical products used by farmers	AI	Chemical products recommended by extension agents	AI	Botanicals used by farmers	Botanicals recommended by extension agents	Non-chemical control used by farmers	Non-chemical recommended by extension agents
Weeds			Herbicides				Weeding	
Witch weed	None						Crop rotation	

Table 15 Extension agent's perceptions of management options used by farmers to control post-harvest pests in soybean, groundnut and cassava, and extension agent's recommendations

Pest	Chemical used by farmers	AI used by farmers	Chemical recommended by EAs	AI recommended by EAs	Botanicals used by farmers	Botanicals recommended by EAs	Non-chemicals farmers use	Non-chemicals recommended by EAs
Groundnut weevil	None		No chemical recommended				Keep nuts unshelled	Keeping nuts unshelled
Mildews (fungi)			Actellic				Store dried crops	Store while very dry
Nankafumbe	Actellic	Pirimiphos-methyl	Actellic, fumigation	Pirimiphos-methyl			Sealed plastic bags	Good clean storage material
Rodents	None		None				Cats	Cats
	Temik	Aldicarb	Temik	Aldicarb			Rat guards	Traps
	None		Ratex				Pit traps	
	Bactrim	Sulfamethoxazole and trimethoprim (medicinal antibiotic)	No chemical recommended				Traps	
		cypermethrin	Indocide	Indomethacin (medicinal anticoagulant)				
Soybean weevil	None		No chemical recommended				None	
Weevils	Actellic super		Actellic super dust	Pirimiphos-methyl + Permethrin	Neem powder	Neem	Keeping nuts unshelled	Sun drying

Pest	Chemical used by farmers	AI used by farmers	Chemical recommended by EAs	AI recommended by EAs	Botanicals used by farmers	Botanicals recommended by EAs	Non-chemicals farmers use	Non-chemicals recommended by EAs
	Actellic dust	Pirimiphos-methyl	Actellic dust	Pirimiphos-methyl	Tobacco powder and ash	Blue gum (tree)	Ash	Proper drying
	Actellic Scanner		Actellic Scanner				Ash+Tobacco	No option
	Actellic liquid		Actellic liquid					None
Termites			Confidor				Use plants that are not attacked by termites	
							Stack bags on pellet	
							None	

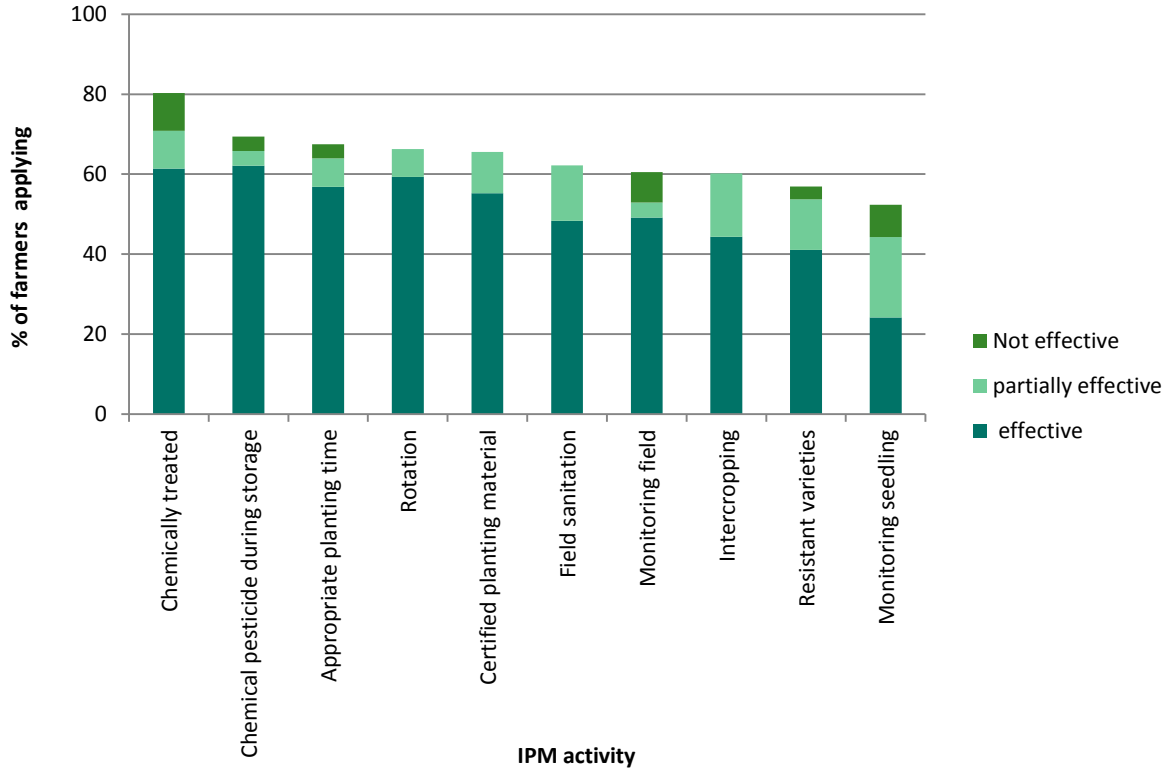

Figure 39 Extension agents' perceptions of IPM practices used by farmers, the percentage of farmers applying each option, and the effectiveness

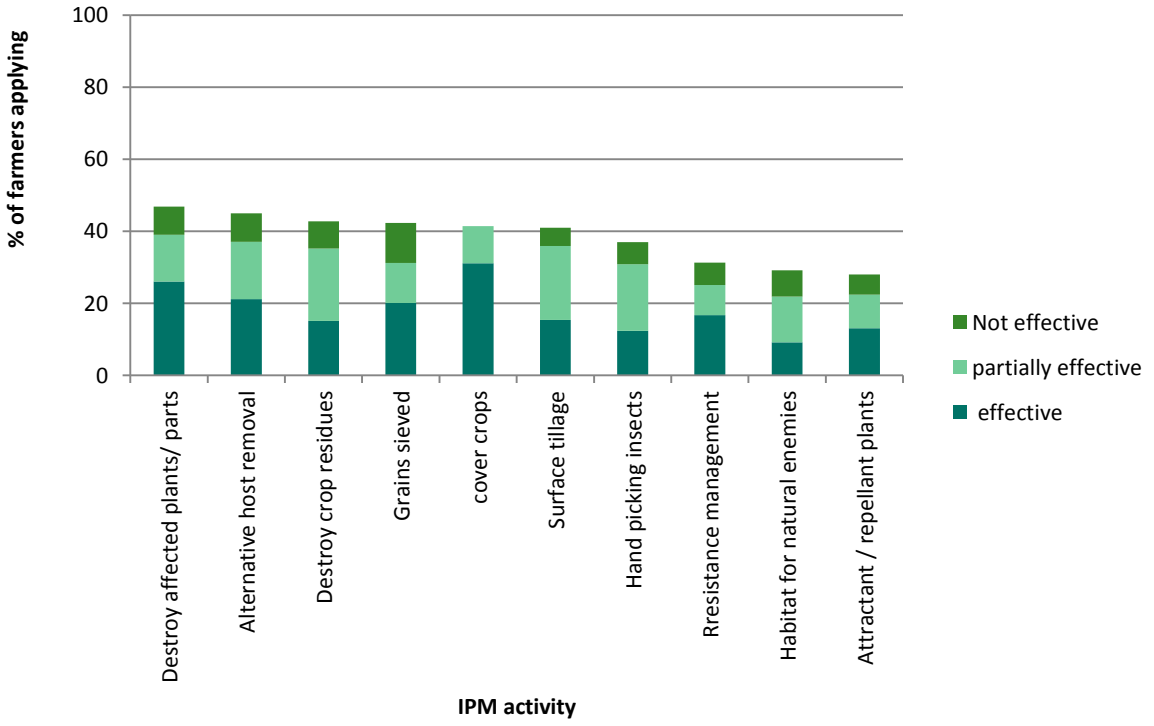

Figure 40 Extension agents' perceptions of IPM practices used by farmers, the percentage of farmers applying each option, and the effectiveness

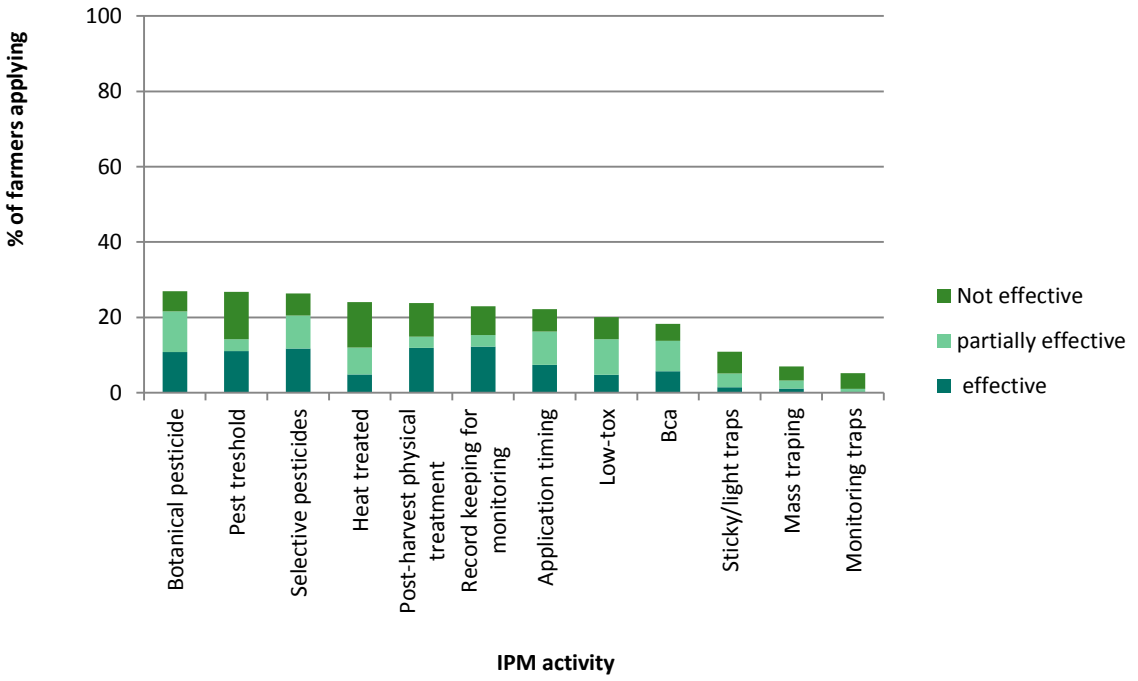

Figure 41 Extension agents' perceptions of IPM practices used by farmers, the percentage of farmers applying each option, and the effectiveness

