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

India

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Executive Summary

This study report is a part of the baseline survey undertaken for fourteen countries in which the Green Innovation Centre programme by GIZ is implemented. The document contains the findings from India wherein the legislations regarding pesticide use are investigated and compared mainly through desk study. The same has also been validated through in-country surveys.

India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. The focal crops (potato and tomato) contribute about $34 million and $69 million respectively of total revenues generated from agricultural exports. The Ministry of Agriculture & Farmers Welfare (MoA&FW) is the main body responsible for the implementation of policy at the national level. The two important policies/acts relating to pesticide use in India are the Insecticides Act, 1968 and the Insecticides Rules, 1971. Public sector institutions comprising State Agricultural Universities and a large network of ICAR institutes known as the National Agricultural Research System (NARS) dominate India's agricultural research system and are instrumental in standardising packages for plant protection. Insecticides/Pesticides Registered under section 9(3) of the Insecticides Act, 1968 are available for use. Biological control is practiced as part of integrated pest management (IPM). Import of biocontrol agents including macrobials is not permitted without a valid import permit issued by the competent authority

Though IPM is highly relevant to the production of potato and tomato under the command area of Green Innovation Centre-driven farms, a general feeling that the packages are too complicated to implement means that farmers are reluctant to use the technology. There is a gap identified between recommendations given by the extension agents and the actual practices followed by farmers. There is certain degree of casualness observed in the application of pesticide and applications are done either without the aid of specially trained professionals or without specific protective clothing. In some cases the use of highly hazardous pesticide is observed in spite of the efforts of extension agents in recommending and facilitating the availability of eco-friendly alternatives.

Although women's responsibilities in crop production were observed to be greater than their male counterparts, their opinions were not taken into consideration when buying the inputs needed for plant protection. There were equal opportunities for extension agents to interact with females and males but women were found to have less influence in the decision-making process.

Through SWOT analysis internal factors that contribute to the program effectiveness were identified, and some of their limitations were highlighted. Further extraneous factors which should be considered to ensure progress is made in the future were also identified. Following this the main recommendations were finalised, including suggestions that HHPs should be identified and substituted with alternatives or less hazardous pesticides. Recommendations were made to develop trainings, plan workshops and make printed material available to bring about an improvement in awareness regarding the use of PPE amongst farmers and extension agents. Efforts to promote the adoption of the use of sprayers that would ensure safety and the use of less pesticide were recommended, alongside there placement of outdated IPM manuals/reference material with new validated lists of chemicals/practices.

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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.

Acronyms

AI	Active ingredient
AICRP	All-India Coordinated Research Project
AINP	All-India Network Project
AINPPR	All India Network Project on Pesticide Residues
APEDA	Agricultural and Processed Food Products Export Development Authority
CROP	Computerised Registration of Pesticides
C&L Inventory	Classification and Labelling Inventory
CABI	Centre for Agriculture and Bioscience International
CIB&RC	Central Insecticides Board & Registration Committee
CIPMC	Central Integrated Pest Management Centres
CP	Country Program
CUE	Critical use exemptions
DNAs	Designated National Authorities
DPPQS	Directorate of Plant Protection, Quarantine & Storage
ECHA	European Chemicals Agency
ESC	Empowered Steering Committee
FAO	Food and Agriculture Organisation of the United Nations
FAW	Fall armyworm
FFS	Farmers' Field Schools
FSSA	Food Safety and Standards Act
FSSAI	Food Safety & Standards Authority of India
GEF	Global Environment Facility
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”)
HHP	Highly hazardous pesticide
HSM	Hazardous Substances Management Division
ICAR	Indian Council of Agricultural Research
ILO	International Labour Organization
IPM	Integrated Pest Management
IRCA	Indian Railways Conference Association
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
MIDH	Mission for Integrated Development of Horticulture
MOA&FW	Ministry of Agriculture & Farmers’ Welfare
MoC&I	Ministry of Commerce and Industries

MoEF&CC	Ministry of Environment, Forest and Climate change
MOFA	Ministry of Food and Agriculture
MoH&FW	Ministry of Health & Family Welfare
MPRNL	Monitoring of Pesticides Residue at National Level
NARS	National Agricultural Research System
NCIPM	National Centre for Integrated Pest Management
NEAC	National Environment Awareness Campaign
NGC	National Green Corps
NIC	National Informatics Centre
NMSA	National Mission for Sustainable Agriculture
NOU	National Ozone Unit
NPIC	National Poisons Information Centre
NPIL	National Pesticides Investigational Laboratory
NPOP	National Programme for Organic Production
NPPO	National Plant Protection Organisation
NPRR	National Pesticides Reference Repository
OCP	Official Contact Points
ODS	Ozone depleting substance
OECD	Organization for Economic Cooperation and Development
PAN	Pesticide Action Network
PHI	Pre-harvest interval
PIC	Prior informed consent
PKVY	Paramapragat Krishi Vikas Yojana
POP	Persistent organic pollutant
PPVFRA	Protection of Plant Varieties and Farmers Rights Authority
QCI	Quality Council of India
SACEP	South Asia Cooperative Environment Programme
TFSC	Technology and Finance Standing Committee
UN	United Nations
WHO	World Health Organisation

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Introduction

Almost 3 billion people globally still suffer from malnutrition, and smallholder farmers in underprivileged regions of the world are particularly vulnerable. Yield losses to pests, diseases and weeds are estimated to be around 35% in major crops (Oerke, 2005), and in developing regions where pest control options are limited these losses may exceed 50%. 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 benefits to farmers. 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 pest management practices for the major pests of the Green Innovation Centres focal crops. 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 the Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO), details the best pesticide management practices. These best practices are designed to minimise adverse effects that may result from pesticide use and to foster the use of sustainable pest management strategies. An analysis of the legal framework compared each country's regulations and policies against the best practices. This legal framework analysis also included an analysis of the registered pesticides and of the hazards linked to their use. For 8 countries – Burkina Faso, Cameroon, Ghana, India, Kenya, Malawi, Mali, and Tunisia – the study was complemented by in-country data collection. This included key informant interviews and group discussions 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, as well as current knowledge of integrated pest management.

Based on the results of the study, CABI drafted, 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 report describes the findings and recommendations for the study conducted in India.

Methodology

The methodology for the study was devised in such a way that it could be implemented in all fourteen 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 any 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 in India, in order to map the value chains for each focal crop (potato and tomato) 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 these focal crops.

Utilising a tool developed by CABI, the most up-to-date version of the national list of registered pesticides and bio pesticides was analysed to identify the full list of active ingredients (AI) and products which are registered for use in India. 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 Guidelines on Highly Hazardous Pesticides (FAO 2016) defines highly hazardous pesticides (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. Highly hazardous pesticides which are registered for use in the country were identified using these criteria and 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. With the support of national partners, the National Insecticides Act of 1968 and the Insecticide Rules, 1971, as well as subsidiary legislation and other policies relating to pests and pesticide management were identified, and an analysis of the existing legal framework for pest and pesticide management was carried out. A cross comparison was made with international guidelines (e.g. from the FAO and the International Labour Organization (ILO)) and other regulatory best practices (e.g. the Organization for Economic Cooperation and Development (OECD)).

Information obtained from the desk study was used to compile a preliminary description of the policy setting process in India. 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.

In country data collection

Twelve farmers were surveyed; seven of these growing tomato and five growing potato. Eight extension officers who managed both potato as well as tomato crops were also given individual questionnaires. Alongside this, one Focus Group Discussion (FGD) was held with four farmers involved in tomato production and four from potato-growing regions. Focus group discussions were also held with four extension officers in both the tomato and potato regions. Care was taken not to use the same farmers/extension officers in the surveys as well as the FGD. The following describes the findings from the data analysis. Focus group discussions and key informant interviews were also held with agro dealers, researchers, policy makers. GIAE officials and the local implementing agencies were also interviewed as a part of the survey. The key areas of investigations were Karnataka, Maharashtra and Andhra Pradesh, India.

Limitations of the methodology and data

Most of the information relating to the legal framework for pest and pesticide use was obtained from the website of the Central Insecticides Board & Registration Committee (CIB&RC), which

describes the Insecticides Act of 1968 and the Insecticides Rule, 1971. Information on the website was found to be dated and not enough content was available to fulfil the purpose of the study. Securing appointments with officials in the Ministry was quite bureaucratic and time-consuming. At times the interviewees were not in possession of up-to-date information. The operation of GIAE-implementing organisations was not scaled-up enough to find a sufficient number of farmers and extension agents to interview during the in-country data collection, bearing in mind that the aim was not to use the same individuals in FGDs as well as individual surveys.

Project sites were located remotely and the distance between locations ranged from 400km to 1000km, so preparation and travel was time-consuming. In almost all locations, printed material was not available so the survey inputs could not be checked against reference literature. Further, responses from individual surveys showed little variation within regions, as respondents all had similar sources of information.

Results

Overview of the agricultural sector

India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep and goat meat, fruit, vegetables and tea in the world (World Bank Group, 2012). It is also the second biggest harvester of vegetables and fruits, accounting for about 9% and 10% of the overall production of vegetable and fruit in the world respectively (Maps of India, 2015). India produces about 45 million tonnes of potato from 2 million hectares of land, with the northern plains contributing about 84% of the total produce (Singh & Lal, 2009). Tomato production in India stands at 18 million tonnes, produced from an area of 0.9 million hectares (Table 1). In the last seven years, the area under potato production has seen a trend of fast upward growth.

According to the FAO World Agriculture statistics, India is among the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fresh meats, select fibrous crops such as jute, several staples such as millets and castor oil seed. India is also the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials, roots, tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India is ranked among the world's five largest producers of over 80% of agricultural produce items, including many cash crops such as coffee and cotton. Table 1 shows the latest available figures of agriculture sector in India.

Table 1 Overview of agriculture sector performance and contribution to the economy

Selected indicators – agriculture sector generally	2007	2010	2013	Most recent available data
Total area of land under agriculture (million ha)	179.62	179.57	179.61	179.60 (2014)
Arable land per person (ha)	0.1363	0.1302	0.1248	0.1233 (2014)
GDP per capita (US$)	1018.16	1345.77	1452.19	1709.38 (2016)
Agricultural value added (% of GDP)	18.93	18.88	18.58	17.35 (2016)
Agricultural value added (annual % growth)	5.79	8.59	5.57	4.88(2016)
Agricultural labour force (% of total labour force)	59.9 (2000)			47.2(2014)
Rural population (% of total)	70.09	69.07	68.00	66.86(2016)
Value of total agriculture production (million US$)	227365.15	303428.11	299997.48	315124.79 (2014)

Source: FAOstat

Key crops, both domestic and for export

The major exportable products are fresh vegetables and seeds, pulses, wheat, milled products, Basmati rice, and cereals, bringing over $16 billion in revenue to the country (Apeda AgriXchange, 2017). Of the focal crops, potato contributes about $34 million and tomato contributes about $69 million in total revenues, generated from agricultural exports (Table 2).

Table 2. Production of key crops in India in 2013

Key commodities (general)	Area harvested (ha)	Yield kg/ha	Production (1000 tonnes)	Export US$ (000)
Rice	44135950	36070	159200	8205309
Wheat	29650000	31538	93510	1911966
Sugar cane	5060000	674308	341200	na
Vegetables	2815000	117986	33213	84098
Bananas	796000	346420	27575	26495
Maize	9430000	24698	23290	1264042
Onions, dry	1217000	158578	19299	603519
Seed cotton	11690000	16179	18913	604
Mangoes, mangosteens, guavas	2500000	72008	18002	20431
Eggplants (aubergines)	722000	186205	13444	84
Soybeans	11716430	10198	11948	106821
Millet	9179000	11886	10910	26318
Chick peas	8522000	10364	8832.5	348421
Rapeseed	12334	12334	7820	23873
Potato	1992200	227606	45343.6	34490
Tomato	880000	207125	18227	69721

Source: FAOstat

General information about the focal crop value chain in country

Fruit and vegetables form an important component of the total consumer spend on food items. The share of fruit and vegetables as a part of India's food expenditure ranged from 26 to 29% between 2005 and 2010. The Indian agriculture industry can be classified into four major product groups; food grains, fruit and vegetables, dairy and meat. These product groups together account for approximately 85% of private final consumption expenditure on food (MART, September, 2014).

Major markets

India has been working on increasing the productivity levels of fruits and vegetables. However, greater emphasis is needed in interventions aimed at marketing the produce effectively. India's varied climatic and soil conditions make it a favourable location for growing a wide variety of horticultural crops including those which have a huge demand overseas. Thus, there is also significant export opportunity, which can be tapped into by building on the infrastructure for proper handling, storage and processing of the produce.

The largest market in terms of handling (buying and selling) of agri-produce is Delhi followed by Mumbai, Bangalore and Pune, which means that supply can be maintained throughout the year. Uttar Pradesh, which isthe largest producer of potato, supplies the product to these large markets, however, it only witnesses market arrivals for 4-5 months of the year.

The focal crops under this study i.e., potato and tomato are among the major products that farmers grow due to their ready commercial take-up. Some of the retail chains and processing industries have set up internal systems with the farmers for production and buy-back. Both these products are marketed fresh as well as processed and are exported to neighbouring countries. Table 3 outlines some of the major markets for the focal crops.

Table 3 Focal crops, product types and major markets

Crop	Products	Major markets
Potato	Fresh/Chilled Potato, value in Rs lacs: 64,056 (2016-17) Quantity in MT: 3,84,246.84 (2016-17) Source: Apeda AgriXchange (2017)	International: Nepal, Sri Lanka, Oman, Mauritius, Kuwait, Malaysia, Maldives, UAE, Seychelles, Hong Kong, Bahrain, Indonesia
	French fries, wedges, cutlets, chips, dehydrated potato products like flakes, granules, Bhujia, Tikki, thickener, fabricated chips, patties and in preparation of premixes used for other products. Source: Apeda AgriXchange (2017)	Domestic: The estimated domestic production of French fries is about 500 MT. Wimpy is reportedly making 70 MT per year
Tomato	Fresh/Chilled Tomato, value in Rs lacs: 54,806 (2016-17) Quantity in MT: 2,67,198.49 (2016-17) Source: Apeda AgriXchange (2017)	International: Pakistan, UAE, Bangladesh, Nepal, Maldives, Oman, Qatar, Saudi Arabia, Kuwait, Bhutan, Singapore

Analysis of factors influencing the retail of the focal crops

Influence of price and other factors

The aggregator governs the supply chain as he can either sell in the market or keep products in cold storage for off-season sale. Expenses are incurred in transportation, grading and cold storage. The wholesaler has the highest margin by virtue of having superior price information available to him. Farmers have the lowest margin since they have less bargaining power, and there may be collusion between wholesalers and aggregators. The retailer also gains a significant share even though they add little value to the product.

Domestic potato market

At present about 68.51% of potato production is consumed as fresh while 10.51% is used for seed and 8.2% goes to processing. A small amount is exported (0.28%) while the remaining 12.5% goes to waste, for example, due to rotting or general wastage across the supply chain. The sizeable amount of potato output lost post-harvest can be put down to the tropical and sub-tropical climates seen across a large part of the country.