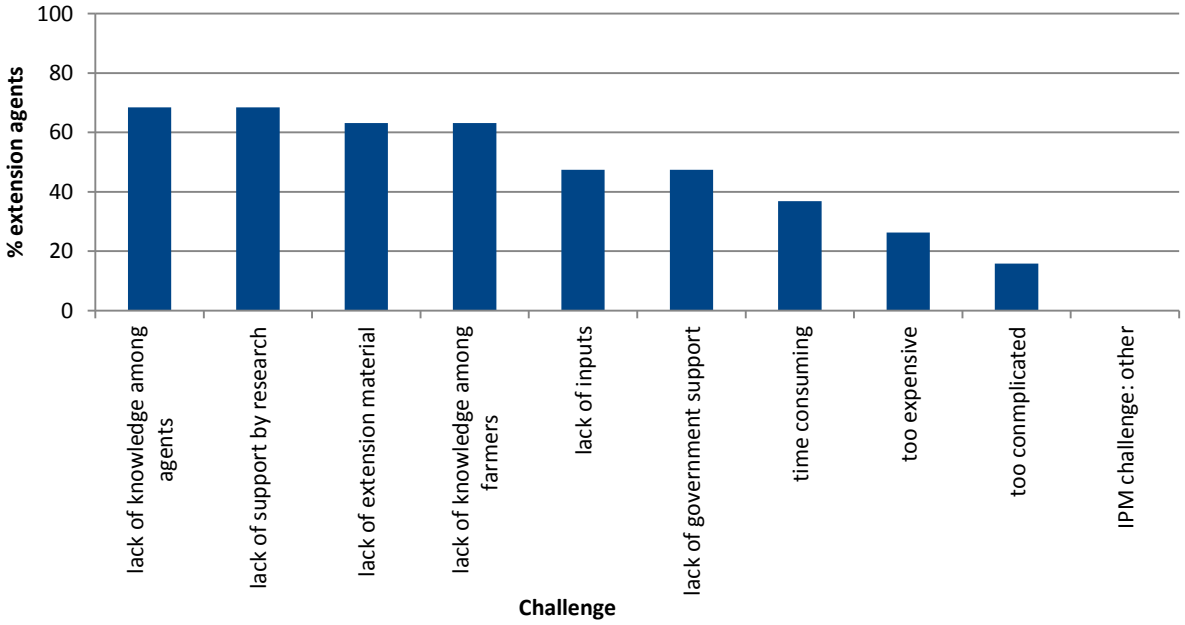

Figure 42 Challenges to implementation of IPM as perceived by extension agents

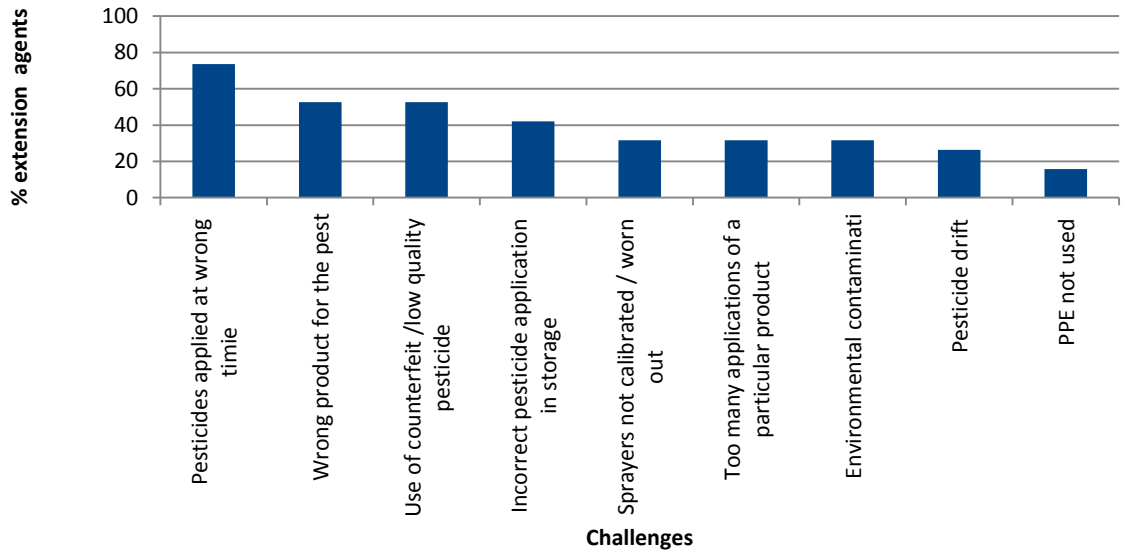

Figure 43 Challenges of pesticide use by farmers as perceived by extension agents

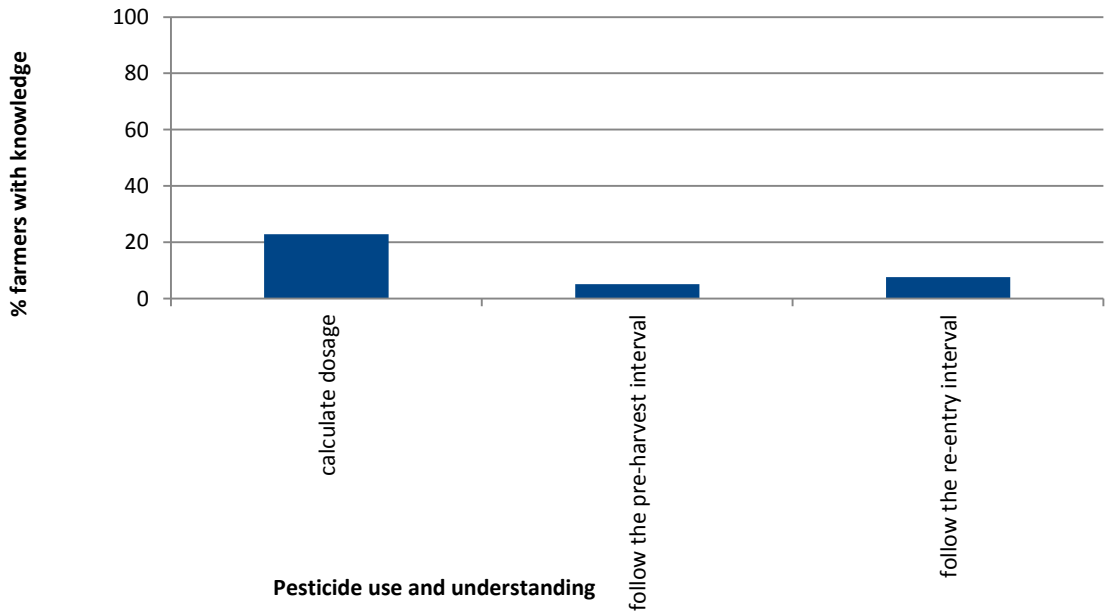

Figure 44 Knowledge challenges faced by farmers when using pesticides as perceived by extension agents

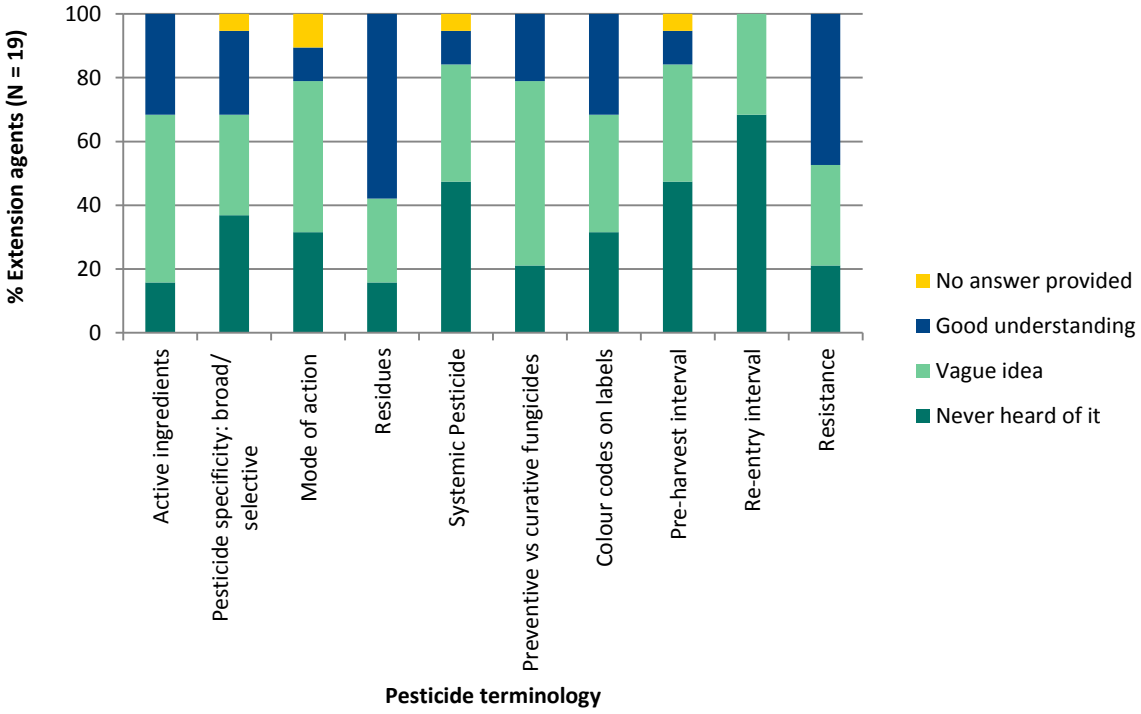

Figure 45 Extension agents' level of understanding of pesticide terminology (self-assessment)

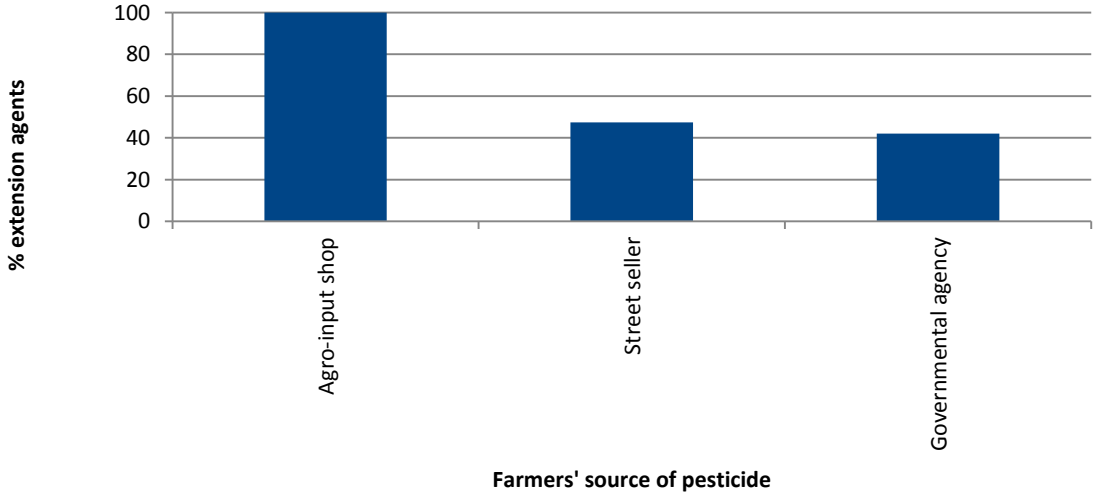

Figure 46 Extension agents' perceptions on farmers' sources of pesticides

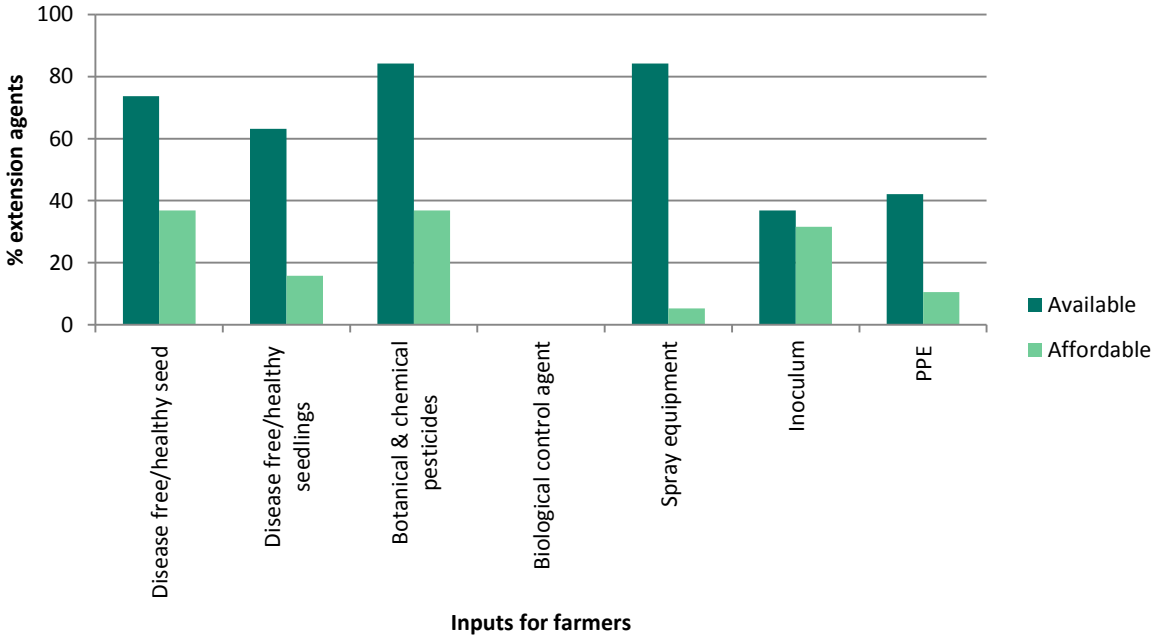

Figure 47 Extension agents' perception of availability and affordability of inputs to farmers