Challenges in retailing focal crops in India

There is high competition from unorganised kirana (local shops) and a lack of quality post-harvest infrastructure. The quality of produce demanded by the consumer is still far from what is produced. There is a fragmented supply base and a large number of intermediaries. Increasing rentals and inflation of food prices are driving up costs in the value chain.

Constraints in logistics and transportation

Transport costs average Rs 0.75-1 per kilogram. However, vehicles are often not fully loaded, leading to under-utilisation of capacity and consequently costs that are higher than they could be.

Table 4 below provides details about the sources of inputs used by farmers. Whilst this list is small, it represents the main suppliers of farm inputs to farmers looked at under this study. A certain level of trust has been developed between the suppliers and their clients for their ability to make the inputs required in the farm available in a timely fashion. The information below was noted while interviewing the farmers and extension staff involved in the project.

Table 4 Sources of synthetic pesticides and bio pesticides

Activity type	Company & Address	Inputs
Agro Input Supplier	Abhishek Pawar Agrodealer Opposite Narayangaon Bus Stand, Narayan Gao, Pune Maharashtra	Machinery Seed/seedlings Fertilisers Pesticides Herbicides Poles and threads for staking Crates for transportation Biopesticides
Agro Input Supplier	Pepsico Co,	PPE
Agro Input Supplier	Ramchandra, Vallabhai Road, Hassan , Karnataka	Pesticides, biopesticides, PPE, seed, fertilizers, growth promoters, nutrients etc,
Agro Input Supplier	BASF India Ltd	Subsidised PPE
Government	State Department of Agriculture, Maharashtra	Biopesticides
Government Agencies	Raitre Samapark Kendra, Hassan, Karnataka.	Subsidised pesticides

Private sector partnerships with German companies were not that evident in the focal crops, but a certain level of engagement was in progress as mentioned below in Table 5.

Table 5 Private sector stakeholders, including planned or existing partnerships with German Companies

Farmer associations	Trade sector actors	Others (indicate role)
There was no mention of direct partnerships between the farmer associations with German companies; however, needs-based services (such as input supply) were observed during interactions with the field staff.	Commission Agent, Kadur Market. Kadur Karnataka	
	Madanapalle or Palamaneru APMC market (Agricultural Produce Marketing Committee, APMC).	BASF (Planned)
	Seed Companies like Nunhems, Namdaari, Syngenta	BAYER (Formalised for apple)
	Bangalore Market	
	Hassan Market	

Organisational arrangements within the national governments for pest and pesticide management

The roles and responsibilities of the government organisations in relation to pest and pesticide management are shared among different ministries or organisations (Table 6).

Table 6 Profiles of government agencies and their responsibilities

Role	Ministry name	Department/agency responsible	Specific functions list (relating to pest and pesticide management)
Registration of pesticides	Ministry of Agriculture & Farmers' Welfare (MOA&FW)	Central Insecticides Board & Registration Committee (CIB&RC)	Develop and implement policies, acts, standards, rules and regulations
Enforcement of pesticide regulations.	Ministry of Agriculture & Farmers' Welfare (MOA&FW)	Central Insecticides Board & Registration Committee	Develop and implement policies, acts, standards, rules and regulations
National Plant Protection Organisation	Ministry of Agriculture & Farmers welfare (MOA&FW)	Directorate of Plant Protection, Quarantine & Storage (DPPQS)	Develop and implement policies, acts, standards, rules and regulations
Food safety.	Ministry of Health & Family Welfare (MoH&FW)	Food Safety & Standards Authority of India (FSSAI)	Develop and implement policies, acts, standards, rules and regulations
Public health issues related to pesticide.	Ministry of Health & Family Welfare (MoH&FW)	Food Safety & Standards Authority of India (FSSAI)	Develop and implement policies, acts, standards, rules and regulations
Plant variety registration.	Ministry of Agriculture & Farmers welfare (MOA&FW)	Protection of Plant Varieties and Farmers Rights Authority (PPVFRA)	Registration of plant varieties
Environment	Ministry of Environment, Forest and Climate change (MoEF&CC)	Hazardous Substances Management Division (HSM)	Contact point for international conventions and development & implementation of environment related acts, rules and regulations
Agricultural research	Ministry of Agriculture & Farmers welfare (MOA&FW)	Indian Council of Agricultural Research (ICAR)	Research – pesticide pre-harvest intervals and pesticide review network
Extension	Ministry of Agriculture & Farmers welfare (MOA&FW)	Extension Division	Implementation of agriculture extension activities
Farmer training	Ministry of Agriculture & Farmers welfare (MOA&FW)	Directorate of Plant Protection, Quarantine & Storage (DPPQS)	To coordinate with state authorities for carrying out training courses
Commodity boards	Ministry of Commerce and Industries (MoC&I)	Agricultural and Processed Food Products Export Development Authority (Apeda AgriXchange))	Promote agriculture exports
Setting and overseeing policies relating to IPM, GAP, organic agriculture and/or sustainable agriculture	Ministry of Agriculture & Farmers welfare (MOA&FW)	Directorate of Plant Protection, Quarantine & Storage (DPPQS)	Implementing IPM systems through central, regional and state centres
Setting and overseeing financial instruments such as subsidies, incentive programmes, taxes on inputs.	National Horticulture Board	Mission Director(s)	General IPM kits, which includes subsidised products for distribution to farmers
Official contact points/designated national authorities for multi-lateral environmental agreements	Ministry of Environment, Forest and Climate change (MoEF&CC)	Montreal Protocol. The Ozone Cell Rotterdam, Basel, Stockholm convention: Hazardous Substances Management Division	Coordination, notification, implementation, policy regarding international conventions in India

Analysis of existing legal framework for pest and pesticide management

The Ministry of Agriculture & Farmers Welfare (MoA&FW) is the main body for the implementation of acts and rules in the country at a national level. The two important instruments relating to pesticides in India are the Insecticides Act, 1968, and the Insecticides Rules, 1971.

The Ministry of Environment, Forests and Climate Change (MoEF&CC) is the nodal Ministry in the Government of India, responsible for all multilateral environmental agreements. These include the Basel Convention on Trans-boundary Movement of Hazardous Substances, Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that deplete the Ozone Layer, the Stockholm Convention on Persistent Organic Pollutants, Rotterdam Convention etc. The International Cooperation (IC) Division within the Ministry coordinates all issues related to international environmental cooperation. The IC Division is responsible for coordinating the United Nations Environment Programme (UNEP), the South Asia Cooperative Environment Programme (SACEP) and the Global Environment Facility (GEF) (Government of India, 2017). While at a national level these two ministries are responsible for the advocacy of national and international agreements, it is the state authority that is responsible for the actual implementation in compliance with directions under the Acts from national Ministries.

Adherence to and implementation of international agreements relating to pesticides

The country became a party to the **Vienna Convention** in 1991, and the **Montreal Protocol** in 1992 and the Government of India has entrusted the work relating to the implementation of the "Montreal Protocol on Substances that Deplete the Ozone Layer" to the MoEF&CC. The Ministry has established an Empowered Steering Committee (ESC) supported by two standing committees; the Technology and Finance Standing Committee (TFSC) and the Standing Committee on Monitoring. The ESC has overall responsibility for the implementation of the Montreal Protocol provisions. The Ministry has also set up an Ozone Cell as a National Ozone Unit (NOU) to undertake activities relating to the implementation of both the Vienna Convention and the Montreal Protocol, and the ozone-depleting substances (ODS) phase-out program in India. India prepared a detailed Country Program (CP) in 1993 for the phase-out of ODSs in accordance with its National Industrial Development Strategy. The Government of India produced the ODS (Regulation & Control) Rules, 2000 (framed under Environment (Protection) Act, 1986), which came into effect in July 2000 to control the production, consumption, export, import, sale and destruction of ODS (MoEF&CC, 2000). The use of methyl bromide was covered in the Environment (Protection) Act, 1986 (Group VIII of Schedule I) with a view to phasing its use out by the 1st January 2015, except for quarantine and pre-shipment applications (Government of India, 2000). The use of methyl bromide is also restricted under the Insecticides Act, 1968 and subject to the following conditions; (a) to be used by the Government Departments/Agencies, who have staff trained to supervise operations, (b) the Plant Protection Adviser to the Government of India must approve commercial pest control operators to be able to stock and use these fumigants and to demonstrate expertise for undertaking fumigation.

The country became a party of the **Rotterdam Convention** in 2005. The Government of India published the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 (superseding the Rules of 1989), which laid down statutory backing for the prior informed consent procedure (PIC), one of the key provisions of the Rotterdam Convention. The production, use and import of most persistent organic pollutant (POP) pesticides are banned in India. In the context of the Rotterdam Convention, The Designated National Authorities (DNAs) for India are within the MoA&FW and the Ministry of Chemicals and Fertilizers. The Official Contact Points (OCPs) are designated in MoEF&CC (APPPC, 2017). The country has submitted 43 import responses, the most recent being azinphos-methyl on the 12th December 2014. India has not specified its stand on mercury-based pesticides, and it has failed to provide import responses for four chemicals including one pesticide; methamidophos. The country provided notice of final regulatory action for one of the pesticides. No proposals for listing Severely Hazardous Pesticide Formulations in Annex III were submitted by the country. A total of 29 pesticides and four insecticide formulations have been banned for import, manufacture and use in the country. The

use of eight other pesticides has been withdrawn, while 18 pesticides have been refused for registration in India (Rotterdam Convention website, 2010).

The country became a party to the **Stockholm Convention** in 2002 and ratified it in 2006. The MoEF&CC, under the Environment Protection Act 1986, is responsible for ensuring the effective implementation of legislation, monitoring and control of pollution (including pesticide levels in soil and water), environmental clearances for industrial development projects, promotion of environmental education, training and awareness, and coordination with concerned agencies at the national and international level. A special unit to monitor the convention implementation and monitoring has been set up within the MoEF&CC. India initiated the process of the development of a National Implementation Plan (NIP) through Global Environment Facility (GEF) funding (MoEF&CC, 2011). A National Steering Committee (NSC) has been constituted to guide and monitor all actions needed for the preparation of the NIP (Government of India, 2011). As a stakeholder in the NSC the MoA&FW (the ministry with responsibility for dealing with pesticides) is responsible for guiding and implementing the NIP. India's NIP has been submitted to the Stockholm Convention Secretariat. As of now, India has ratified 12 initially listed POPs and is in the process of the ratification of selected newly listed POPs (Toxicswatch, 2017). All POPs pesticides in India are covered under the Insecticides Act, 1968 and the Insecticide Rules, 1971 of the MoA&FW. The only POP pesticide permitted for manufacture and use is DDT. India is the only country in the world to still manufacture DDT. The firm Hindustan Insecticide Limited (HIL), a Government of India enterprise, is the only producer of DDT in India, and its only use permitted is by the Ministry of Health under its vector control programme.

The country became a party of the **Basel Convention** in 1990 and this was ratified in 1992. The Hazardous Wastes Management Rules Act 1989 provides a statutory framework to give force to this Multilateral Environmental Agreement in India. A recent revision of this act was published by the Government of India in the Ministry of Environment, Forest and Climate Change (MoEF&CC) vide number G.S.R. 582(E), dated the 24th July, 2015 in the Gazette of India. The Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016 was notified to ensure the safe handling, processing, treatment, storage, collection, transportation, collection, and disposal of hazardous waste. A strategy for the import and export of hazardous and other wastes has also been published under this act.

The country is a party of the **International Labour Organisation Safety and Health in Agriculture Convention** (C184). India has been a member of the ILO since 1919 and ratified the Convention in March 2000. The "National Policy on Safety, Health and Environment at Work Place" by the Ministry of Labour and Employment provides a statutory framework on Occupational Safety and Health in respect of all sectors of industrial activities including the construction sector, designing suitable control systems of compliance, enforcement and incentives for better compliance (ILO, 2013). The main act governing the system on safety and health in agriculture is The Insecticides Act, 1968. The Government of India constituted the Central Insecticides Board to advise the Central Government and State Governments on technical matters arising out of the administration of this Act. One representative of the board must be an expert in industrial health and occupational hazards, to be nominated by the National Government (CIB&RC, n.d.). The Insecticides Act, 1968, also deals with the manufacturing, packaging, labelling, distribution, handling and use of insecticides in general. Therefore, the control measures given in this Act relating to hazards in the use of insecticides are applicable to the agriculture sector as well. This Act is enforced by the State Agriculture Departments as far as its applicability to agricultural operations is concerned. The Insecticides Act, 1968 ensures the health and safety of unorganised sector workers engaged in agriculture and construction activities, however, implementation of these legislations is tardy (Government of India 2011b). Chapter VIII of the Insecticides Rules, 1971 details provisions regarding protective clothing, equipment, and other facilities for workers during manufacture, etc. of insecticides.

Instructions for the safe use of pesticides are published and circulated through various central and state institutes (Government of India, 2016).

Overview of national regulations relating to pests and pesticide management

The legal foundation of quarantine regulation is provided by the **Destructive Insects & Pests Act, 1914** (2 of 1914). The Plant Quarantine (Regulation of Import into India) Order, 2003 notified under this Act, regulates the import of agricultural commodities and wood packaging material. All regulatory provisions for the import of plants and plant materials into the country are available at the Directorate of Plant Protection, Quarantine and Storage website (Plant Quarantine Order, 2015).

India is a signatory to the 2003 FAO "International Code of Conduct on the Distribution and Use of Pesticides". The import, manufacture, sale, transport, distribution and use of pesticides is regulated under the Insecticides Act, 1968, with the objective of ensuring the efficacy and safety of all products. So far 279 pesticides and 116 combined formulations have been registered/approved for use in India. The details of registered as well as banned pesticides are available from the Central Insecticides Board & Registration Committee website (http://cibrc.nic.in/). Complete details of pesticide usage, monitoring and documentation is carried out on an annual basis and includes information on production, demand by state, consumption by state, prices, sale points, pesticide import and export statistics (Directorate of Plant Protection, Quarantine & Storage, 2016).

Laws

- The Destructive Insects and Pests Act, 1914 and Destructive Insects and Pests (Amendment and Validation) Act, 1992 (No.12 of 1992, 31st March, 1992) amendments. This act has made provisions for preventing the introduction into India of any insect, fungus or other pest, which is or may be destructive to crops.
- The Insecticides Act, 1968 (CIB&RC, n.d.) regulates the import, manufacture, sale, transport, distribution and use of insecticides with a view to preventing risk to human beings or animals.
- The Insecticides Rules, 1971 (CIB&RC, n.d.). These rules were formed to create processes for streamlining the registration, marketing, storage, transportation, etc. of pesticides in the country.
- The Plant Quarantine Order, 2003, regulates the import and prohibition of import of plants and plant products into India (Plant Quarantine Order, 2015).