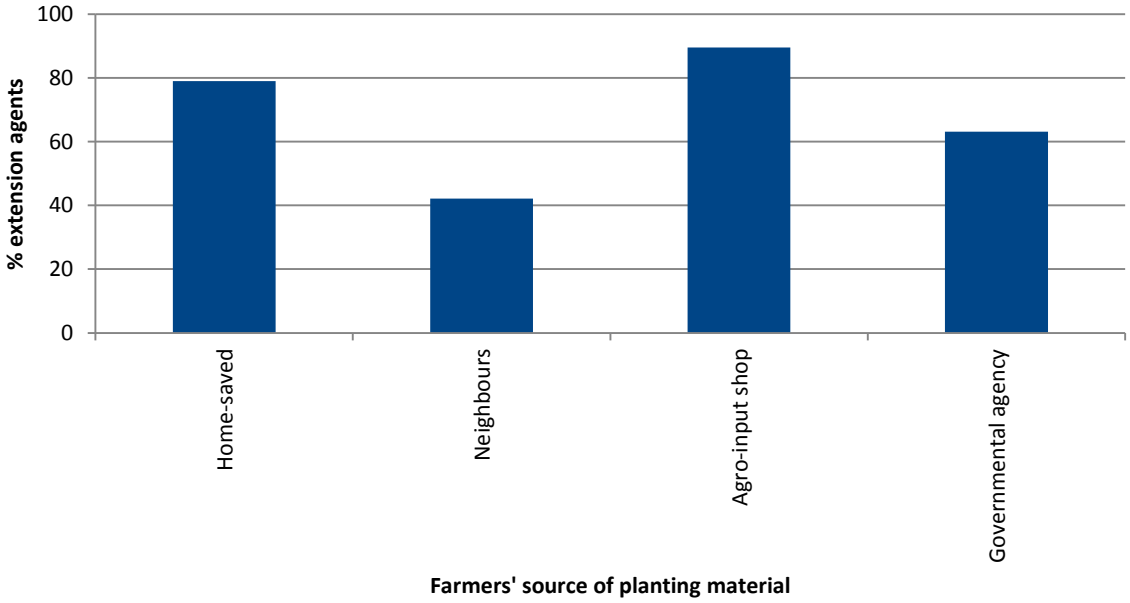

Figure 48 Extension agents' perceptions of farmers' sources of planting material

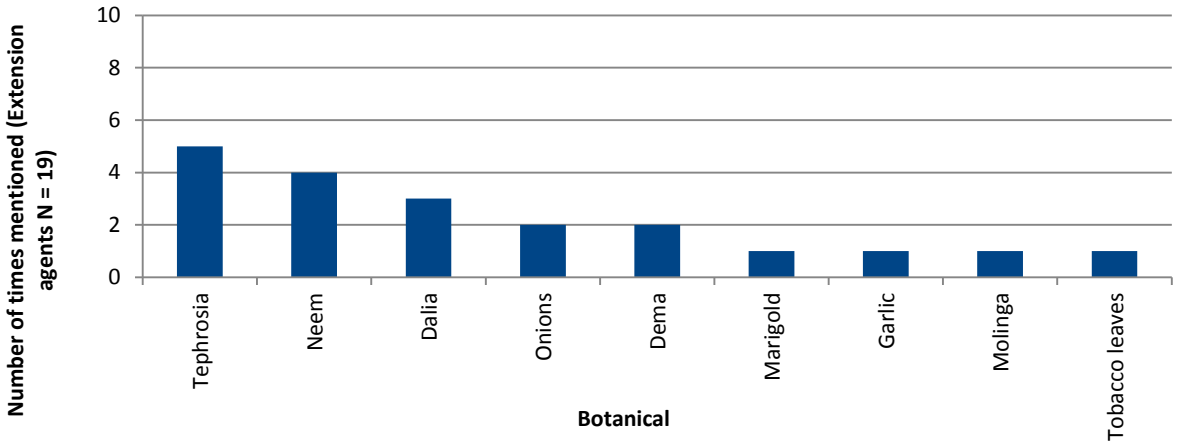

Figure 49 Extension agents' perception of botanicals used by farmers

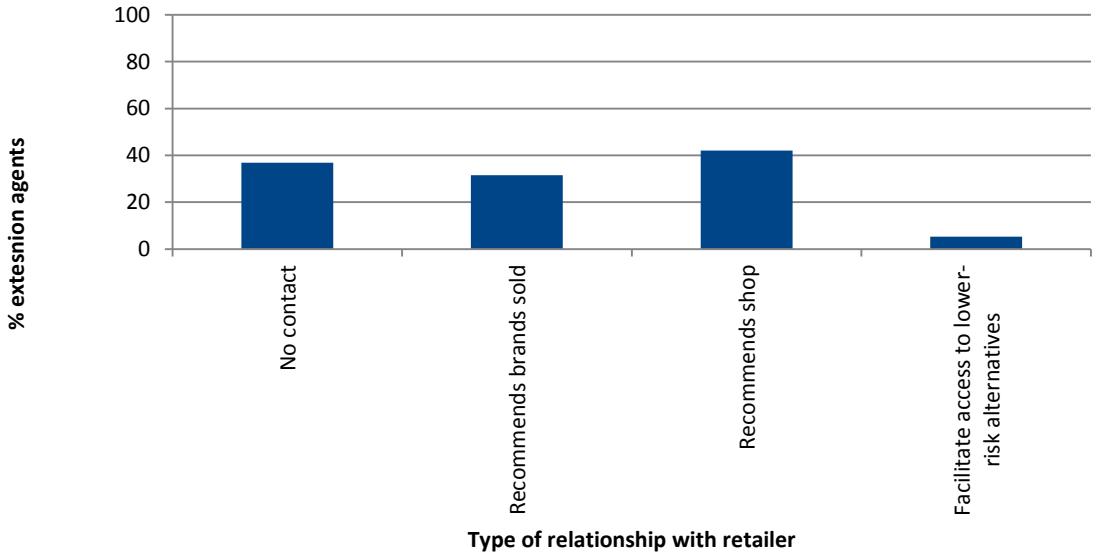

Figure 50 Extension agents' relationship with pesticide retailers

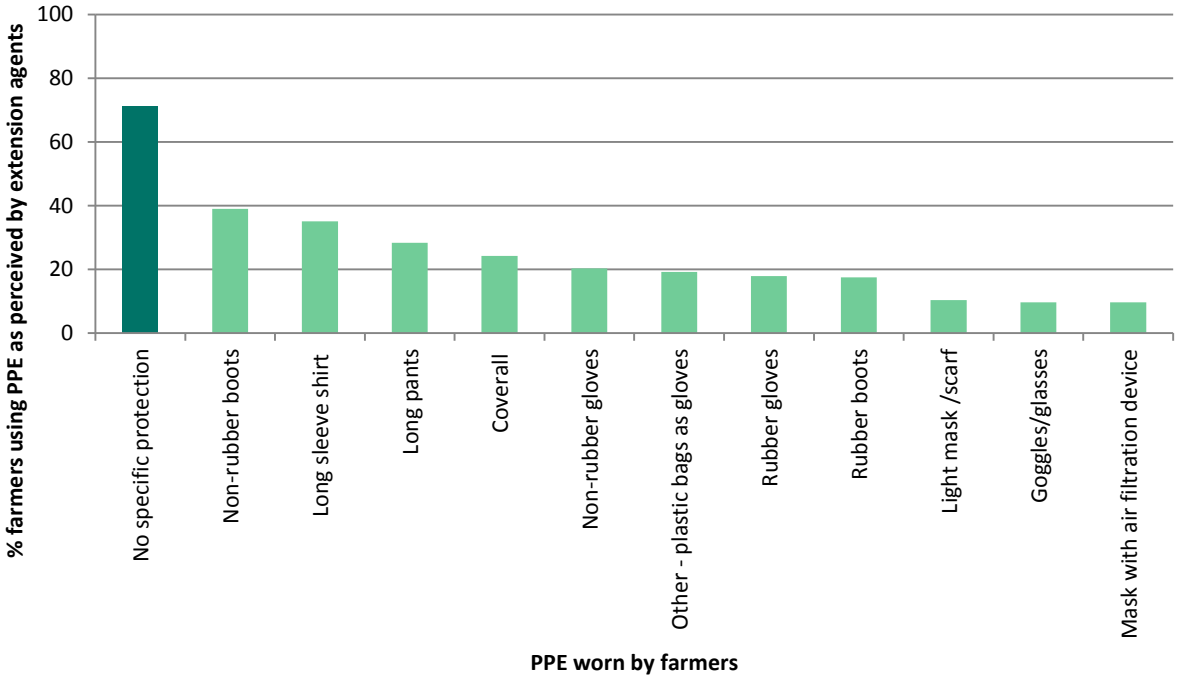

Figure 51 Extension agents' perception of farmers' PPE use

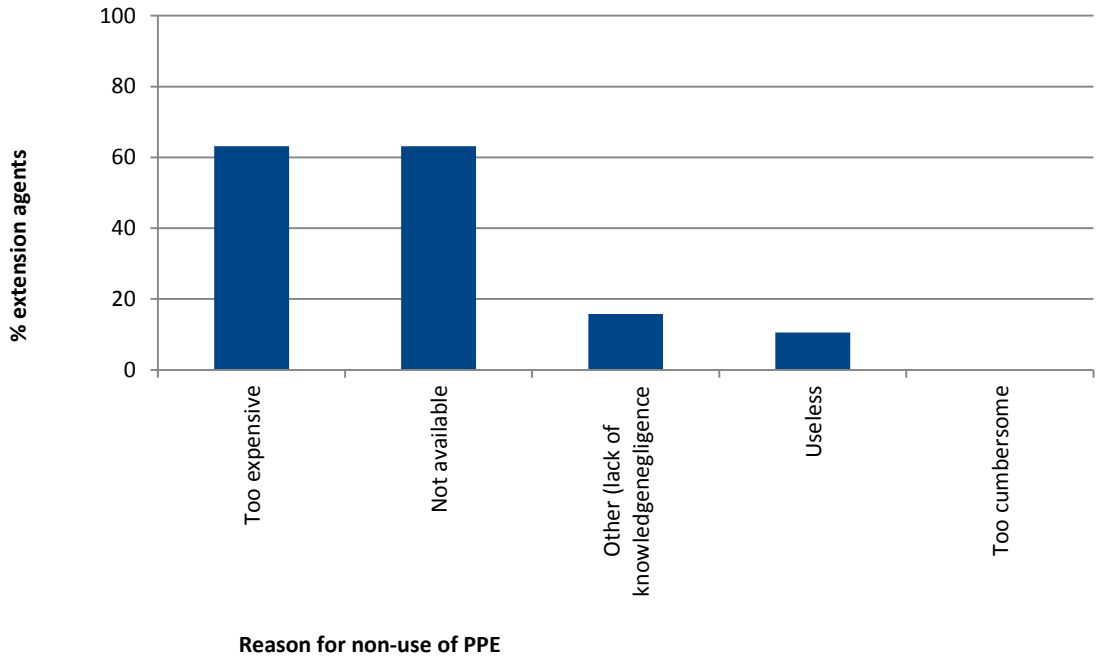

Figure 52 Extension agents' perceptions of reasons why farmers do not use PPE

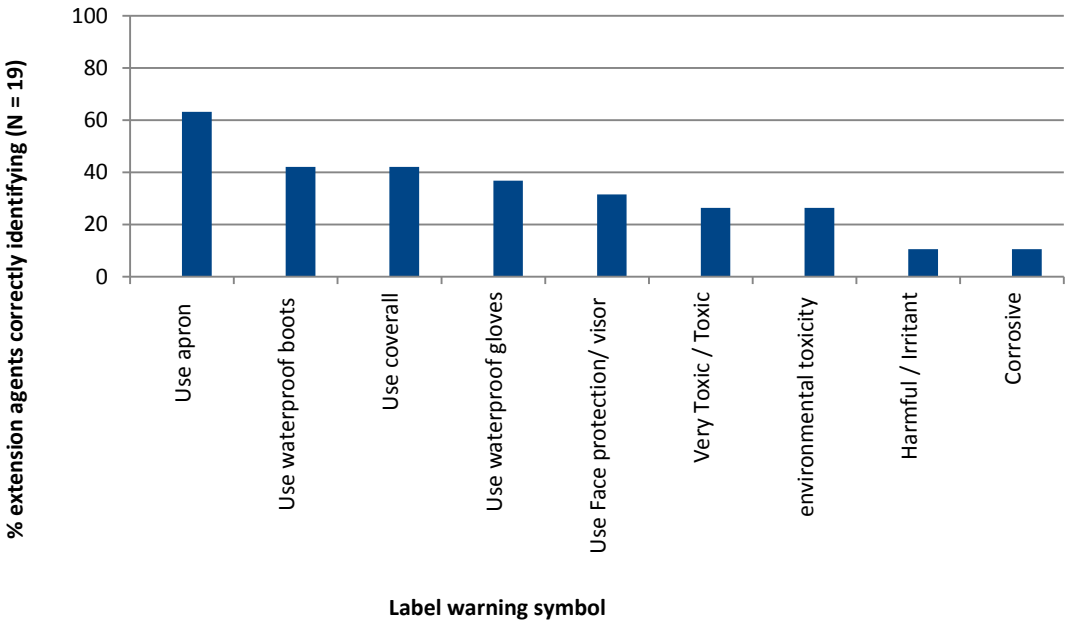

Figure 53 Extension agents able to correctly identify warning symbols on pesticide labels

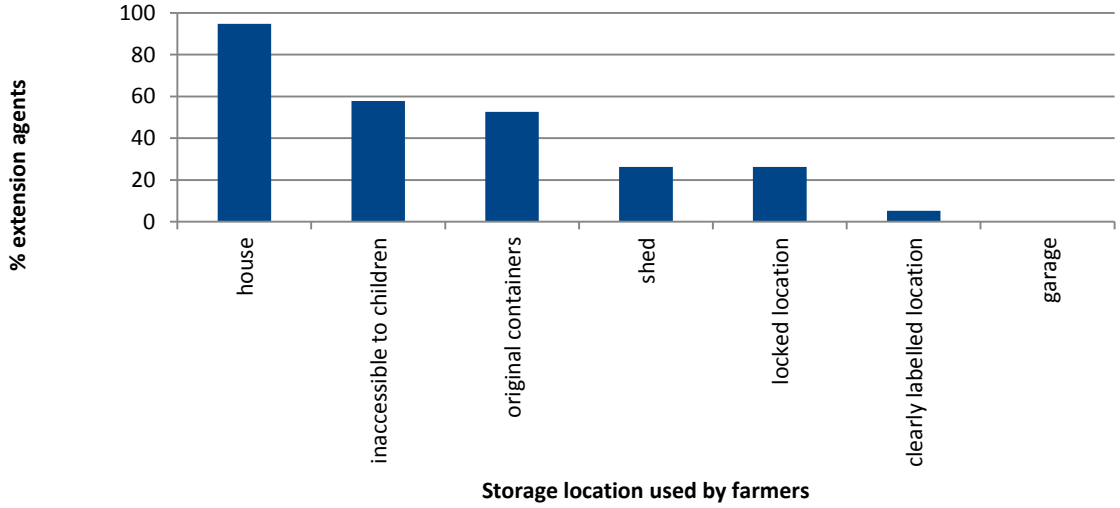

Figure 54 Extension agents' perceptions of locations used by farmers to store pesticides

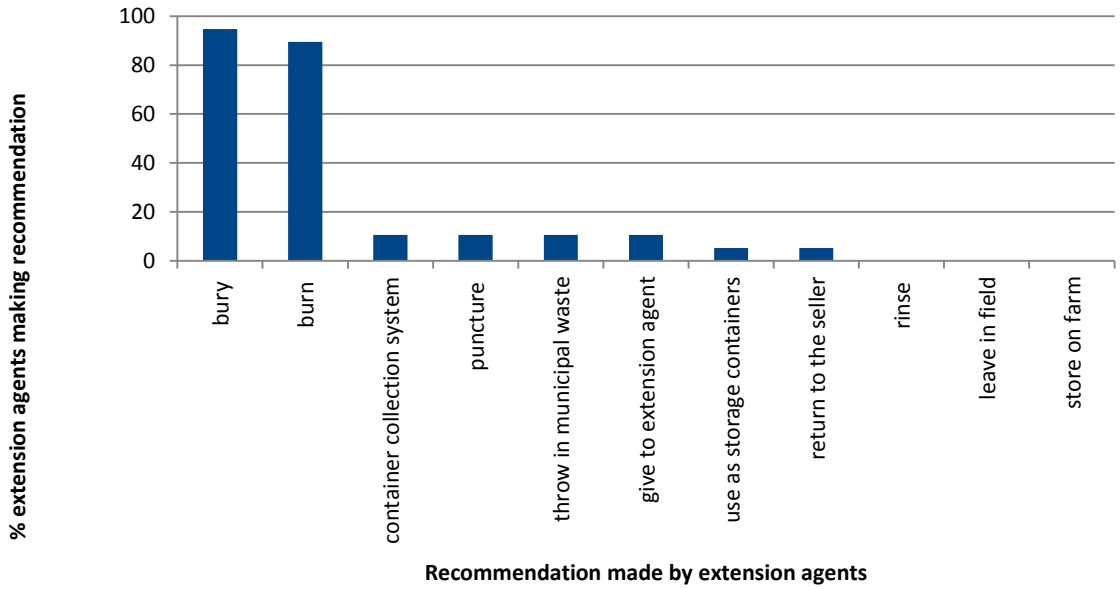

Figure 55 Extension agents' recommendations to farmers for disposal of pesticide containers

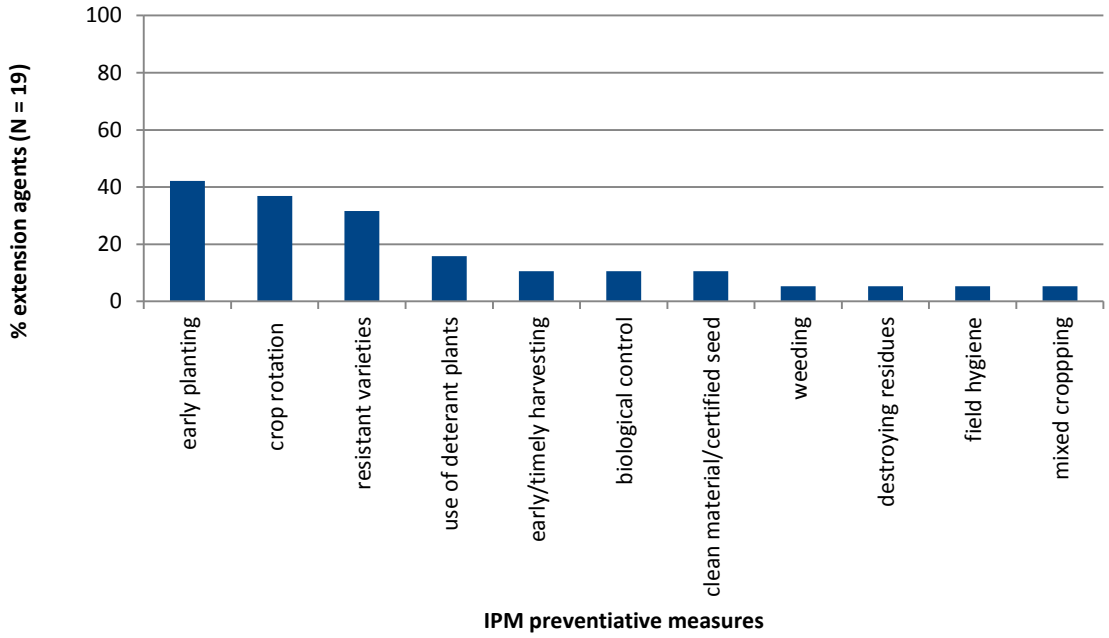

Figure 56 Extension agents' examples of IPM practices – preventative measures

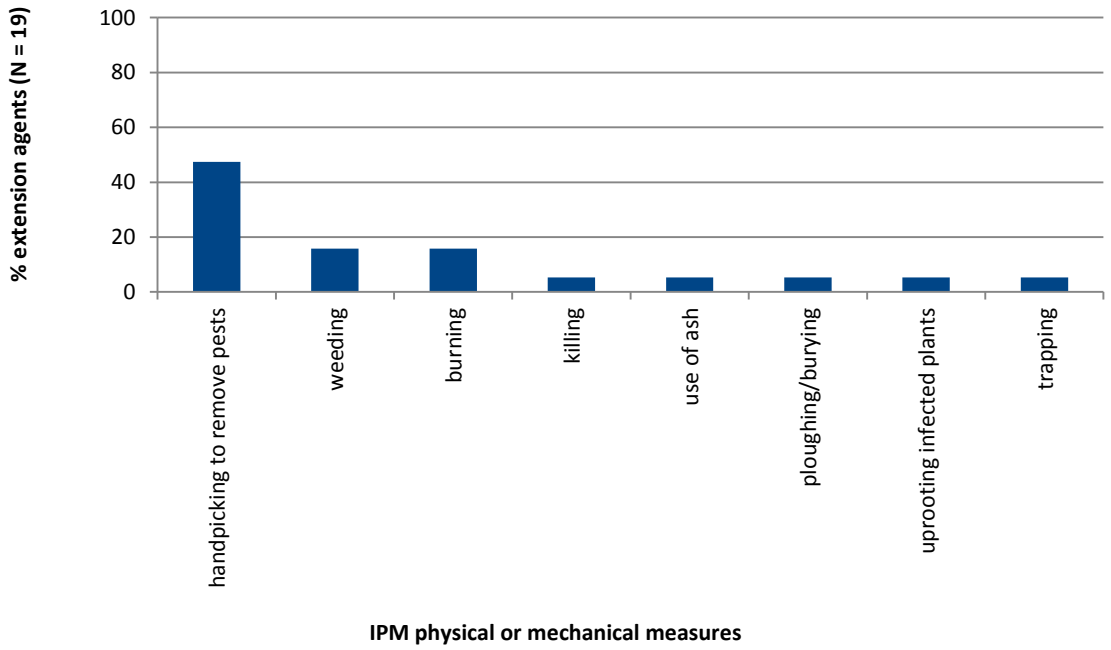

Figure 57 Extension agents' examples of IPM practices – physical/mechanical measures