Policies to promote reductions in unnecessary pesticide use, including IPM, GAP, organic production and sustainable agriculture

The major activities in the plant protection sector include quarantine inspection of imported agricultural commodities; phytosanitary certification to enable the export of plants and plant materials; technical facilitation to help gain market access for agricultural commodities; containment and eradication of exotic pests; surveillance and monitoring of crops for insect-pests, diseases and weeds; issuing advisories to farmers and extension workers; control of desert locusts; regulation and quality assurance of pesticides; promotion of integrated pest management; development of human resources in plant protection and monitoring of pesticide residues. The NPPO works in tandem with research institutions and state governments to fulfil its mandate. Capacity building, training and human resource development in plant protection is managed by the National Institute of Plant Health Management (NIPHM).

Integrated Pest Management

The Department of Agriculture and Cooperation promotes the Integrated Pest Management (IPM) approach under the scheme "Strengthening & Modernization of Pest Management" through 35 Central Integrated Pest Management Centres (CIPMCs) located in 29 States and one Union Territory (Directorate of Plant Protection, Quarantine & Storage, 2016b).

The mandate of these Centres is pest/disease monitoring, production and release of bio-control agents, conservation of bio-control agents and Human Resource Development in IPM. This is done by providing training to Agricultural Extension Officers and farmers at the grassroots levels by organising Farmers' Field Schools (FFSs). IPM packages have been developed for 87 crops, and the Government has supported 352 bio-control laboratories for the promotion 15 of bio-control

agents(Directorate of Plant Protection, Quarantine & Storage, 2016b). Consumption of pesticides in India was 57000 MTs (technical grade) during 2016-17 while bio-pesticide consumption was 6340 MTs (Directorate of Plant Protection, Quarantine & Storage (2016c). The Ministry of Agriculture & Farmers Welfare is also implementing a programme “Monitoring of Pesticides Residue at National Level” to determine pesticide residues in agricultural produce and irrigation water. These CIPMCs undertake various activities including popularising the IPM approach among the farming community, conducting regular pest surveillance and monitoring to assess the pest/disease situation, and playing a catalytic role in the spread of innovative IPM skills to extension workers and land farmers.

The National Centre for Integrated Pest Management was established in 1988 in the campus of ICAR at New Delhi (www.ncipm.org.in). The objective of this centre is to conduct research and develop crop specific protocols for catering to the needs of plant protection and to promote environmentally sound IPM technologies in India.

The Quality Council of India (QCI) has established a “Good Agriculture Practices Voluntary Certification Scheme” (Quality Council of India, 2015) The QCI is a joint venture between the Government of India and private industries, aiming to establish an accreditation structure in the country and improve quality in general through its National Quality Campaign. The GAP Voluntary Certification Scheme is aimed at promoting sustainable agriculture, contributing to meeting national and international environment objectives, improving the safety and quality of food and other agricultural products. It is also expected to help increased compliance to national and international regulations, standards and guidelines regarding pesticides and contaminants (Quality Council of India, 2015).

The National Programme for Organic Production (NPOP) was implemented through the MoA&FW in 2001. The NPOP operates under the overall guidance of the Department of Commerce and provides a certification programme for organic agriculture and products, an accreditation programme for certification agencies, certification of organic products, and encourages the development of organic farming and organic processing (Government of India Press Information Bureau, 2016).

The government also promotes organic farming through various schemes/programmes including the following; National Mission for Sustainable Agriculture (NMSA), Paramapragat Krishi Vikas Yojana (PKVY), Rashtriya Krishi Vikas Yojana, Mission for Integrated Development of Horticulture (MIDH), National Mission on Oilseeds & Oil Palm, and the Network Project on Organic Farming of ICAR (Government of India Press Information Bureau, 2015). The PKVY is a cluster-based programme in which fifty or more farmers are encouraged to form a group in order to undertake organic farming. Farmers will be provided with money (Rs 20,000 per acre) to assist in seed purchasing, harvest and transport (Government of India Press Information Bureau, 2015, Government of India Ministry of Agriculture and Farmers Welfare, 2017). The NMSA was created to enhance agricultural productivity especially in rain fed areas. It focuses on integrated farming, water use efficiency, soil health management and synergising resource conservation. The programme has been in operation since 2014.

Other schemes indirectly influencing the sustainable farming in India are through modern extension systems such as the National Mission on Agricultural Extension and Technology, which aims to spread farm extension services and mechanization. There is a Support to State Extension Programmes for Extension Reforms scheme in which the government provides additional support to states for setting up the Farmer Advisory Committees (FACs) and other activities such as educating and creating awareness amongst farmers (MoA&FW)

Research

Public sector institutions comprising state agricultural universities and a large network of ICAR institutes known as the National Agricultural Research System (NARS) dominate India’s agricultural research system. Research and development in the field of persistent organic pollutants (POPs) in India has been undertaken in a decentralized manner. Work on pesticides is

being undertaken under various schemes of the Ministry of Agriculture. For example, the Indian Council for Agriculture Research (ICAR) started the All-India Coordinated Research Project (AICRP) on pesticide residues in 1984-85 with a view to developing protocols for the safe use of pesticides. The project was later renamed the All-India Network Project on Pesticide Residues (AINP), aiming to undertake work on the persistence of pesticides on different crops. Based on the data generated, waiting periods have been worked out for the safety of consumers. The National Centre for Integrated Pest Management (NCIPM) under the ICAR system is largely responsible for conducting trials on biological-based pesticides and verifying the efficacy of these for approval for application on crops. Other initiatives are the setting up of project directorates under ICAR, which look into the focused research on sustainable agriculture using biocontrol products. There are AICRPs on research, utilization and promotion of non-chemical technologies.

Legal framework for non-chemical preventive and direct control measures

Registration is required for biological control products under the Insecticides Act, 1968. Under this Act the active ingredients as well as formulated products are to be tested under two agro-climatic conditions for efficacy against the targeted pest, shelf life studies, container compatibility and toxicity to environment. This gives the product a provisional registration under section 9-3B and permits the marketing of the product for three years. During this time the manufacturers are able to generate data for a permanent registration under 9(3). Bio-pesticides, including pesticides of plant origin as well as microbials, which do not leave a residue on the crop are exempted from the regulation of setting up MRLs and tolerance limits. Subsidy schemes are decided and implemented at state levels, and these vary from state to state. A few national schemes are promoted by the National Horticulture Board and National Horticulture Missions, including some that are “credit linked projects relating to establishment of hi-tech commercial production units involving use of bio-pesticides” (National Horticulture Board, 2010).

Price and trade policy, including subsidies

Prices are both market driven as well as being influenced by government purchase. There are various input industries which have their own extension and market channels to mobilise products through a dealer network to the farmers. At the same time the government also obtains the product through various schemes run by the state departments which procure products through tenders and supply the stock to the farmers through the department and ground level extension officers.

For the focal crops under this study; potato and tomato, no minimum standard price is provided by central government, however, the state government may provide temporary minimum standard prices for potato on a case by case basis to support farmers in distress due to price crashes etc. (Acharya, 2017).

Integrated pest management subsidies are managed by the Department of Horticulture as well as the Department of Agriculture. Pesticides are provided at subsidised rates in some states. Under the Karnataka State Guidelines there are two schemes in operation; one is through national IPM subsidy in which a subsidy of around Rs 1200/ha is given. Another is a state department integrated pest management scheme wherein Rs 2000/ha is provided for religious and caste-based minorities. Most of the time farmers will purchase pesticides from an authorised dealer. Sometimes they do not use the recommended pesticide, even though IPM is promoted and pesticides are available at subsidised rates. Currently subsidies to cover the costs of PPE are not in place (Telephone conversation with Dr. Nagraju, Joint Director, State department of Horticulture, Karnataka).

Registration (synthetic pesticides and biopesticides)

The Central Insecticide Board & Registration Committee (CIB&RC) is the national organisation responsible for formulating the rules and regulations for pesticides in India. CIB&RC has constituted a Registration Committee consisting of a Chairman and up to five Board members (including the Drugs Controller, India, and the Plant Protection Advisor to the Government of India). The committee is responsible for (i) registering insecticides after scrutinising their formulae and verifying claims made by the importer or the manufacturer as regards their efficacy and safety to

human beings and animals; and (ii) to perform such other functions as are assigned to it by or under this Act.

Section 36 of the Insecticides Act, 1968 (46 of 1968) has conferred powers to the CIB&RC to issue complete guidelines for registration, considering the scientific basis, effectivity and risk management. Under the CIB&RC guidelines ("Guidelines for Registration", 2011), applicants are required to submit data on chemistry, bioefficacy and residues, toxicity, packaging and processing on the molecules as per the guidelines of Registration Committee. Different categories of registration include export, technical import, formulation import, indigenous manufacture, technical indigenous manufacture, new source, new formulation, etc. On receipt of an application for the registration of an insecticide, the Committee may, after satisfying itself that the insecticide to which the application relates conforms to the claims made by the importer or by the manufacturer, and on payment of such fee as may be prescribed, allot a registration number and issue a certificate of registration within a period of twelve months from the date of receipt of the application. If the Committee is unable to arrive at a decision within 12 months, they may extend the period by a further period not exceeding six months. If the Committee is of the opinion that the precautions claimed by the application to ensure safety to human beings or animal are not such as can be easily observed or the use of the insecticide involves serious risk to human beings or animals, it may refuse to register the insecticide. The CIB&RC has developed a system for the online registration of pesticides called the Computerised Registration of Pesticides (CROP).

Biocontrol agents which are not covered by the national authority handling the registration of pesticides, e.g. macro-organisms

The import of biocontrol agents including macrobials is not permitted without a valid import permit issued by a competent authority described in schedule X (Plant Quarantine Information System, n.d.). For all matters relating to export, guidelines from the National Biodiversity Act (NBA, 2004) are to be complied with.

Packaging and Labelling

Chapter V of the Insecticides Rules, 1971, discusses in detail the requirements for packing and labelling of insecticides. It states that "No person shall stock or exhibit for sale or distribute [or cause to be transported] any insecticide unless it is packed and labelled in accordance with the provisions of these rules" and that "Every package shall be approved by the Registration Committee". The requirements described in the Insecticides Rules, 1971 include the following:

"The packaging of every pesticide shall include a leaflet detailing the following:

- The plant disease, insects and noxious animals or weeds for which the insecticide is to be applied, the adequate direction concerning the manner in which the insecticide is to be used at the time of application;
- Particulars regarding chemicals harmful to human beings, animals and wild life, warning and cautionary statements including the symptoms of poisoning, suitable and adequate safety measures and emergency first-aid treatment where necessary;
- Cautions regarding storage and application of insecticides with suitable warnings relating to inflammable, explosive or other substances harmful to the skin;
- Instructions concerning the decontamination or safe disposal of used containers;
- A statement showing the antidote for the poison shall be included in the leaflet and the label;
- If the insecticide is irritating to the skin, nose, throat or eyes, a statement shall be included to that effect;
- The common name of the insecticide as adopted by the International Standards Organisation, and where such a name has not yet been adopted such other name as may be approved by the Registration Committee."

"The officially approved label should have the following particulars either printed or written in indelible ink on the label of the innermost container of any insecticide and on the outermost covering in which the container is packed:

- Name of the manufacturer (if the manufacturer is not the person in whose name the insecticide is registered under the Act, the relationship between the person in whose name the insecticide has been registered and the person who manufactures, packs or distributes or sells it shall be stated);
- Name of insecticide (brand name or trade mark under which the insecticide is sold).
- Registration number of the insecticide;
- Kind and name of active and other ingredients and percentage of each (the common name accepted by the International Standards Organisation or the Indian Standards Institutions of each of the ingredients shall be given and if no common name exists, the correct chemical name which conforms most closely with the generally accepted rules of chemical nomenclature shall be given);
- Volume of net contents (the net contents shall be exclusive of wrapper or other material. The correct statement of the net content to terms of weight, measure, number of units of activity, as the case may be, shall be given. The weight and volume shall be expressed in the metric system);
- Batch number;
- Expiry date, i.e. the date up to which the insecticide shall retain its efficiency and safety;
- Antidote statement."

"The label shall be located in a prominent place and occupying not less than one-sixteenth of the total area of the face of the label, a square, set at an angle of 45^{o} (diamond shape). The upper portion of the square shall contain the following symbols and warning statements.

- Insecticides belonging to Category I (Extremely toxic) shall contain the symbol of a skull and cross-bones and the word "POISON" printed in red;
- Insecticides in Category II (highly toxic) will contain the word "POISON" printed in red and the statement "KEEP OUT OF THE REACH OF CHILDREN"; shall also appear on the label at appropriate place, outside the triangle,
- Insecticides in Category III (moderately toxic) shall bear the word "DANGER" and the statement "KEEP OUT OF THE REACH OF CHILDREN"; shall also appear on the label at suitable place outside the triangle;
- Insecticides in Category IV (Slightly toxic) shall bear the word "CAUTION".

The lower portion of the square shall contain a colour that reflects the insecticide's toxicity (Table 7).

Table 7 Classification of insecticides by hazard according to the Insecticides Rules, 1971

Classification of Insecticides	Medium lethal dose by the oral route acute toxicity LD50 mg/kg body weight of test animals	Medium lethal dose by the dermal route dermal toxicity LD50 mg/kg body weight of test animals	Colour of identification band on the label
1. Extremely toxic	1-50	1-200	Bright red
2. Highly toxic	51-500	201-2000	Bright yellow
3. Moderately toxic	501-5000	2001-20000	Bright blue
4. Slightly toxic	More than 5000	More than 20000	Bright green

As of 18 January, 2017 India has not adopted the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). However, hazard and safety information is covered to some extent in following rules: Manufacture, Storage and import of Hazardous Chemical Rules, 1989 (MoEF&CC). The Government of India has also drafted rules known as the Hazardous substances (Classification, Packaging and Labelling) Rules, 2011, wherein most of the components under the GHS are mentioned. The law is still under discussion (MoEF&CC, 2011b).

Marketing

Pesticide advertising is covered broadly in the Pesticide Management Bill, 2008, but it is not approved by the cabinet and therefore not in force. This proposed bill covers the topics like pesticide advertising, prohibitions for advertising of unregistered, false and misleading content regarding pesticides.

Transport

Chapter VII of the Insecticide Rules, 1971 regulates the process of transport of pesticide and states that packages containing insecticides, offered for transport by rail, shall be packed in accordance with the conditions specified in the Red Tariff, issued by the Ministry of Railways. The red tariff states that "Explosives and other dangerous goods which cannot be loaded together in the same wagon under the rules contained in the Indian Railways Conference Association(IRCA) Red Tariff must also be tendered under separate forwarding notes and should be booked as separate consignments. Packages containing explosives, inflammable and other dangerous goods should be marked and should bear the pictorial labels as prescribed in the IRCA Red Tariff" (IR, n.d.).

- "No insecticide shall be transported or stored in such a way as to come into direct contact with foodstuffs or animal feeds;
- No foodstuffs or animal feeds that have become mixed up with insecticides as a result of any damage to packages containing insecticides during transport or storage shall be released to the consignees unless they have been examined for possible contamination by competent authorities, as may be notified by the State Government;
- If any insecticide is found to have leaked out in transport or storage it shall be the responsibility of the transport agency or the storage owner to take such measure urgently to prevent any poisoning and pollution of soil or water."