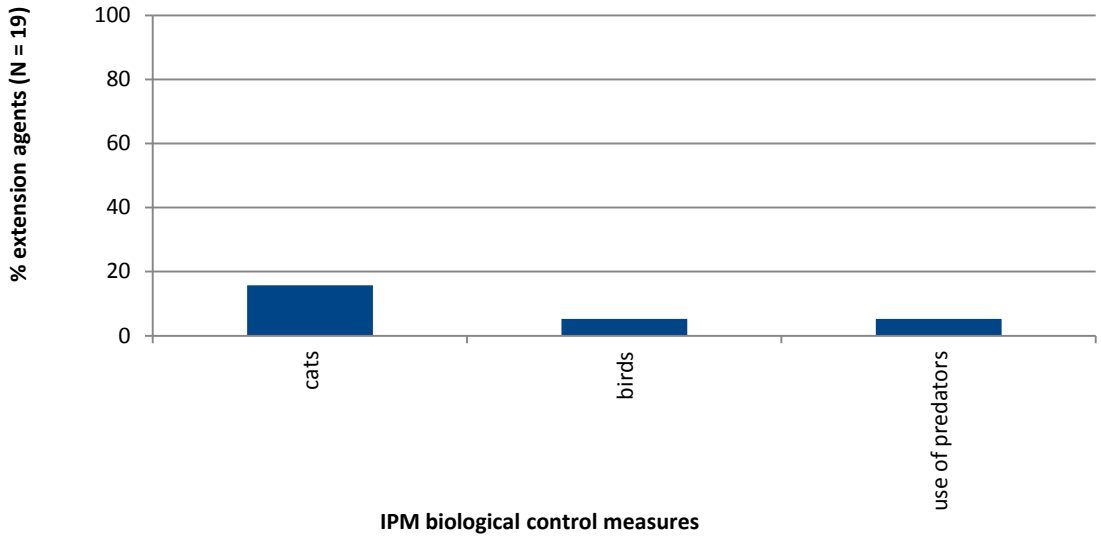

Figure 58 Extension agents' examples of IPM practices – biological control measures

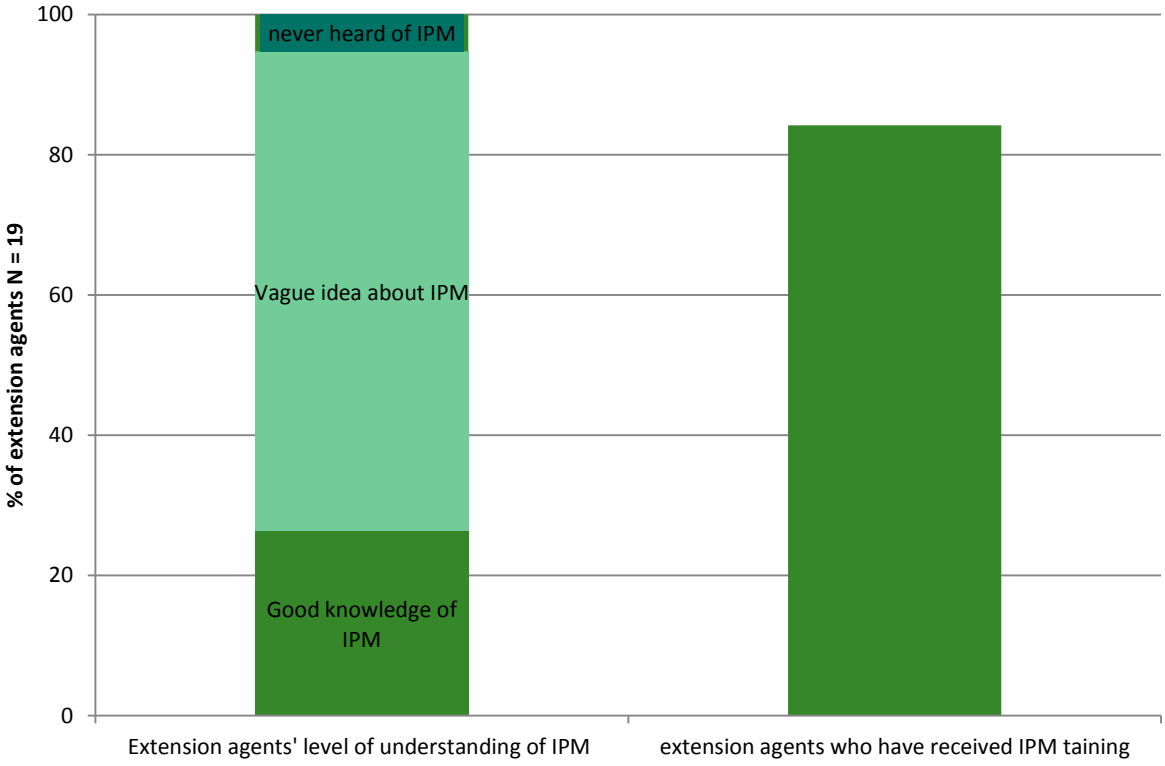

Figure 59 Extension agents' understanding of IPM and training in IPM

Annex VII Pesticide hazards, assessment of risks and documented harmful effects of pesticides

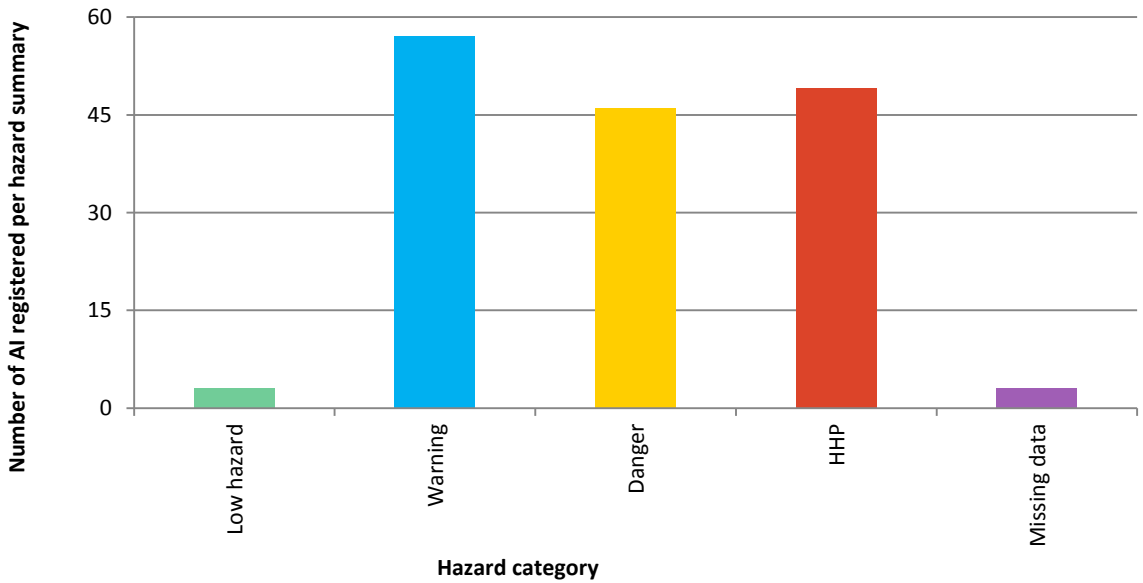

Figure 60 Number of AI in each hazard category

Table 16 AI which were identified to be HHPs

HHP AI	Chemical class	Use type	HHP1 Acute toxicity	HHP2 Carcino genicity	HHP3 Mutageni city	HHP4 Reproduc tive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU approved	GIZ classific ation	Number of products registered
Abamectin	Macrocyclic Lactone - avermectin	Insecticide	1			2	N	N	N	Y	Approved	B	21
Alachlor	Amide	Herbicide	2	2			N	Y	N	Y	Not approved	A	6
Aldicarb	Carbamate	Insecticide, Nematicide	1A				N	Y	N	Y	Not approved	A	2
Aluminium phosphide	Fumigant	Insecticide, Rodenticide s	1				N	N	N	Y	Approved	B	22
Benomyl	Benzimidazole	Fungicide	U	2	1A / 1B	1A / 1B	N	N	N	Y	Not approved	A	4
Beta-cyfluthrin	Pyrethroid	Insecticide	1B			2	N	N	N	Y	Approved	A	19
Borax	Biochemical biopesticides - Inorganic compounds / Minerals	Herbicide, Insecticide	3			1A / 1B	N	N	N	Y	Not listed	A	2
Captan	Phthalimide	Fungicide	U	1B			N	N	N	N	Approved	B	1
Carbaryl	Carbamate	Insecticide	2	1B			N	N	N	Y	Not approved	B	7
Carbendazim	Benzimidazole	Fungicide	U	2	1A / 1B	1A / 1B	N	N	N	Y	Not approved	A	2
Chlorfenvinphos	Organophosphorus	Insecticide	1B				N	N	N	Y	Not approved	A	4
Chlorothalonil	Aromatic fungicide	Fungicide, Oomycide	U	1B			N	N	N	Y	Approved	B	14
Diazinon	Organophosphorus	Insecticide	2	2		1B	N	N	N	Y	Not approved	B	1
Dichlorvos (ddvp)	Organophosphorus	Insecticide, Acaricide	1B	2			N	N	N	Y	Not approved	A	11
Disulfoton	Organophosphorus	Insecticide, Acaricide	1A				N	N	N	Y	Not approved	A	4
Diuron	urea	Herbicide	3	1B			N	N	N	Y	Approved	B	27
Endosulfan	Organochlorine	Insecticide, Acaricide	2				Y	Y	N	Y	Not approved	A	14

HHP AI	Chemical class	Use type	HHP1 Acute toxicity	HHP2 Carcino genicity	HHP3 Mutageni city	HHP4 Reproduc tive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU approved	GIZ classific ation	Number of products registered
Epoxiconazole	Triazole	Fungicide		1B		1A / 1B	N	N	N	Y	Approved	A	3
Ethoprop	Organophosphorus	Insecticide, Nematicide	1A	1B			N	N	N	Y	Approved	A	6
Ethylene dibromide	Fumigant	Fumigant, Insecticide		1B			N	N	N	Y	Not listed	A	16
Fenamiphos	Organophosphorus	Insecticide, Nematicide	1B				N	N	N	Y	Not listed	A	5
Flusilazole	triazole	Fungicide	2	2		1A / 1B	N	N	N	Y	Not approved	A	2
Furfural	Unclassified	Fungicide, Nematicide		1B			N	N	N	N	Not approved	B	2
Glufosinate ammonium	organophosphorus	Herbicide				1A / 1B	N	N	N	Y	Not listed	A	2
Iprodione	dicarboximide	Fungicide	2	1B			N	N	N	Y	Approved	B	4
Iprovalicarb	carbamate	Fungicide	3	1B			N	N	N	Y	Approved	B	2
Isoxaflutole	oxazole	Herbicide	U	1B	-		N	N	N	Y	Approved	B	6
Magnesium phosphide	Fumigant	Insecticide		1B		2	N	N	N	Y	Approved	B	3
Malathion	Organophosphorus	Acaricide, Insecticide	1				N	N	N	Y	Approved	B	14
Mancozeb	Dithiocarbamate	Fungicide, Oomycide	U	1B		2	N	N	N	Y	Approved	B	53
Maneb	Carbamate	Fungicide	U	1B		1B	N	N	N	Y	Not approved	B	1
Metam-sodium	Dithiocarbamate	Fungicide, herbicide, nematicide	2	1B			N	N	N	Y	Approved	B	9
Methamidophos	Organophosphorus	Insecticide	1B				N	Y	N	Y	Not approved	A	12
Methiocarb	Carbamate	Insecticide, Molluscicid e	1B				N	N	N	Y	Approved	A	2
Methomyl	Carbamate	Insecticide	1B				N	N	N	Y	Approved	A	4
Methyl bromide	Fumigant	Fumigant, Insecticide, Herbicide, Nematicide			2	2	N	N	Y	Y	Not approved	A	3

HHP AI	Chemical class	Use type	HHP1 Acute toxicity	HHP2 Carcino genicity	HHP3 Mutageni city	HHP4 Reproduc tive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU approved	GIZ classific ation	Number of products registered
Monocrotophos	Organophosphorus	Insecticide	1B		2		N	Y	N	Y	Not approved	A	8
Oxadiazon	Oxadiazolone	Herbicide	U	1B		2	N	N	N	Y	Approved	B	12
Oxamyl	Carbamate	Insecticide, Nematicide	1B				N	N	N	Y	Approved	A	16
Permethrin	Pyrethroid	Insecticide	2	1B			N	N	N	Y	Not approved	B	41
Propineb	Dithiocarbamate	Fungicide, Oomycide	U	1B		2	N	N	N	N	Approved	D	4
Propoxur	Carbamate	Insecticide	2	1B			N	N	N	Y	Not approved	B	2
Pymetrozine	Organophosphorus – Pyridine	Insecticide		1B			N	N	N	Y	Approved	B	1
Quizalofop-p-tefuryl	Phenoxy	Herbicide	2		2	1A / 1B	N	N	N	Y	Approved	A	1
Terbufos	Organophosphorus	Insecticide, Nematicide	1A			2	N	N	N	Y	Not approved	A	2
Thiacloprid	Neonicotinoid	Insecticide	2	1B		2	N	N	N	Y	Approved	B	4
Topramezone	Pyrazole	Herbicide	-			1A / 1B	N	N	N	N	Pending	#N/A	1
Zeta-cypermethrin	Pyrethroid	Insecticide	1B	2	-	-	N	N	N	Y	Approved	A	1
Zinc phosphide	Inorganic-Zinc	Rodenticide	1B	-	-	-	N	N	N	Y	Approved	A	2

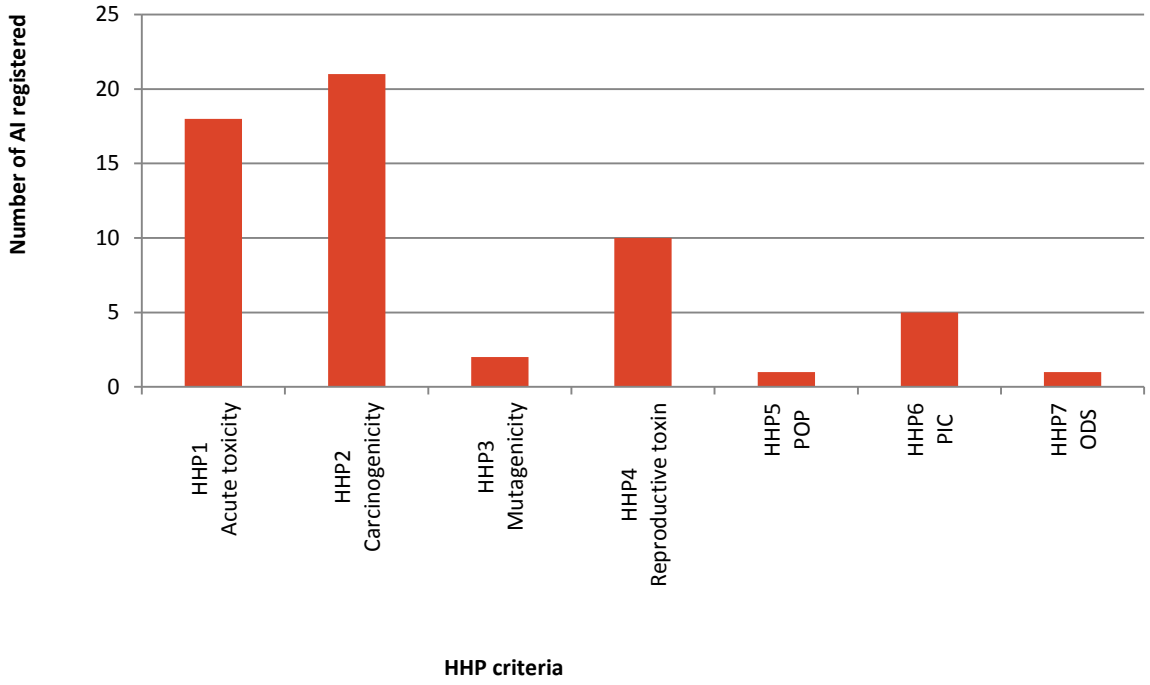

Figure 61 Number of HHP AI per HHP criterion

Table 17 List of AI registered in Malawi that require exceptional authorization for recommendation or procurement

Pesticide AI	Chemical class	Use type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU	Number of products registered
1,3-Dichloropropene	Fumigant	Nematicide	Danger	N	Y	Y	Not approved	2
Abamectin	Macrocyclic Lactone - avermectin	Insecticide	HHP	N	N	Y	Approved	21
Acephate	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved	10
Acetochlor	Chloroacetamide	Herbicide	Warning	N	Y	Y	Not approved	29
Aluminium phosphide	Fumigant	Insecticide, Rodenticides	HHP	N	N	Y	Approved	22
Ametryn	Triazine	Herbicide	Danger	N	N	N	Not approved	13
Amitraz	Formamidine	Insecticide	Danger	N	Y	N	Not approved	1
Atrazine	Triazine	Herbicide	Warning	N	Y	Y	Not approved	20
Bendiocarb	Carbamate	Insecticide	Danger	N	N	Y	Not approved	4
Butralin	Dinitroaniline	Herbicide	Danger	N	Y	N	Not approved	9
Captan	Phthalimide	Fungicide	HHP	N	N	N	Approved	1
Carbaryl	Carbamate	Insecticide	HHP	N	Y	Y	Not approved	7
Carbosulfan	Carbamate	Insecticide	Danger	N	Y	Y	Not approved	4
Chlorothalonil	Aromatic fungicide	Fungicide, Oomycide	HHP	N	N	Y	Approved	14
Chlorpyrifos	Organophosphorus	Insecticide, Acaricide	Danger	N	N	Y	Approved	81
Clothianidin	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved	5
Copper hydroxide	Inorganic - copper	Fungicide, Oomycide, Bactericide	Danger	N	N	Y	Approved	7
Cypermethrin	Pyrethroid	Insecticide, Acaricide	Danger	N	N	Y	Approved	92
Deltamethrin	Pyrethroid	Insecticide	Danger	N	N	Y	Approved	109
Diazinon	Organophosphorus	Insecticide	HHP	N	Y	Y	Not approved	1
Dichlorophen	Hetrocyclic	Fungicide, Herbicide, Bactericide, Algicide	Warning	N	Y	N	Not approved	1
Dimethenamid-P	Amide	Herbicide	Warning	N	N	N	Approved	1
Dimethoate	Organophosphorus	Insecticide	Danger	N	N	Y	Approved	25
Diuron	Urea	Herbicide	HHP	N	N	Y	Approved	27
Fatty alcohols	Alcohol/ester	Plant Growth Regulator	Missing data	N	N	N	Not approved	2