Import and export

Chapter IX of the Insecticide Rules, 1971, discusses the permission of import of pesticides through selected air ports, land frontiers, railway stations and sea ports only. Section 15 of Chapter IV outlines the procedures for the granting of licences, issuance of memo and maintenance of records. Other rules as stated in the Insecticides Rules, 1971 and the Insecticides Act, 1968 apply to all import/export of pesticide products in and out of India.

Apart from the above rules, the following guidelines have been produced by the CIBR&C for the import/export of pesticides ("Guidelines for Registration", 2011):

- Guidelines for the import of a sample quantity of pesticides for research, testing and trial purposes
- Guidelines for the Registration of FIM vs FI (Formulation Indigenous Manufacture vs Formulation Import).
- Data requirements for the registration of import of formulations of pesticide from a new source where import of formulation has been registered without registration of technical data
- Guidelines/data requirements for the registration of import of pesticide products for manufacturing use
- Data requirements for the registration of aluminium phosphide for import into the country
- Data requirements for the import of concentrated pyrethrum extract
- Guidelines for dealing with applications for registration under the export only category
- Guidelines for star export houses – accreditation system

Clause 12 seeks to make provisions relating to the registration of pesticides. It provides that any person may make a separate application for the registration of each pesticide for its import, manufacture or export. It also provides that pesticides which are registered under the provisions of

Insecticides Act, 1968 shall be deemed to have been registered under the corresponding provisions of the Bill. It also imposes a responsibility on the applicant for registration to provide complete information on all the known adverse effects of the pesticide on human beings, animals and environment. It also provides that after receipt of an application complete in all respects the Registration Committee, within a period of two years after making such enquiry as it considers necessary, and after satisfying itself that the claim made by the applicant as regards the expected performance and efficacy of the pesticide as well as its safety to human beings, animals and environment, and availability or provision of requisite minimum infrastructure to manufacture and stock, the Committee may register such pesticide, allot a registration number and issue a certificate of registration. It also provides that no pesticide shall be registered for import or manufacture unless tolerance limits are specified for its residues on crops and commodities under the Food Safety and Standards Act, 2006. It also makes provisions for non-reliance on data, which means that the data submitted for the purpose of registration of a pesticide which has not been previously registered shall not be relied upon for registration of the same pesticide by any other person for the period of three years, or if the pesticide has been granted a patent then for the period of the patent. It also empowers the Central Government to relax or exempt the said provision of the non-reliance on data in case of national exigency or in case of public interest or for the use by Government or academic and research purpose.

Licensing and requirements for sale

The Insecticides Act, 1968 directs that any person desiring to manufacture or to sell, stock or exhibit for sale or distribute any insecticide, or to undertake commercial pest control operations with the use of any insecticide may make an application to the licencing officer for the granting of a licence. All such applications shall comply with the Insecticides Rules, 1971 (Chapter IV) according to the conditions specified below:

- If the licensee wants to undertake during the period of the licence to manufacture for sale any additional insecticides, he shall apply to the licensing officer for the necessary endorsement in the licence on payment of the prescribed fee for every category of insecticides.
- Applications for the grant or renewal of a licence to sell, stock or exhibit for sale or distribute insecticides shall be made in the prescribed format of the Insecticides Rules (Form VI or Form VII).
- Section 10C states that no person shall manufacture, store or expose for sale or permit the sale or storage of any insecticide in the same building where any articles consumable by human beings or animals are manufactured, stored or exposed for sale. However, nothing contained in this rule will apply to the retail sales of household insecticides from the building wherefrom other articles consumable by human beings or animals are usually sold provided such household insecticides have been registered as such and are packed and labelled in accordance with these rules.
- No person in possession of an insecticide in respect of which an Insecticides Inspector has made an order under rule 30 shall, in contravention of that order, sell or otherwise dispose of any stock of such insecticide.

Section 3A of Chapter IV prescribes that any person who applies for the granting of a licence for undertaking pest control operations should be at least a graduate in Agriculture or in Science with Chemistry as a subject with a certificate of a minimum of 15 days training from any of the CIB&RC approved Institutions. Section 43 of Chapter VIII mentions that the pilots for aerial spraying operations shall undergo specialization training including clinical effects of the insecticides.

A licensing officer may, after giving a reasonable opportunity of being heard to the applicant approve or refuse to grant any licence.

Availability restrictions in accordance with pesticide hazards

The Pesticide Management Bill, 2008 mentions regulations regarding the availability and use of pesticides in accordance with hazards but this bill has not been approved by the cabinet and is

therefore not in force. This proposed bills covers type of formulation, application method, restrictions, limiting of availability etc.

Handling and use, including regulations on application equipment

Chapter VIII of the Insecticide Rules, 1971 fixes the provisions regarding protective clothing, equipment, and other facilities for workers during manufacture, etc. of insecticides. Section 39 of chapter VIII prescribes the requirement for protective clothing and describes the rules as follows:

- Persons handling insecticides during manufacture, formulation, transport, distribution or application, shall be adequately protected with appropriate clothing.
- The protective clothing shall be used wherever necessary, in conjunction with respiratory devices as laid down in rule 40 of the Insecticides Rules, 1971.
- The protective clothing shall be made of materials which prevent or resist the penetration of any form of insecticides formulations. The materials shall also be washable so that the toxic elements may be removed after each use.
- A complete suit of protective clothing shall consist of the following articles:
  - Protective outer garment/overalls/hood/hat.
  - Rubber gloves or other protective gloves extending half-way up to the fore-arm, made of materials impermeable to liquids;
  - Dust-proof goggles;
  - Boots.
- For preventing the inhalation of toxic dusts, vapours or gases, the workers shall use any of the following types of respirators or gas-masks suitable for the purpose:
  - Chemical Cartridge Respirator;
  - Supplied-air Respirator;
  - Demand flow type respirator;
  - Full-face or half-face gas-masks with canister.

All persons who are engaged in the work of handling, dealing with or otherwise coming in contact with the insecticides during manufacture/formulation of insecticides, or being engaged during spraying operation shall be examined medically before their employment and at least quarterly in the case of those engaged in manufacturing/formulation units and yearly in any other cases including operators while in service by a qualified doctor who is aware of risks to which such persons are exposed. The workers also should be educated regarding the effects of poisoning and the first-aid treatment to be given.

The manufacturers and distributors of insecticides and persons who undertake to spray insecticide on a commercial basis (hereafter in these rules referred to as operators) shall keep sufficient stocks of such first-aid tools, equipment, antidotes, injections and medicines as may be required to treat poisoning cases arising from inhalation, skin, contamination, eye contamination and swallowing.

Requirements for training

Section 42 of Chapter VIII of the Insecticides Rules, 1971 prescribes that the manufacturers and distributors of insecticides and operators shall arrange for suitable training in observing safety precautions and handling safety equipment provided to them.

Storage

Section 36 of Chapter VII of the Insecticides Rules, 1971 states the conditions for the storage of pesticides as follows:

- “The package containing insecticides shall be stored in separate rooms or premises away from the rooms or premises used for storing other articles or shall be kept in a separate cupboard under lock and key depending upon the quantity and nature of the insecticides

- The rooms or premises used for storing insecticides shall be well built, dry, well-lit and ventilated and of sufficient dimension."

Disposal of unused pesticides

Section 44 of Chapter VIII emphasizes the need for the disposal of used packages, surplus materials and washings of insecticides and states that it shall be the duty of manufacturers, formulators of insecticides and operators to dispose of packages or surplus materials and washing in a safe manner so as to prevent environmental or water pollution.

Section 10A of Chapter IV of the Insecticide Rules, 1971 states the compliance for segregation and disposal of date-expired pesticides as follows:-"Immediately after the date of expiry all such stocks after being segregated and stamped `not for sale' or `not for use' or `not for manufacture', as the case may be, shall be kept by the licensee in a separate place specially demarcated for the purpose with a declaration, date-expired insecticide, to be exhibited on the conspicuous part of the place. All such stocks then shall be disposed of in an environment friendly manner as may be specified from time to time by the Central Government in consultation with the Central Insecticides Board and shall not be used for remanufacture."

Disposal of empty pesticide containers

Article 44 of chapter VIII of the Insecticides Rules, 1971 mentions the disposal of used packages and states that disposal of empty packages and washing must be done in a safe manner so as to prevent environmental and water pollution. It also emphasizes that packages shall not be left outside to avoid reuse. It makes it mandatory for operators that packages shall be broken up and buried away from dwellings. A leaflet carrying the instructions with the packed pesticide should contain also instructions concerning the decontamination or safe disposal of used containers.

Residue monitoring in food and Maximum Residue Levels

Tolerance limits of pesticides are established under the Prevention of Food Adulteration Act, 1954, through the Ministry of health and Family Welfare (MoH&FW). Maximum residue limits (MRL) are fixed by the MoH&FW on the basis of information provided in a prescribed performa submitted by the applicant along with the application for the registration of the pesticide which contains the details on its toxicity, residue and chemistry aspects. The Ministry of Health and Family Welfare (MoHFW), regulates MRLs of pesticides and agrochemicals in food products through the implementation of the Food Safety and Standards Act (FSSA), 2006. The FSSA Act authorises the Food Safety and Standards Authority of India (FSSAI, 2016) to "specify the limits for use of food additives, crop contaminants, pesticide residues, residues of veterinary drugs, heavy metals, processing aids, mycotoxins, antibiotics and pharmacological active substances and irradiation of food." The existing MRLs on pesticides and agrochemicals are specified in the Food Safety and Standards Regulations, 2010 – Chapter 8, pages 531-548. MRLs are listed by chemical product for specific food items/commodities. FSSAI has developed a manual of methods of analysis of pesticide residues in foods (FSSAI, 2016). The CIB&RC Medical Toxicology Unit works closely with the FSSAI to set MRLs, which are subsequently included in the Food Safety and Standards Regulations. The Ministry of Agriculture CIB&RC has indicated that it would not approve new insecticide registrations without established MRLs.

In 2006, the Ministry of Agriculture initiated a program to monitor pesticide residues at the national level. The results of the survey are published on the FSSAI website.

In case of food, grain, fruits, vegetables, dry fruits, tree nuts other basic commodities, the Ministry of Agriculture works through the Plant Quarantine Office at the Port to test for the presence of banned pesticides and agrochemicals. The Project Coordinating Cell of the All India Network Project on Pesticide Residues (AINPPR), Indian Agricultural Research Institute (MoA&FW, 2015) produces an annual progress report on the Monitoring of Pesticide Residues at the National Level. In the absence of an established MRL, the Ministry of Health authorities generally refer to CODEX Alimentarius MRLs, as long as the pesticide in question has not been banned.

Other relevant human health and environmental protection regulations

MoEF&CC runs different programs like the National Environment Awareness Campaign (NEAC), National Green Corps (NGC), Seminars/Symposia/Workshops/Conferences, and other awareness programmes. The main purpose of these programmes and schemes of the Ministry is to enhance the understanding of people at all levels about the relationship between human beings and the environment and to develop capabilities/skills to improve and protect the environment. The schemes were launched during the last two to three decades with the basic objective of promoting environmental awareness among all sections of the society and to mobilise people's participation in the preservation and conservation of the environment (MoEF&CC, n.d.).

The National Poisons Information Centre (NPIC) is part of the Department of Pharmacology, All India Institute of Medical Sciences, New Delhi. The Centre works 24x7 and provides on the spot information on the management of various poisoning incidents to health care professionals, Government and private hospitals all over the country (WHO, 2018).

Compliance and enforcement

Section 16 of Chapter V of the Insecticides Rules, 1971 prohibits the sale or distribution of insecticides unless packed and labelled in accordance with the provisions of these rules. Section 31 of Chapter VI also prohibits any person in possession of an insecticide in respect of which an Insecticides Inspector has made an order, in contravention of that order, from selling or otherwise disposing of any stock of such insecticide.

Section 4 of the Insecticides Act, 1968 gives powers to central government to constitute a "Central Insecticides Board" and "Registration committee" to advise the Central Government and State Governments on technical matters arising out of the administration of the Act and to carry out other functions assigned to the board by or under this Act. Sections 21 & 26 of Chapter VI of the Insecticide Rules, 1971 prescribe the eligibility for appointment as an insecticide analyst and insecticide inspector. Section 22 of Chapter VI of the Insecticides Rules, 1971 defines that the Insecticides Analyst shall have the power to call for such information of particulars or do anything as may be necessary for the proper examination of the samples sent to him either from the Insecticide Inspector or the person whom the sample was obtained. Clause 22 of Insecticide act, 1968 prescribes the sampling procedure to be followed by Insecticide Inspectors.

Under Section 16 of the Insecticides Act, 1968 Central Government has notified in the Official Gazette of its intention to establish a Central Insecticides Laboratory under the control of a Director to be appointed by the Central Government to carry out the functions entrusted to it by or under this Act. Functions of the Central Insecticides Laboratory shall be carried out by the head of the institution. Section 30, 31 & 32 of Chapter VI of the Insecticides Rules, 1971 states the procedures for prohibitions of disposal of pesticides in the case of non-compliance and prescribes forms for different actions required. Section 29 deals with the offences of dealing in misbranded, uncertified, unlicenced or prohibited insecticides and obstructing public officers as per the different clauses of the Insecticides Act, 1968. Section 29 of this act also deals with the punishments against these offences as follows: for the first offence, an imprisonment for a term which may extend up to two years, or with a fine which may extend to two thousand rupees, or with both. For the second and subsequent offences, with imprisonment for a term which may extend to three years, or with a fine, or with both

Section 14 of the Insecticides Act, 1968 deals with the consequences of infringement and states that licences may be revoked or suspended if the holder has failed to comply with the conditions subject to which the licence was granted or has contravened any of the provisions of this Act.

Farm characteristics and production practices in focal crops

Summary information about farmers in the study area

Twelve farmers (seven growing tomato and five growing potato) were surveyed. Alongside this, one Focus Group Discussion (FGD) was held with four farmers involved in tomato production and

four from the potato region, as well as FGDs in both the tomato and potato region, with four extension officers in each one. Care was taken make sure the farmers used in the survey were not also involved in the FGDs.

Pest problems in the focal crops

The main field pests of tomato were *Helicoverpa* and sucking pests, listed by 87.5% and 75% of farmers respectively (Annex V, Figure 1). Other pests included blight, reported by 71.4% of farmers, powdery mildew (25%), downy mildew (12.5%), tomato spotted wilt (12.5%), leaf curl (25%), damping off (100%), leaf miner (62.5%) and Tospovirus (25%) (Annex V, Figure 1). Similarly, the extension agents also reported blight (both early and late) as a major issue in tomato production, as well as damping off, *Helicoverpa* and sucking pests (Annex V, Figure 2). The extension agents considered some pests to be of greater importance than the farmers had reported, and these included spotted wilt, leaf miner, fruit borer and cutworm They also reported that *Tuta absoluta* seems to be emerging as an important pest of the crop (Annex V, Figure 2).