Pesticide AI	Chemical class	Use type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU	Number of products registered
Fenitrothion	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved	19
Fenthion	Organophosphorus	Avicide, Insecticide	Danger	N	Y	Y	Not approved	2
Fenvalerate	Pyrethroid	Insecticide	Danger	N	N	Y	Not approved	6
Fipronil	Pyrazole	Insecticide	Danger	N	Y	Y	Not approved	4
Fluazifop-p-butyl	Phenoxy	Herbicide	Warning	N	Y	N	Not listed	11
Flumetralin	Growth inhibitor	Plant Growth Regulator	Warning	N	N	Y	Approved	8
Furfural	Unclassified	Fungicide, Nematicide	HHP	N	Y	N	Not approved	2
Glyphosate	Organophosphorus	Herbicide	Danger	N	N	Y	Approved	143
Haloxyfop-p-methyl	Phenoxy	Herbicide	HHP	N	N	Y	Approved	34
Hexazinone	Triazinone	Herbicide	Warning	N	N	N	Not approved	12
Imidacloprid	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved	70
Imiprothrin	Pyrethroid	Insecticide	Warning	N	N	Y	Not listed	16
Indoxacarb	Oxadiazine	Insecticide	Danger	N	N	Y	Approved	22
Iprodione	Dicarboximide	Fungicide	HHP	N	N	Y	Approved	4
Iprovalicarb	Carbamate	Fungicide	HHP	N	N	Y	Approved	2
Isoxaflutole	Oxazole	Herbicide	HHP	N	N	Y	Approved	6
Lambda-cyhalothrin	Pyrethroid	Insecticide	Danger	N	N	Y	Approved	92
Lufenuron	Biochemical biopesticides - Insect Growth Regulators	Insecticide	Warning	N	N	Y	Approved	11
Magnesium phosphide	Fumigant	Insecticide	HHP	N	N	Y	Approved	3
Malathion	Organophosphorus	Acaricide, Insecticide	Danger	N	Y	Y	Approved	14
Mancozeb	Dithiocarbamate	Fungicide, Oomycide	HHP	N	N	Y	Approved	53
Maneb	Carbamate	Fungicide	HHP	N	N	Y	Not approved	1
Metam-sodium	Dithiocarbamate	Fungicide, herbicide, nematicide	HHP	N	N	Y	Approved	9
Metolachlor	Amide	Herbicide	Danger	N	N	N	Not approved	18
Metribuzin	Triazinone	Herbicide	Danger	N	N	Y	Approved	17
Msma	Arsenical	Herbicide	Danger	N	N	N	Not approved	7
Oxadiazon	Oxadiazolone	Herbicide	HHP	N	N	Y	Approved	12

Pesticide AI	Chemical class	Use type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU	Number of products registered
Paraquat	Quaternary ammonium	Herbicide	Danger	N	Y	Y	Not approved	12
Permethrin	Pyrethroid	Insecticide	HHP	N	Y	Y	Not approved	41
Pirimiphos-methyl	Fumigant, organophosphorous	Fumigant, Insecticide, Acaricide	Warning	N	N	Y	Approved	36
Prallethrin	Pyrethroid	Insecticide	Danger	N	N	Y	Not listed	9
Profenofos	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved	57
Prometryn	Triazine	Herbicide	Warning	N	N	N	Not approved	24
Propoxur	Carbamate	Insecticide	HHP	N	N	Y	Not approved	2
Pymetrozine	Organophosphorus - pyridine	Insecticide	HHP	N	Y	Y	Approved	1
Saflufenacil	Amide	Herbicide	Warning	N	N	N	Not approved	3
Spinetoram	Biochemical biopesticides - Microbial extracts / fermentation products / enzymes	Insecticide	Warning	N	N	Y	Approved	15
Spinosad	Biochemical biopesticides - Microbial extracts / fermentation products / enzymes	Insecticide	Warning	N	N	Y	Approved	23
Tebuthiuron	Urea	Herbicide	Warning	N	N	N	Not approved	4
Terbutryn	Triazine	Herbicide	Warning	N	N	Y	Not approved	10
Tetramethrin	Pyrethroid	Insecticide	Warning	N	N	Y	Not approved	14
Thiacloprid	Neonicotinoid	Insecticide	HHP	N	N	Y	Approved	4
Thiamethoxam	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved	29
Thidiazuron	Urea	herbicide	Warning	N	N	N	Not approved	1
Trifluralin	Dinitroaniline	Herbicide	Danger	N	Y	Y	Not approved	4

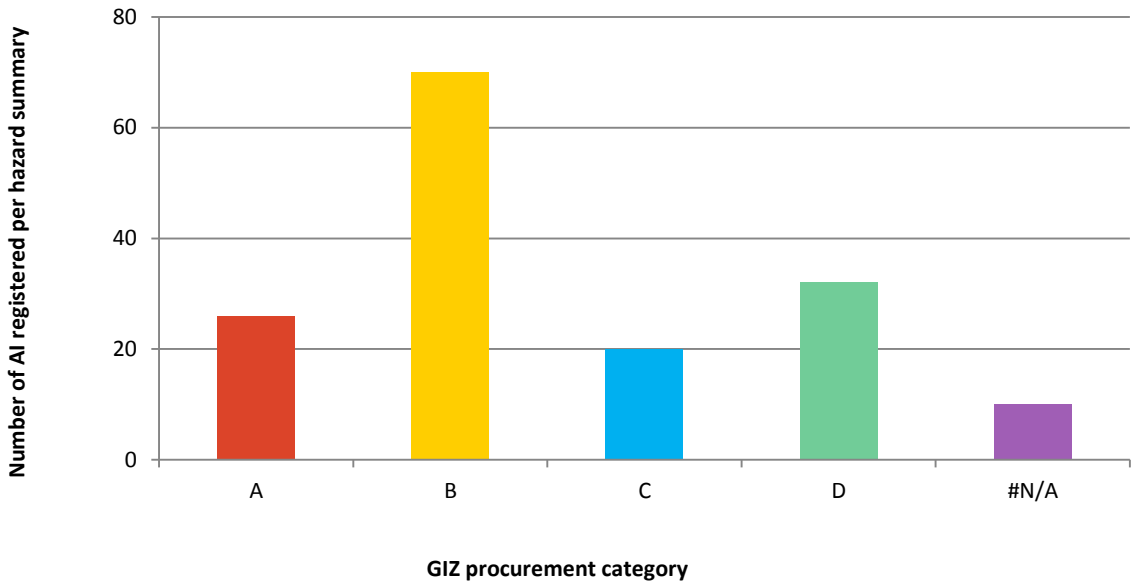

Figure 62 Number of AI per GIZ procurement category

Table 18 List of the key pests of groundnut and soybean, with the HHP and non-HHP AI that are registered for their management

Pest common names	Pest scientific name	Crop	AI effective against target pest that are registered for use on the target crop and are not HHP	HHPs used to manage the target pest[2]
Pod borer, bollworm, American bollworm, old world bollworm	*Helicoverpa armigera*	Soybean	Fenvalerate (GIZ Class: B) Lambda-cyhalothrin (GIZ Class: B) Spinetoram (GIZ Class: B)	Beta-cyfluthrin
Semilooper	*Chrysodeixis* spp.	Soybean	Cypermethrin (GIZ Class: B) Fenvalerate (GIZ Class: B) Lambda-cyhalothrin (GIZ Class: B)	Monocrotophos
Soybean Rust	*Phakopsora pachyrhizi*	Soybean	Difenoconazole (GIZ Class: C) Propiconazole (GIZ Class: C) Tebuconazole (GIZ Class: C) Triadimenol (GIZ Class: C) Trifloxystrobin (GIZ Class: D) Copper Oxychloride (GIZ Class: C) Copper Oxide (GIZ Class: D)	Epoxiconazole
Frogeye Leafspot	*Cercospora sojina*	Soybean	*No registered non-HHP pesticide*	Epoxiconazole
Purple seed stain	*Cercospora kikuchii*	Soybean	*No registered non-HHP pesticide*	Epoxiconazole
Undefined insects (aphids, caterpillars…)		Soybean / Groundnut	Lambda-Cyhalothrin (GIZ Class: B)	Carbaryl
Coleopteran storage pests (weevils, bruchids)	*Sitophilus granarium, Caryedon seratus*	Soybean / Groundnut	Alpha-cypermethrin (GIZ Class: C) Deltamethrin (GIZ Class: B) Fenitrothion (GIZ Class: B) Pirimiphos-methyl (GIZ Class: B) Spinosad (GIZ Class: B) Azadirachtin (GIZ Class: D) Deltamethrin (GIZ Class: B)	Aluminium phosphide Permethrin

[2] The list of HHPs includes those that are registered for use against the pest and those which are being used by farmers or recommended by extension agents, even if they are not registered.

Pest common names	Pest scientific name	Crop	AI effective against target pest that are registered for use on the target crop and are not HHP	HHPs used to manage the target pest[2]
Rodents		Soybean / Groundnut	*No registered non-HHP pesticide*	Aldicarb
Rust	*Puccinia arachidis*	Groundnut	Boscalid (GIZ Class: D) Copper Oxychloride (GIZ Class: C) Copper Oxide (GIZ Class: D) Pyraclostrobin (GIZ Class: D) Boscalid (GIZ Class: D)	Flusilazole Carbendazim Chlorothalonil Mancozeb
Early leaf spot	*Mycosphaerella arachidis, Cercospora arachidicola*	Groundnut	Boscalid (GIZ Class: D) Copper Oxychloride (GIZ Class: C) Copper Oxide (GIZ Class: D) Difenoconazole GIZ Class: C) Pyraclostrobin (GIZ Class: D) Boscalid (GIZ Class: D)	Flusilazole Carbendazim Chlorothalonil Mancozeb
Groundnut aphids	*Aphis craccivora*	Groundnut	Lambda-Cyhalothrin (GIZ Class: B)	Carbaryl
Undefined leaf miner, possibly groundnut leaf miner	*Aproaerema modicella*	Groundnut	Methoxyfenozide (GIZ Class: D) Deltamethrin (GIZ Class: B)	Abamectin

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