Of the potato farmers 100% reported sucking pests and blight as major pests/diseases, followed by *Spodoptera litura* (60%) and leaf miner (40%) (Annex V, Figure 3). The extension officers' observations broadly supported the farmer data with 100% reporting sucking pests, late blight and tuber rotting, although only 33% listed *Spodoptera* as a problem (Annex V, Figure 4). Other minor pests reported by the farmers were root grubs, bacterial wilt and mycoplasma. (Annex V, Figure 3)

Current crop protection methods

The use of chemicals to control pests by farmers cultivating tomato was high, with 67% of farmers using this method (Annex V, Figure 5). Cultural practices were used by 62% of farmers and botanicals used by 50%. There were some efforts being put into controlling pests using biopesticides, with 23% of farmers using this method. A smaller percentage (11%) of farmers also used home-based pesticides (Annex V, Figure 5). Farmers on innovation farms are currently using 37 different chemicals, of which 59% belonged to GIZ category B and as many as 13% belonged to category A (not allowed for use). About 13% of the chemicals used belonged to category C and another 13% belonged to category D. Some of pesticides like Imidacloropid, Acetamoprid, Thiamethoxam, and Chlorpyriphos are being used because they are broad spectrum and there are no substitutes for them. There is a possibility that their use could be reduced and costs minimised by avoiding over usage. However, the farmers might not be convinced that the reduced number of sprays will control the pests (FGD, Extension Kadur). Other chemicals of concern are Propex Super (Profenofos +Cypermethrin) for *Spodoptera* There is no need for this chemical and in early stages when the first spray is applied it leads to a resurgence of mites and the death of natural enemies). A highly hazardous pesticide, Dichlorovos, is reported to be used for aphids only because of "the effervescence created by adding this chemical".

STP is type of sprayer which only a few farmers own, and they rent out this equipment to other farmers for spraying. This equipment enables farmers to spray larger areas in less time.

Farmer scouting methods and knowledge of BCAs and pests according to the extension officers is shown in Annex V, Figure 21. Knowledge of other methods included crop rotation, planting certified seeds and use of the appropriate planting time. Figure 22 (Annex V) shows which of these components the farmers are aware of and which of them are being implemented. Farmers also noted that some of these methods are available and affordable to them (Annex V, Figure 23). The extension officers reported that as many as 80% of farmers used chemicals to manage the pests on their crops, and they considered that the other practices listed above were used much less frequently.

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

The indiscriminate use of chemicals is practiced by farmers because of certain constraints in the use of IPM practices. The extension agents reported that farmers do use different strategies alongside chemicals to manage cultivation (Annex V, Figure 7), of which crop rotation, planting certified seeds and use of the appropriate planting time are major practices. Integrated pest management is highly relevant to the area. The extension agents have received training on this

subject, but there is still a challenge in broadening its use since farmers find IPM too complicated and they often lack appropriate knowledge and extension material (Annex V, Figure 8). For these reasons they tend to rely on chemicals, which do not result in sustainable control.

Plant protection practices applied in organic agriculture

Organic plant protection practices included the use of neem cake along with biological control products like *Trichoderma*, *Pseudomonas* and *Paecilomyces* for the management of soil-borne diseases. It was also found that viruses are used for the management of fruit borer. Some other practices included the use of pheromone traps for pests like *Spodoptera*, *Tuta absoluta* and *Helicoverpa* (Table 8). Cultural control methods such as border cropping and mulching are used against a variety of pests.

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

All farmers agree that the pesticides are available from agro-dealers. Twenty-two percent of farmers were also able to obtain pesticides from a government agency. Eighty percent of the farmers report that biocontrol products are available and affordable, but although other botanicals and chemicals are available they are not necessarily affordable (Annex V, Figure 23).

Table 8: Management of pests and diseases of tomato as reported by extension workers

Pest	Active Ingredient	Homemade pesticide	Cultural	Biopesticide	Mechanical
Sucking pests	Imidachlorpid	Neem oil	Border crop	*Beauveria*	Yellow sticky traps
	Difenthurion	Karanj oil	Clean cultivation		Blue sticky traps
	Propenphosorin				
	Spinosad				
	Chloropyriphos				
	Lamda cyhalothrin				
Downy mildew					
Powdery mildew					
Helicoverpa	Cypermetherin		Border crop	Nuclear polyhedrosis virus	Pheromone trap
	Chlorantrinitrpole				
	Indoxicarb				
Blight	Bordeaux mixture	Jamdu plant milk and mixing with water	Mulching		
	Difenconozole				
	Chlorothalonil				
	Mancozeb				
	Carbendezim				
	Cyanoanil				
Tomato spotted			Mulching		

Pest	Active Ingredient	Homemade pesticide	Cultural	Biopesticide	Mechanical
wilt					
Tomato leaf curl		Decoction of neem leaves			
	Quinalphos				
Damping off	Copper oxychloride	Neem cake	Mulching	Trichoderma	
	Copper	Cow urine		Pseudomonas	
	Humic Acid	Panchagavya			
	Thiomethaxome				
	Acetamprid				
	Metaxyl				
Leafminer	Trizaphos				
Tospovirus	Chloantranilprole				
	Fipronil				
	Chlorantraniliprole				
Tuta absoluta					Pheromone trap
Spodoptera litura					Pheromone trap

State of the implementation of international agreements relating to pesticides, including the FAO's IPM Concept and FAO's International Code of Conduct on Pesticide Management

A policy is in place to develop and promote the use of IPM (key informant interviews, Chittor) and a governmental website (http://cibrc.nic.in) facilitates access to information on matters including pesticide hazards and risks, residues in food, IPM/IVM, alternatives to highly hazardous pesticides and related regulatory and policy actions. A policy (Pesticide Bill 2007) is currently pending and it is expected that this will encourage and promote research on alternatives to existing pesticides that pose fewer risks, such as non-chemical preventive and direct control measures. There are efforts being made by implementing agencies, like Agriculture and Finance Consultants (AFC) to produce and disseminate relevant and clear educational materials on pesticide use and management (FGD, Extension Peth), however there is very little in place to promote the use of suitable personal protective equipment.

Farmers adhere to legislation that prohibits the use of pesticides for any purpose, or in a manner other than that prescribed on the label (FGD, Extension, Peth). Although the legislation requires employers to take the necessary measures to protect the health of their workers and the environment; very few farmers adhere to these laws (FGD Extension, Peth). There is an effort to make provisions for safe storage of pesticides as recommended by the extension agents, which are followed by farmers to some extent, and also to prevent the accumulation of obsolete pesticides and used containers. The regulations in the Insecticides Act, 1968 governing the disposal of empty pesticide containers are the same across the country and are seen to be more or less followed up (Annex V, Figure 10).

Pesticide handling and use

Almost 70-80% of the extension agents recommend that the farmers should keep the pesticide inaccessible to children and should store the used pesticide in a shed and/or in their original

containers (Annex V, Figure 9). Forty-five percent of extension agents advise the farmers to bury the containers after use and only 45% farmers of keep the pesticides in their original containers under locked conditions (Annex V, Figure 10). More than 20% of farmers keep the used pesticide in their house without any warning or safety precautions. Although 60% of the farmers take the advice of their extension agents and burn the empty containers, 50% also report sometimes giving away or selling the empty containers (Annex V, Figure 10).

Health and safety

All the farmers were able to read warning signs like “use waterproof boots while spraying pesticides”, however very few of them (<20%) understand what “corrosive” meant (Annex V, Figure 11). Personal protection equipment is well adopted amongst the tomato farmers (less so among the potato farmers) and 70% of them wear long sleeved shirts and pants while spraying. Around 30% of potato farmers wear long boots and 20% of the farmers wear a light scarf as a mask while spraying pesticide (Annex V, Figure 12). More than 80% of farmers report that they can get PPE from an agro-dealer shop, and 10% of farmers procure PPE from hospitals. Sixty percent of farmers think that using PPE is cumbersome and is not required, however, the extension agents expressed that this attitude was more common than the farmers actually reported during interviews themselves (FGD,Peth).

Knowledge of pests, IPM and rational pesticide use

The knowledge of pests amongst the farmers was quite sound and they were fully aware that pests like sucking pest are becoming a major issue in the crop production. They broadly categorised sucking pests and were not fully aware of the distinction between aphids, mites and jassids etc. Tomato farmers were asked if they scouted their fields for pests, and more than 20% of them never did so in any of the following stages; seedling stage, field stage and storage (Annex V, Figure 13). Over half of the tomato farmers scouted daily during the field stage and 42% during the seedling stage. During the storage stage, scouting for pests became a weekly routine. In contrast the potato farmers were not so keen on scouting and their daily scouting was restricted to the seedling stage (60%). However, during the storage stage 80% of the potato farmers carried out weekly scouting (Annex V, Figure 13).

When purchasing pesticides around half of the farmers made a decision based on effectiveness, while 32% relied on agro-dealer advice. Other factors that influenced pesticide purchase were availability and recommendations by others (Annex V, Figure 14). More than 60% of the farmers said they read the label information before they applied a pesticide (Annex V, Figure 15), and are well aware of colour codes on the label. Most farmers take the weather into consideration before deciding to spray (Annex V, Figure 16).

Training and sources of information

More than 70% of farmers rely on their mobiles as a source of information. Around 58% get their information from the television, followed by advice from neighbours and then agro-dealers, extension agents and radio (Annex V, Figure 17). Extension agents get their training from local implementing partners and research institutes, which support them by providing information. Printed information is also available to the farmers and extension agents from GIZ, who also periodically provide training on IPM and other pest management related subjects **(**Annex V, Figure 18).

State of science on crop protection

Pest/Disease	Recent research
Tuta absoluta	Tomato was the preferred host for its development, followed by potato and eggplant (Sridhar et al., 2015)
	Traps containing the female sex pheromone attracted moths from a distance of 100m demonstrating its efficiency, and it can last up to 90 days in the field (Bhanu et al., 2017).
	Of 11 insecticides evaluated against *T. absoluta* over two seasons spinetoram (12 SC@1.25 ml/L), cyantraniliprole (10 OD @1. 8 ml/L), flubendiamide (480 SC@ 0.3 ml/L) and spinosad (45 SC@0.3 ml/L) were found to be the most effective, both on leaf and fruits (Sridhar et.al., 2016)
Tomato fruit borer, whitefly and leaf miner	The insecticide Emamectin benzoate (1.9% EC @ 300 ml a.i./ha) was found to be effective against pests of tomato (Srivastava et al., 2017).
Tomato sucking pest	Seed treatment of tomato with Thiamethoxam (70% WS @ 4.20 g a.i/kg of seed) reduced the early season insect-pests (aphid and thrips) and had very little effect on the natural enemy population (Maurya et al., 2015)
Thrips	*Metarhizium flavoviride* var. *minus* was highly effective against tomato thrips, *Thrips tabaci* Lindeman (Hemalatha, 2015).
Leafminer	NSKP 10% was found to be effective against leaf miners (Barde & Shrivastava, 2017).
Whitefly	Neem oil 3% was found to be effective against whitefly (Barde & Shrivastava, 2017).
Fruit borer/tomato	African marigold as a trap crop (45 day old seedlings at every 16th row of tomato), collection & destruction of fruit borer infested fruits & spray of insecticide (1st spray of neem based insecticide at 28 days after transplanting & 2nd spray of Propenophos 50 EC at 35 days) after transplanting was found to be effective (Upesh Kumar, 2017).
	Planting of African marigold after every 8 rows of tomato as well as on the periphery of the plot and two sprays of *Helicoverpa armigera* NPV @ 350 LE/ha on appearance of first instar larvae followed by spray of Decidan 32.8% EC @ 15 ml/10 litre was found to be effective (Jakhar & Suman, 2015).
Fruit borer in tomato	Setting pheromone traps at 50 traps/ha led to a significantly lower number of eggs (0.78/10 twigs) and a lower larval population (1.32/10 twigs), resulting in less fruit damage (Shah et al., 2017).
Whitefly/tomato	Chlorfenapyr + acetamiprid was evaluated and found to be a good treatment against whitefly, with only 6.6% of pest incidence (Mandal, 2017).
Tomato/Early blight	Efficacy of a talc-based formulation of antagonist *Pseudomonas flourescens* (Psf) delivered through two different forms of substrate, farmyard manure (FYM) and vermicompost, for the management of tomato early blight disease was demonstrated, and can be considered as one component along with chemical control in developing an IPM programme for the management of early blight disease in tomato. (Manikandan & Raguchander, 2014).
Tomato/Soil borne disease	Fungal bioagents (*Trichoderma viride* and *Paecilomyces lilacinus)*, together with neem oilseed cake and botanical antagonists were found to work as an IPM package in improving productivity and quality of tomato and okra, showing a reduction in disease complex arising from soil borne fungal diseases and root-knot nematode incidences (Goswami et al., 2012)
Fusarium	A combination of *Trichoderma harzianum*, *T. asperellum*, and *T. virens* were found to be able to control wilt in tomato (Akrami & Yousefi, 2015).
Fusarium	Bavistin 50 WP and Ridomil Gold 68 WP were found to be effective in inhibiting the mycelial growth of dry rot. Bavistin was found to be effective as a tuber dip treatment. All the fungicides tested were also evaluated under cold storage. Bavistin was found to be the most effective, with disease control observed of up to 87% in infected tubers (Kumar & Sekhon, 2016).
Tomato/Early blight	A foliar spray of 5 µg/mL of biosynthesized silver nanoparticles in *Alternaria solani* infected plants resulted in an increase of 32.58% in fresh weight and 23.52% in total chlorophyll content of tomato as compared to untreated *A. solani* infected plants (Kumari et al., 2017).
Spodoptera	The larval mortality of *Spodoptera* increased with increased concentrations of SINPV irrespective of the host plants (Bhandari et al., 2017).

Pest/Disease	Recent research
	Pheromone traps lowered the damage caused by the insect. However, the performance of the pheromone traps and lures, and the activity of the pest were influenced by several weather factors especially maximum temperature, minimum temperature, evaporation and wind speed (Prasannakumar et al., 2012).
Mites	Emamectin benzoate 1.9% EC @ 300 ml a.i./ha proved to be effective against mites on tomato plants (Srivastava et al., 2017).
Aphid, thrips and broad mite	Potassium salts of fatty acids (Lastraw®) and an oil-based formulation of *Beauveria bassiana* (Myco-Jaal®) at higher doses reduced the aphid population by 67.13%-68.52%, compared to the untreated control. They also reduced the thrips population by 80%-84%. Only Lastraw® was found to be more effective in reducing the damage caused by broad mite than Myco-jaal at higher temperature conditions in net-houses in May-June (Kaur & Srinivasan, 2014).
Phytopthora	Effective eco-friendly management must be adopted to control potato blight. Cultural practices are the first line of defence while forecasting, physiological strategies, biological control, host plant resistance and bio-technological approach are essential for efficient, effective and eco-friendly management (Shailbala & Kumar, 2017).
	Metoctradin 27% + Dimethomorph 20.27% (w/w) SC @ 0.08 & 0.1% were effective for managing late blight of potato and could be incorporated in to the management of late blight at the farmer level (Lal et al., 2017).
	A modified JHULSACAST model was found to be able to predict late blight within 14 days with an accuracy of 100%, depending on weather conditions (Chakraborty et al., 2015).
	Adoption of a web-based advisory system meant that farmers saved on fungicide costs per hectare in the range of Rs 6501 to 6468 during 2012-13, Rs 6502 to 6762 during 2013-14 and Rs 3880 to 4108 during 2014-15 crop. If one contact fungicide was saved on 50000 ha of the area under potato cultivation the saving was approximately Rs 41.7 million, and if one systemic spray is avoided on the same area the saving on fungicide costs is Rs 165 million. (Sekhon et al., 2017)
	An application of Eugin in combination with Mancozeb was found to be effective against late blight; soil application of Antirot 10DP + mixed fertilizer showed effective results against soil and tuber borne diseases of potato like brown rot, common scab and soft rot (Chakraborty et al., 2014)
	Iprovalicarb shows excellent fungicidal activity against *Plasmopara viticola*, *Peronospora vicia*, *Phytophthora* sp., *Alternaria* sp. in grapes, potatoes, tomatoes, tobacco and vegetables (Maity & Mukherjee, 2009).

A review carried out into the recent status of science (above) showed that some promising strategies are in development for the management of pests such as the tomato fruit borer (Srivastasva et al., 2017, Upesh Kumar, 2017) and sucking pests (Maurya et al., 2015). Some ways to replace the use of harmful chemicals with biologicals are suggested for thrips (Hemalatha et al., 2015) and for other sucking pests (Kaur & Srinivasan, 2014). Some interesting ideas for the integrated disease management of early blight have been outlined (Manikandan & Raguchander, 2014, Madhuree, 2017) and some more comprehensive management options for complex soil pest management have been suggested by Goswami et al. (2012). Various management option for the new pest on tomato crop, *Tuta absoluta,* have been recommended, including chemicals (Sridhar et al., 2016) and pheromone technology (Bhanu et Al., 2017).
Late blight is seen as a severe disease in potato causing, considerable loss to farmers, but it can be reliably predicted with weather models like JHULSACAST (Chakraborty et al., 2015) and a web-based model system (Shekhon, 2017). It can also be managed using environmentally plant-based products (Chakraborty et al., 2014).

Review and analysis of existing extension material

The existing extension material is distributed by AFC consultants and consists of brochures on the management of pests and diseases, written in two local languages; Marathi and Kannada. They cover mite, blight, rotting of tuber and to a lesser extent *Spodoptera* on potato. The extension material for tomato also mainly addresses fungal diseases, as these are considered to be the

major pests by extension officers (Annex V, Figure 4) and they mainly recommend the use of chemicals to combat these diseases (Annex V, Table 9).

Advisory service characteristics and the advice they provide

Overview of extension service providers

The extension agents are mostly under 30 years of age and have a minimum of 2-3 years of experience. Extension agents appear to have less communication with female tomato farmers than with males (Annex V, Figure 19), however they seem to communicate equally with male and female potato farmers.

Perception of extension agents about the practice of IPM by farmers, their knowledge of pests and rational pesticide use

Extension agents are aware of biological control agents and some of them are aware of economic thresholds (Annex V, Figure 20). IPM is highly relevant to the area and the extension agents have received training sessions on this subject, however extension agents indicated that IPM is too complicated, that farmers lack knowledge and that they lack any extension material on the subject.

Only 29% of the total extension officers are aware of the economic thresholds for each pest (Annex V, Figure 20) and think that 96.25% of farmers use a monitoring approach to decide on pesticide applications for managing the pest (Annex V, Figure 21). The current recommendation by extension agents showed that out of the 24 pesticides/chemicals recommended for the focal crops 54.1% belonged to category B of the GIZ procurement list, which states that these chemicals should be used only as an exception and elaborate verification is needed for their use. Nearly 21% belonged to category D, which are chemicals that should be used with appropriate precautions and 8.3% belonged to category C, which are chemicals that should be used only by authorised staff under strict protection and should not be used by small-scale farmers. It was also observed that 12.5% belonged to category A, which are chemicals whose use is strictly prohibited. (Annex V, Table 9). According to the extension agents, the main reasons why low toxic alternatives are not so popular is that there is less awareness of them among farmers, they can be used only when the pest population is low, there are very few training materials available, they need to be shown to be cost effective and the farmers want to be compensated for the time taken to attend training sessions.

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

Identification of the HHPs which are registered in India

The 272 AI registered in India differed in terms of their overall hazard level (Annex V, Figure 24): 64 of the AI which are allowed for use met one or more of the HHP criteria; 77 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”); 99 AI were categorized as “Warning”; 15 AI were categorized as “Low hazard” (there were no known human health hazard statements associated with the AI); and key human health hazard data was missing for 17 AI. The AI which were identified to be HHPs are listed in Annex II.

Of the HHPs identified, 42% were carcinogens, 33% were either extremely or highly acutely toxic, 23% were reproductive toxins and 3% were mutagens (Annex V, Figure 25). Alachlor, carbofuran, DDT, ethylene dichloride, monocrotophos and phosphamidon all require prior informed consent under the Rotterdam Convention, and DDT is also a POP listed in the Stockholm Convention. For several AI, more than one of the HHP criteria was met: benomyl, carbendazim, DDT, diclofop-methyl, epoxiconazole, monocrotophos and phosphamidon.

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 (in 94 AI). Other human health effects which were

identified included endocrine disruption (seen in 26 AI), allergic reactions (in 66 AI), the potential for serious eye damage (78 AI) and the potential for organ damage, both specific and general (in 104 AI). The human health hazard statements covering health effects were included in the determination of hazard category. With respect to environmental hazards, 186 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 72 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. Forty-six of the identified AI are currently listed in the Rotterdam database of notifications of final regulatory action. One hundred and twelve of the AI are included in the PAN HHP list (2016). On an AI basis, over 50% of the AI are allowed for use in the EU (approved = 138 AI) or pending approval for use in the EU (pending = 2 AI) whereas the other 49% are not allowed for use in the EU (not approved = 95 AI) or otherwise not listed (37 AI). Refer to Annex II for information on the specific AI.

Sixteen of the identified AI are allowed for use in organic agriculture in that they are listed in Annex II of Commission Regulation (EC) 889/2008. Forty-nine 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 (72 AI) of the AI identified through this study are not listed in the 2009 classification. Based on the LD_{50} of the AI, four of the AI which are not listed in the 2009 classification can also be considered to be class U: *Beauveria bassiana*, chromafenozide, *Helicoverpa armigera,* nucleopolyhedrovirus (HEARNPV) and sulfosulfuron.

According to the GIZ procurement policy, 31 AI fall into procurement category A (not allowed), 120 AI fall into procurement category B (only as exception, elaborate verification needed), 27 AI fall into procurement category C (only by authorised staff with strict protection; not for small farmers) and 66 AI fall into procurement category D (appropriate precaution) (Annex V, Figure 26). Twenty-eight of the AI have not been classified by GIZ.

Eight HHP AI were used by farmers or recommended by extension agents. Farmers reported using the fungicides copper sulphate, Carbendazim and Mancozeb as well as the insecticides Monocrotophos, Thiodicarb and Triazophos. Extension agents recommended the fungicides Carbendazim and Mancozeb as well as the insecticides Carbofuran, Phorate and Triazophos. The current study identified 23 non-HHP AI also registered to manage the pests for which HHPs are currently used or recommended. For the vast 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 Annex IV. The only pest for which no HHP alternative AI was identified was tuber rot of potato seedlings.

Conclusions

The Insecticides Act, 1968 is quite old and the more recent Pesticide Bill 2007 is still pending for enforcement. This makes many of the legislations especially pertaining to use of biocontrol not legally valid. The use of PPE for the application of chemicals is also not well enforced and there are no proper directives. It was found that farmers are using many of the chemicals that fall into category B, and which are recommended to be used only as an exception in cases where an alternative is not available. This is not complied with, and the farmers' choice of pesticide is dependent on the agro dealer rather than any consideration of the harmful categories that the chemicals might belong to. Various safer alternatives that could replace the current practice of using HHPs for the focal crop pests and diseases are also suggested. The practice of IPM though found cumbersome by farmers could be made popular by more training, demonstrations and media messages that might motivate the farmers to use these methods. The issue of a lack of availability of biopesticides could be addressed by linking up with input manufacturers.

Main findings SWOT Analysis

Strengths	**Weakness**
1. Roles defined among extension officers and aware of management practices 2. Strong awareness among project teams and beneficiaries about biological management options 3. Qualified staff who are trained in IPM practices (e.g. regular IPM trainings of trainers) 4. Collaborations and linkages with international/national institutes (e.g., Wageningen University, World Vegetable Centre, Indian institutes etc.) 5. Strong network and partnerships with private sector organisations (e.g., Bayer, BASF, T-Jet etc) 6. Introduction of newer spraying technologies to reduce pesticides usage (e.g., nozzle, boom sprayers) 7. Partnerships developed among farmers groups with local universities (e.g., Agriculture University of Dharwad) for supply of biocontrol agents 8. Farmer advisory app (smart farming app) in the process of development 9. Access to government bodies based on official implementation agreement (MoA&FW between GIZ and SDoA/H) 10. Sensitization regarding gender inclusion and awareness about handling of pesticides 11. Associations with Green colleges	1. Training/reference material not fully available at project sites 2. Usage of outdated IPM manuals in some project locations. 3. Not all partners are aware of the GIZ procurement list 4. Information gap for correct application of pesticide application by extension agents due to their out of date previous knowledge (e.g. from earlier jobs in pesticide companies) 5. Lack of internalization of information among the extension officers regarding PHIs in following pesticide spray schedule(s). 6. Women's awareness/practice level about safe application of pesticide is low.
Opportunities	**Threats**
1. Regulatory framework in place that can be tapped for strengthening of linkages and scale up 2. Existing programme for trainings by AgriCentres (KVK)/MANAGE can be linked to train the agrodealers 3. Linkages with the existing programmes for written recommendations and mass extension campaigns etc 4. Gradual improvement and acceptance regarding use of PPE by beneficiaries 5. Possibility of using low volume, high spray technologies for economic usage of pesticide	1. Conflict/contradiction with local agro-dealers as they feel such services promoting eco-friendly alternatives and reducing use of chemicals decrease the sales turnover 2. Regulatory framework, though strong, lacks proper implementation and is outdated 3. Outdated PoPs still carry recommendations of banned/restricted chemicals 4. Bank loans are available only for conventional farming 5. Principal certificate required annually from government authority to release products gets delayed, so they are not available in market 6. MRLs not monitored for domestic consumption

Recommendations for action

1. Since the regulatory framework is in place, the HHPs should be identified and substituted with alternatives or less hazardous pesticides
2. Efforts should be made to link the current project with existing national training programmes by Krishi Vigyan Kendra (KVKs)/Management Diploma in Agricultural Extension Services for Input Dealers (DAESI) to train agro-dealers
3. Linkages with existing rural advisory programmes to encourage and promote prescription-based pesticide sale (written recommendations by extension officers)
4. There should be trainings, workshops and printed material planned to bring about an improvement in awareness regarding the correct use of PPE amongst farmers and extension officers.
5. There should be efforts to promote the adoption of the use of low volume high spray technologies
6. Training/reference material should be available at all locations with extension officers enabling them to provide relevant and valid information to farmers
7. Outdated IPM manuals/reference material should be replaced with new validated lists of chemicals/practices
8. The updated GIZ procurement list, which emphasises the use of safer chemicals that are low in toxicity, should be uniformly circulated amongst all the project-implementing agencies for compliance by extension officers and other concerned project stakeholders
9. It was noted that some of the extension officers had worked previously with pesticide companies and continue to recommend pesticides which can be hazardous. Such extension officers should be directed to follow strict instructions as documented and validated by GIZ to ensure a uniform package of practices.
10. Activity-based manuals should be developed to improve the understanding of information regarding pesticide hazard management amongst extension officers, so as to promote internalisation of the concept by the trainees i.e. extension officers and farmers.
11. Development of activities to strategize and implement the actions related to safe and careful handling of pesticides by women should be put in place and circulated among the project stakeholders.

References

Acharya, N (2017). Potato price crashes in Bengal; MSP move fails to cheer farmers. Business Standard. Retrieved from http://www.business-standard.com/article/markets/potato-price-crashes-in-bengal-govt-subsidy-fails-to-cheer-farmers-117031600350_1.html

Akrami, M., Yousefi, Z. (2015). Biological control of Fusarium wilt of tomato (*Solanum lycopersicum*) by *Trichoderma* spp. as antagonist fungi. Biological Forum. Vol.7 No.1 pp.887-892 ref.35.

Apeda AgriXchange (2017). INDIA EXPORT OF AGRO FOOD PRODUCTS. Retrieved from http://agriexchange.apeda.gov.in/indexp/Product_description.aspx?hscode=07019000

APPPC (2017). Report of the APPPC Sub-regional Training Workshop for the Designated National Authorities on the Rotterdam Convention Focusing on Increasing Notifications 13-17 March 2017, Surabaya, Indonesia. Retrieved from http://www.fao.org/fileadmin/templates/rap/files/meetings/2017/170323_Final_report.pdf

Bairwa, A., Venkatasalam, E. P., Sudha, R., Umamaheswari, R., Sharma, A. and Singh, B. P. (2016). Management of late blight disease in kharif potato at Karnataka. Potato Journal Vol.43 No.2 pp.173-181.

Barde, S. K., Shrivastava, S. S. (2017). Efficacy of plant products against serpentine leaf miner and white fly on tomato. Biosciences, Biotechnology Research Asia Vol.14 No.3 pp.1187-1190.

Bhandari, P.; Chaudhary, S.; Nayana, E. D.; Bhawna Sharma; Baheti, H. S.; Raza, S. K. (2017). Influence of host plants on *Spodoptera litura* (F.) and SL-NPV. Indian Journal of Entomology, Vol.79 No.3 pp.381-382.

Bhanu, K.R.M., Ramchandra V.A. Walekar and Mamatha, B. (2017). Monitoring of *Tuta absoluta* (Tomato Leaf Miner) using Pheromone Traps: A recent invasive pest in India. Environment and Ecology 35(4A): 2971-2976.

Chakraborty, A., Banerjee, H. and Dey, S. (2014). Bio-efficacy of Eugin 5EC against Late blight and Antirot 10DP against soil and tuber borne diseases of potato in West Bengal. Journal of Mycopathological Research Vol.52 No.1 pp.93-96

Chakraborty, A., Singh, B. P., Ahmad, I. and Sharma, S. (2015). Forecasting late blight of potato in plains of West Bengal using JHULSACAST model. Potato Journal Vol.42 No.1 pp.50-57.

Chemsafetypro, http://www.chemsafetypro.com/Topics/GHS/GHS_in_Other_Countries.html

Chinniah, C., Ravikumar, A., Kalyanasundaram, M., Parthiban, P. (2016). Efficacy of newer acaricide and insecticide molecules against sucking pests of chilli. Annals of Plant Protection Sciences, Vol.24 No.2 pp.202-207

CIB&RC (n.d.). Central Insecticides Board & Registration Committee. Retrieved from http://cibrc.nic.in/

Directorate of Plant Protection, Quarantine and Storage (n.d.). Plant Quarantine System. Government of India. Retrieved from http://plantquarantineindia.nic.in/PQISMain/Default.aspx

Directorate of Plant Protection, Quarantine & Storage (2016). Pesticides Monitoring and Documentation. Retrieved from http://ppqs.gov.in/divisions/pesticides-monitoring-documentation

Directorate of Plant Protection, Quarantine & Storage (2016b). Integrated Pest Management. Retreived from http://ppqs.gov.in/divisions/integrated-pest-management

Directorate of Plant Protection, Quarantine & Storage (2016c). IPM at a Glance. Retrieved from http://ppqs.gov.in/divisions/integrated-pest-management/ipm-glance

FAO (2016) .Guidelines on Highly Hazardous Pesticides. International Code of Conduct on Pesticide Management. Rome, Italy FAO (2017) FAOstat database. Retrieved from http://www.fao.org/faostat/en/#home

FSSAI (2016) Manual of Methods of Analysis of Foods. Pesticide Residues. Retrieved from https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwiX18ex8d3WAhWLQo8KHfWtCPMQFggwMAI&url=https%3A%2F%2Fwww.fssai.gov.in%2Fdam%2Fjcr%3A34b311bb-4141-4a41-ad92-65e9258c2bc5%2FManual_Pesticides_Residues_09_01_2017.pdf&usg=AOvVaw2d8iq8Q5orZ88l5T_-o93g

Goswami, B. K., Bhattacharya Chaitali, Singh Neetu, and Paul, M. P. R. (2012). IPM package for the management of soil borne fungal and root knot nematode diseases on tomato and okra. Pesticide Research Journal Vol.24 No.1 pp.91-95.

Government of India (2000) Ministry of Environment and Forests. Notification. New Delhi. Retrieved from http://www.envfor.nic.in/legis/ods/odsrcr.html

Government of India (2011) National Implementation Plan, Stockholm Convention on Persistent Organic Pollutants. Retrieved from http://envfor.nic.in/sites/default/files/NIP_0.pdf

Government of India (2011b) Report of the Working Group on Occupational Safety and Health for the Twelfth Five Year Plan (2012 TO 2017). Retrieved from http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/policy/wcms_211795.pdf

Government of India (2016) *Instruction for Safe Use of Pesticide.* Directorate of Plant Protection, Quarantine & Storage. Retrieved from http://ppqs.gov.in/divisions/integrated-pest-management/instruction-safe-use-pesticide

Government of India (2017) Ministry of Environment, Forests and Climate Change, Introduction. Retrieved from http://envfor.nic.in/division/items-work-handled-5

Government of India Press Information Bureau (2015) Promoting Organic Farming. Ministry of Agriculture & Farmers Welfare. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=118622

Government of India Press Information Bureau (2016). Implementation of NPOP. Ministry of Commerce and Industry. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=155000

Government of India Ministry of Agriculture and Farmers Welfare (2017). Guideline for Model Organic Cluster Demonstration and Model Organic Farm under Paramapragat Krishi Vikas Yojana scheme. Retrieved from

(http://ncof.dacnet.nic.in/Operational_Guidelines/PKVYguidelines_Feb17.pdf

Guidelines for Registration (2011). Retrieved from http://cibrc.nic.in/guidelines.htm

Hemalatha, S., Ramaraju, K., Jeyarani, S. (2015). First record of *Metarhizium flavoviride* Gams & Rozsypal var. *minus* on brown plant hopper from Tamil Nadu, India with infectivity on chilli and tomato thrips. Journal of Entomological Research. Vol.39 No.1 pp.15-20.

ILO (2013). National Policy on Safety, Health and Environment at Workplace. Retrieved from http://www.ilo.org/asia/WCMS_182422/lang--en/index.htm

IR (n.d.). Retrieved from http://www.indianrailways.gov.in/railwayboard/uploads/codesmanual/CommManual-II/commercialmanualIIch14_data.htm

Jakhar, B. L. and Suman, S. (2015). Evaluation of different modules for the management of tomato fruit borer, *Helicoverpa armigera* pest of tomato. Journal of Applied and Natural Science Vol.7 No.1 pp.155-158

Kaur, S. and Srinivasan, R. (2014). Evaluation of an organic salt and entomopathogenic fungal formulation against insect and mite pests on sweet pepper under net-house conditions in Punjab, India. Pest Management in Horticultural Ecosystems Vol.20 No.2 pp.141-147.

Kaur, R., Joshi, N., Virk, J. S. and Sharma, S. (2016). Evaluation of Pseudomonas fluorescens for the management of tomato early blight disease and fruit borer. Journal of Environmental BiologyVol.37 No.5 pp.869-872 ref.28

Kumar, S. and Sekhon, P. S. (2016). *Fusarium* spp. causing dry rot of potato and their chemical management. Plant Disease Research Vol.31 No.1 pp.59-65

Kumari, M., Pandey, S., Bhattacharya, A., Mishra, A. and Nautiyal, C. S. (2017). Protective role of biosynthesized silver nanoparticles against early blight disease in Solanum lycopersicum Plant Physiology and Biochemistry Vol.121 pp.216-225

Lal, M., Singh, B. P., Yadav, S., and Sharma, S. (2017). Ametoctradin 27% + Dimethomorph 20.27% (w/w) SC: a new molecule for management of late blight of potato in India. Journal of Experimental Zoology, India, Vol.20 No.2 pp.1119-1123.

Maity, A. and Mukherjee, I. (2009). Assessment of iprovalicarb, a systemic fungicide in/on cabbage (*Brassica oleracea* var. *capitata*). Bulletin of Environmental Contamination and Toxicology Vol.83 No.3 pp.341-347

Mandal, S. K. (2017). Field evaluation of pesticide schedule against *Bemisia tabaci* in tomato. Annals of Plant Protection Sciences, Vol.25 No.2 pp.421-423.

Manikandan, R., Raguchander, T. (2014). Prevalence of tomato wilt disease incited by soil borne pathogen *Fusarium oxysporum* f. sp. *lycopersici* (Sacc.) in Tami Nadu. International Journal of Tropical Agriculture, Vol.32 No.1/2 pp.279-283.

Maps of India (2015). Scenario of Agriculture in India. Retrieved from https://www.mapsofindia.com/indiaagriculture/

MART Value Chain Analysis and Feasibility Strategy of Product Clusters in TSP areas of Odisha. Retrieved from http://otelp.org/Downloads/Mart_value_Chain.pdf

Maurya, S. K., Maurya, R. P., Singh, D. (2015). Evaluation of thiamethoxam 70% WS as seed treatment against early sucking pests of tomato. Journal of Applied and Natural Science Vol.7 No.2 pp.763-767.

MoA&FW, Extension reforms monitoring system. Retrieved from: http://extensionreforms.dacnet.nic.in

MoA&FW (2015). Monitoring of Pesticide Residues at National Level. Annual Progress Report (April, 2014 - March, 2015). Retrieved fromhttp://www.indiaenvironmentportal.org.in/files/file/Annl_rpt_2015.pdf

MoEF&CC (n.d.). Environmental Education, Awareness and Training (EEAT). Retrieved from http://www.moef.nic.in/division/environmental-education-awareness-and-training-eeat

MoEF&CC (n.d.). Hazardous Substance Management. Retrieved from http://www.moef.nic.in/hazardous_substances_management

MoEF&CC (2000). Ministry of Environment and Forests Notification. Retrieved from http://envfor.nic.in/legis/ods/odsrcr.html

MoEF&CC (2011). Government of India National Implementation Plan. Retrieved from http://envfor.nic.in/sites/default/files/NIP_0.pdf

MoEF&CC (2011b). Ministry of Environment and Forests Notification. Gazette of India. Retrieved from http://www.moef.nic.in/downloads/rules-and-regulations/SO523_E_new.pdf

National Horticulture Board (2010). Operational Guidelines. Schemes of National Horticulture Board. Retrieved from http://nhb.gov.in/schemes/NewGuidelines.pdf

NBA (2004). National Biodiversity Authority Rules. Retrieved from http://nbaindia.org/content/17/20/1/rules.html

Oerke EC (2005) Crop losses to pests. J Agr Sci 144:31–43.

http://www.unicentroagronomia.com/imagens/noticias/jackson_artigo_questoes_ingles_jackson.pdf

Plant Quarantine Information System (n.d.). The PQ Order, 2003 - Consolidated version. Retrieved from http://plantquarantineindia.nic.in/PQISPub/html/PQO_amendments.htm

Plant Quarantine Order (2015). Updated and Consolidated Version of the Plant Quarantine Order (Regulation of Import into India), 2003. Retrieved from http://plantquarantineindia.nic.in/PQISPub/pdffiles/pqorder2015.pdf

Prasannakumar, N. R., Chakravarthy, A. K., Naveen, A. H. (2012). Influence of weather parameters on pheromone trap catches of potato cutworm, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae). Current Biotica, Vol.5 No.4 pp.508-512.

Quality Council of India (2015). Good Agricultural Practices (GAP) Voluntary Certification Scheme. Retrieved from http://www.qcin.org/good-agricultural-practices.php

Rotterdam Convention website (2010). Country Profiles. Retrieved from http://www.pic.int/Countries/CountryProfiles/tabid/1087/language/en-US/Default.aspx

Sekhon, P. S.; Amarjit Singh; Sandeep Jain; Monica Attri (2017). Use of web based decision support system for the management of late blight of potato in Punjab.Indian Journal of Economics and Development Vol.13 No.3 pp.576-580

Shah, K. D., Jhala, R. C., Dhandge, S. R. (2017). Standardization of pheromone traps for the mass trapping of *Helicoverpa armigera* (Hubner) Hardwick in tomato. Current Agriculture Research Journal Vol.5 No.1 pp.45-49.

Shailbala, S. and Kumar, A. (2017). Eco-friendly management of late blight of potato - a review. Journal of Applied and Natural Science Vol.9 No.2 pp.821-835.

Sharma, S. L. 1974 Buckeye rot, a destructive disease of tomato in Himachal Pradesh. Pesticides Vol.8 No.5 pp.31-32

Singh, J. P., and Lal, S. S., (2009). Climate change and potato production in India. ISPRS Archives XXXVIII-8/W3 Workshop Proceedings: Impact of Climate Change on Agriculture. Retrieved from http://www.isprs.org/proceedings/XXXVIII/8-W3/b2/6-127_ISRO%20F.pdf.

Sridhar, V., Nitin, K. S., Naik, S. O., Nagaraja, T. (2015). Comparative biology of South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) on three solanaceous host plants. Pest Management in Horticultural Ecosystems 2015 Vol.21 No.2 pp.159-161.

Sridhar, V., Onkaranaik, S., Nitin, K. S. (2016). Efficacy of new molecules of insecticides against South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Pest Management in Horticultural Ecosystems. Vol.22 No.2 pp.137-145.

Srivastava, R. M., Sumit Kumar, Lokesh Bora. (2017). Studies on field efficacy of newer insecticides on population dynamics of major insect pests and mite infesting tomato crop. Journal of Entomological Research Vol.41 No.3 pp.257-266.

Toxicswatch (2017) Implementation of Stockholm Convention on Persistent Organic Pollutants (POPs) in India & outcome of triple CoP. ToxicsWatch, Journal of Earth, Science, Economy and Justice. Retrieved from http://www.toxicswatch.org/2017/08/implementation-of-stockholm-convention.html

Upesh Kumar, Suresh Kumar, Prem Naresh. (2017) Integrated pest management module for the management of fruit borer in tomato. Lifesciences Leaflets Vol.85 pp.72-75 ref.7

WHO (2018). World Health Organization India. Poisons. Retrieved from http://www.searo.who.int/india/topics/poisons/en/

World Bank Group (2012) India: Issues and Priorities for Agriculture. Retrieved from http://www.worldbank.org/en/news/feature/2012/05/17/india-agriculture-issues-priorities

Annexes

Annex I: Overview of the legal framework for pesticide use in comparison to international standards

Indicator	In place
Adherence to and implementation of international agreements relating to pesticides	
The country is a party to the Montreal Protocol	✓
The country enacted provision relating to the implementation of the Montreal Protocol	✓
The country is a party to the Rotterdam Convention	✓
The country enacted provision relating to the implementation of the Rotterdam Convention	✓
The country is a party to the Stockholm Convention	✓
The country enacted provision relating to the implementation of the Stockholm Convention	✓
The country is a party to the Basel Convention	✓
The country enacted provision relating to the implementation of the Basel Convention	✓
The country is a party of the International Labour Organisation Safety and Health in Agriculture Convention (C184)	✓
The country enacted provision relating to the implementation of the International Labour Organisation 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	✓
A policy is in place to facilitate access to information on matters including pesticide hazards and risks, residues in food, IPM/IVM, alternatives to highly hazardous pesticides and related regulatory and policy actions	✓
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.	✓
Regulations related to the manufacture of pesticides	
A regulation addressing the manufacture and packaging of pesticides exists:	X
• 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 wastes, emissions and effluents	X
• It ensures that packaging or repackaging is carried out only on licensed premises that comply with safety standards	X

Indicator	In place
• 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	X
Legal framework for non-chemical preventive and direct control measures	
Registration is required for non-chemical preventive and direct control measures	✓
A subsidy scheme for non-chemical preventative and curative control methods is in place.	✓
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 personal protective equipment (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	✓
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	
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 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	✓
The legislation clearly defines the activities and types of pesticides requiring registration (e.g. all pesticide uses or a subset)	✓
• There are special requirements for products used on seed / plant material	X
• 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	X
• There are provisions for use of unregistered pesticides in emergency situations	X
Low toxicity / low risk pesticides are defined	X

Indicator	In place
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 products 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:	✓
o Identity, biology and ecology of the agent	✓
o Information for assessment of safety and effects on human health	✓
o Information for assessment of environmental risks	✓
o Information for assessment of efficacy, quality control and benefits of use	✓
o Toxicity for humans and the environments of additives (for microbial biological control agents only)	✓
The legislation contains other provision which aims at facilitating the registration of biopesticides / biological control agents	✓
The legislation indicates the validity period for registrations	✓
The legislation describes procedures for denial of registration and appeal	✓
The legislation describes requirements for label extension	✓
The legislation provides for review of registered pesticides and empower the registration body to impose new conditions in view of new information	✓
The legislation describes requires mandatory re-registration at specified intervals	
The legislation assigns responsibility for keeping records	✓
The legislation includes provisions ensuring confidentiality of trade secrets.	
A pesticide register compiling all registered products is made publicly available by the responsible authority. It contains the following information:	✓
• Trade names of the products	✓
• Registration numbers	✓
• Name(s) of the active ingredient(s)	✓
• Concentration of the active ingredient(s)	✓
• Formulation type	✓
• Authorized uses including crops and target pests	✓
• The name of the registrant	✓
• The period of registration	✓
• User groups are identified (e.g. use of some pesticides is restricted, e.g. to certified professionals);	✓

Indicator	In place
A separate list containing the pesticide products that are banned or severely restricted is published by the national authority. Likewise biopesticides are listed identified in a separate list.	✓
Analysis of registered pesticide list for highly hazardous pesticides and alternatives	
List the time of last update	✓
The number of AI registered	✓
The number of products registered	
The number of registrants	
For the banned list, the last time it was updated, the number (and identity) of the banned pesticides	✓
Last updated in October, 2015, 60 pesticides are banned	
Biocontrol agents which 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:	✓
• To carry out pest risk analysis of biological control agents	✓
• To obtain, provide and assess documentation as appropriate, relevant to the export, shipment, import or release of biological control agents and other beneficial organisms	✓
• 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	✓
• To encourage monitoring of release of biological control agents or beneficial organisms in order to assess impact on target and non-target organisms	
Packaging and Labelling	
The legislation specifies the products to which the packaging and labelling requirements apply (e.g. apply equally to imported and domestically manufacturer products)	✓
The legislation specifies the technical requirements for packaging and re-packaging	✓
The legislation incorporates requirements for packaging and labelling into the registration process	✓
The legislation requires packaging that is safe	✓
The legislation requires packaging which will not degrade under normal conditions (e.g. packaging material should be impermeable to contents)	✓
The legislation requires packaging which does not resemble common packaging of consumable goods,	✓
The legislation requires that packaging or re-packaging only take place on licensed premises where staff are adequately protected	✓
The legislation bans re-packaging when effective controls are not possible in the national context	✓
The legislation prohibits the re-packaging 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	✓

Indicator	In place
• Use type	✓
• Type of formulation	✓
• Active ingredient name	✓
• Active ingredient 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)	✓
• Directions for use	✓
• Warning against container reuse, instructions for storage and disposal	✓
• Legal requirement that pesticides be used in a way which is consistent with the label	✓
The legislation lists how the information in the label should be communicated (languages, system of weights and measures…)	✓
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	X
• It defines pesticide advertising broadly to cover all forms;	X
• It prohibits the advertising of unregistered or illegal pesticides	X
• It prohibits false or misleading advertising of pesticides	X
• It prohibits advertising contrary to approved uses or label instructions	X
• It designates the authority responsible for enforcement	X
Transport	
A regulation addressing the transport of pesticides is in place	✓
• It sets out requirements for vehicles and containers	
• It prohibits the transport of pesticides in the same vehicle as passengers, animals, food or feed	✓
• It requires physical separation in cases where joint transport or storage is unavoidable	✓
Import and export	
The legislation contains provisions specifically addressing the import and export of pesticides	✓

Indicator	In place
• 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	✓
• It fosters collaboration between the competent national authority and the customs department at points of entry	✓
• It establishes exceptions for donations or imports by public entities for specific purposes	X
• 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	
Requirements for sale	
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	✓
• It includes among the decision-making criteria for the grant of a licence issues such as storage, display, training, knowledge, record-keeping, safety equipment and emergency plans.	✓
• It prescribes the separation of pesticide from food and medicine	✓
• It prescribes that pesticides may only be sold in its undamaged original container	✓
• It prescribes that pesticides may only be sold with a readable label	✓
• It prescribes that pesticides must not be sold to minors	✓
• It prescribes that shops that sell pesticides must have a firefighting equipment	X
• It prescribes that shops that sell pesticides must have a warning board	✓
Licensing	
The legislation contains provisions to identify which pesticide-related activities are permitted only to operators that hold a valid license	✓
• It prescribes that a valid license must be held for manufacture and packaging	✓
• It prescribes that a valid license for sale must be held	✓
• It prescribes that a valid license must be held for transportation, import and export	✓
• It prescribes that a valid license must be held for special applications	✓
• It imposes specific and more restrictive requirements for severely restricted pesticides	✓
• It provides for back up inspections	✓
• It establishes a system to receive and evaluate applications, in order to assess risk	✓
• It sets out clear criteria for the grant 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	✓

Indicator	In place
• It enables the authority to impose fees for services associated with licensing; and	✓
• 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
• It contains provision to limit the availability of pesticides that are sold to the general public through non-specialized outlets	X
• It contains restrictions which specifically targets products used on seed/planting material.	x
• It contains restrictions which specifically target products used for post-harvest applications	x
Handling and use, including regulations on application equipment	
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	✓
The legislation requires employers to take the necessary measures to protect the health of workers and the environment.	✓
• 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	✓
The legislation contains provisions to permit pesticide application equipment and personal protective equipment 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 of the recommended application	X
• Appropriate calibration of the spraying equipment for the pesticides to be applied	✓
The legislation contains provisions to prescribe the responsible cleaning of application equipment	✓
• To rinse the content of the tank with fresh water and to apply the remaining liquid on the treated field	✓
• Application equipment must be rinsed externally in the field	✓
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	X
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 license or permit	✓
• For all products and application methods	X

Indicator	In place
• Only for specific products application methods	X
• The content of the mandatory trainings is described in the law	X
Restrictions related to vulnerable groups	
The legislation contains any provision to prevent the use of pesticides by and sale of pesticides to children or pregnant and nursing women	
The legislation requires employers to take the necessary measures to prevent use by children and other vulnerable groups	X
Requirements for personal protection equipment	✓
A policy is in place to place to promote the use of personal protective equipment which is suitable.	✓
The legislation prescribes the use of personal protective equipment 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	✓
• 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	X
Storage	
The legislation makes provisions for safe storage of pesticides	✓
• It differentiates between private, end-user or home storage and bulk or commercial storage	X
• It imposes record-keeping requirements on those storing pesticides	✓
• 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	✓
o The plant protection products are stored in their original containers and packs	✓
o The plant protection products are stored according to label storage requirements	X
o The plant protection products that are liquid formulations are stored on shelving that is never above those products that are powder or granular formulations	X
o The plant protection product storage facilities are built in a manner that is structurally sound and robust	X
o The plant protection product storage facilities have sufficient and constant ventilation of fresh air to avoid a build-up of harmful vapours	X
o The 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
o The plant protection product storage facilities are equipped with shelving that is not absorbent in case of spillage	X
o The 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

Indicator	In place
o The 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 case of spillage of plant protection products	X
o 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 meters of the plant protection product/chemical storage facilities and designated mixing areas	X
o 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 meters, 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, establish and implement an action plan for their disposal	X
The legislation contains provisions to ensure that disposal of hazardous pesticide waste are carried out in an environmentally sound manner	X
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	X
The legislation contains provisions for the implementation of a toxic waste collection scheme	✓
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	✓
• The regulations governing disposal of empty pesticide containers is the same across the country	✓
• Appropriate PPE 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 secure, ventilated location)	X
• The regulation bans the re-use of empty pesticide containers	✓
• Burying empty pesticide container 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)	X
• Empty containers are classified as hazardous waste regardless of or not 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 container to manufacturer or to the place of purchase or to the place indicated on the invoice issued at the time of purchase	X

Indicator	In place
• 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…)	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 health effects of pesticides and pesticide poisoning incidents / on environmental contamination and adverse effects, including the monitoring pesticide residues in feed, drinking water and/or the environment.	✓
• It assigns responsibility for mandatory monitoring and data collection with respect to pesticides	✓
• It sets out the powers and responsibilities of the responsible body and the inspection corps with regard to information-gathering	X
• It imposes reporting requirements on manufacturers, importers, distributors and sellers of pesticides	X
• It requires reporting of pesticide-related incidents to the competent authority	X
Residue monitoring in food and Maximum Residue Levels	
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 maximum residue levels (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 to follow the MRLs set by the *Codex Alimentarius*	✓
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.	✓
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.	✓
A policy is in place to establish national or regional poisoning information centres	✓
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	✓
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	✓
The legislation designates the national authority responsible for inspection	✓
• It defines the powers of the inspectors	✓

Indicator	In place
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	✓
• It determines proportional and deterrent fines and include 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	✓

Annex II. List of highly hazardous pesticide active ingredients registered for use in India

Highly Hazardous Pesticide Active Ingredients	Chemical Class	Use Type	HHP1 Acute toxicity	HHP2 Carcino-genicity	HHP3 Muta-genicity	HHP4 Repro-ductive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU Approved	GIZ Class
2-methoxyethylmercury chloride	Organomercury	Fungicide	N	1A / 1B	N	N	N	N	N	N	Not listed	#N/A
Abamectin	Macrocyclic lactone - avermectin	Insecticide	1	N	N	2	N	N	N	Y	Approved	B
Alachlor	Amide	Herbicide	2	2	N	N	N	Y	N	Y	Not approved	A
Aluminum phosphide	Fumigant	Insecticide, Rodenticides	1	N	N	N	N	N	N	Y	Approved	B
Benomyl	Benzimidazole	Fungicide	U	2	1A / 1B	1A / 1B	N	N	N	Y	Not approved	A
Beta-cyfluthrin	Pyrethroid	Insecticide	1B	N	N	2	N	N	N	Y	Approved	A
Bromadiolone	Coumarin	Rodenticide	1A	N	N	N	N	N	N	Y	Approved	A
Butachlor	Amide	Herbicide	3	1B	N	N	N	N	N	Y	Not approved	B
Captan	Phthalimide	Fungicide	U	1B	N	N	N	N	N	N	Approved	B
Carbaryl	Carbamate	Insecticide	2	1B	N	N	N	N	N	Y	Not approved	B
Carbendazim	Benzimidazole	Fungicide	U	2	1A / 1B	1A / 1B	N	N	N	Y	Not approved	A
Carbofuran	Carbamate	Insecticide, Nematicide	1B	N	2	N	N	Y	N	Y	Not approved	A
Chlorothalonil	Aromatic fungicide	Fungicide, Oomycide	U	1B	N	N	N	N	N	Y	Approved	B
Copper sulfate	Inorganic - copper	Fungicide, Oomycide, Bactericide	2	1A / 1B	N	N	N	N	N	N	Approved	C
Coumatetralyl	Coumarin	Rodenticide	1B	N	N	N	N	N	N	Y	Not approved	A
Cyfluthrin	Pyrethroid	Insecticide	1B	N	N	2	N	N	N	Y	Not approved	A
Ddt	Organochlorine	Insecticide, Acaricide	2	2	N	N	Y	Y	N	Y	Not approved	A
Diazinon	Organophosphorus	Insecticide	2	1B	N	1B	N	N	N	Y	Not approved	B
Dichlorvos (ddvp)	Organophosphorus	Insecticide, Acaricide	1B	2	N	N	N	N	N	Y	Not approved	A
Diclofop-methyl	Phenoxy	Herbicide	2	1B	N	1A / 1B	N	N	N	Y	Approved	B
Dinocap	Dinitrophenol	Fungicide, Acaricide	2	N	N	1A / 1B	N	N	N	Y	Not approved	A

Highly Hazardous Pesticide Active Ingredients	Chemical Class	Use Type	HHP1 Acute toxicity	HHP2 Carcino-genicity	HHP3 Muta-genicity	HHP4 Repro-ductive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU Approved	GIZ Class
Diuron	Urea	Herbicide	3	1B	N	N	N	N	N	Y	Approved	B
Edifenphos	Organophosphorus	Fungicide	1B	N	N	N	N	N	N	Y	Not approved	A
Ethylene dichloride	Fumigant	Insecticide	N	1B	N	N	Y	N	N	N	Not listed	A
Flusilazole	Triazole	fungicide	2	2	N	1A / 1B	N	N	N	Y	Not approved	A
Glufosinate ammonium	Organophosphorus	Herbicide	N	N	N	1A / 1B	N	N	N	Y	Not listed	A
Glyphosate	Organophosphorus	Herbicide	3	1B	N	2	N	N	N	Y	Approved	B
Hexythiazox	Thiazolidine	Acaricide	U	1B	N	N	N	N	N	Y	Approved	B
Iprodione	Dicarboximide	Fungicide	3	1B	N	N	N	N	N	Y	Approved	B
Iprovalicarb	Carbamate	Fungicide	U	1B	-	N	N	N	N	Y	Approved	B
Kresoxim-methyl	Strobilurin	Fungicide	N	1B	N	N	N	N	N	Y	Approved	B
Linuron	Urea	Herbicide	3	2	N	1A / 1B	N	N	N	Y	Not approved	A
Magnesium phosphide	Fumigant	Insecticide	1	N	N	N	N	N	N	Y	Approved	B
Malathion	Organophosphorus	Acaricide, Insecticide	3	1B	N	N	N	N	N	Y	Approved	B
Mancozeb	Dithiocarbamate	Fungicide, Oomycide	U	1B		2	N	N	N	Y	Approved	B
Methomyl	Carbamate	Insecticide	1B	N	N	N	N	N	N	Y	Approved	A
Methyl bromide	Fumigant	Fumigant, Insecticide, Herbicide, Nematicide	N	N	2	2	N	N	Y	Y	Not approved	A
Methyl parathion	Fumigant	Fumigant, Insecticide, Fungicide, Nematicide, Herbicide	1A	N	N	N	N	N	N	Y	Not approved	A
Metiram	Dithiocarbamate	Fungicide, Oomycide	U	1B	N	2	N	N	N	Y	Approved	B
Monocrotophos	Organophosphorus	Insecticide	1B	N	2	N	N	Y	N	Y	Not approved	A
Oxadiargyl	Oxadiazolone	Herbicide	N	N	N	1A / 1B	N	N	N	N	Not approved	B
Oxadiazon	Oxadiazolone	Herbicide	U	1B	N	2	N	N	N	Y	Approved	B
Oxydemeton-methyl	Organophosphorus	Insecticide	1B	N	2	2	N	N	N	Y	Not approved	A

Highly Hazardous Pesticide Active Ingredients	Chemical Class	Use Type	HHP1 Acute toxicity	HHP2 Carcino-genicity	HHP3 Muta-genicity	HHP4 Repro-ductive toxin	HHP5 POP	HHP6 PIC	HHP7 ODS	PAN HHP	EU Approved	GIZ Class
Oxyfluorfen	Diphenyl ether	Herbicide	U	1B	N	N	N	N	N	Y	Approved	B
Permethrin	Pyrethroid	Insecticide	2	1B	N	N	N	N	N	Y	Not approved	B
Phorate	Organophosphorus	Insecticide, Nematicide, Acaricide	1A	N	N	N	N	N	N	Y	Not approved	A
Phosphamidon	Organophosphorus	Insecticide, Nematicide	1A	N	2	N	N	Y	N	Y	Not approved	#N/A
Propargite	Sulfite ester	Acaricide	3	1B	N	N	N	N	N	Y	Not approved	B
Propetamphos	Organophosphorus	Insecticide, Acaricide	1B	N	N	N	N	N	N	Y	Not approved	A
Propineb	Dithiocarbamate	Fungicide, Oomycide	U	1B	N	2	N	N	N	N	Approved	D
Propoxur	Carbamate	Insecticide	2	1B	N	N	N	N	N	Y	Not approved	B
Pymetrozine	Organophosphorus - pyridine	Insecticide	N	2	N	N	N	N	N	Y	Approved	B
Quizalofop-p-tefuryl	Phenoxy	Herbicide	2	N	2	1A / 1B	N	N	N	Y	Approved	A
Sodium cyanide	Unclassified	Insecticide, Rodenticides	1B	N	N	N	N	N	N	N	Not approved	A
Thiacloprid	Neonicotinoid	Insecticide	2	1B	N	2	N	N	N	Y	Approved	B
Thiodicarb	Carbamate	Insecticide, Molluscicide	N	1B	N	2	N	N	N	Y	Not approved	B
Thiometon	Organophosphorus	Insecticide, Acaricide	1B	N	N	N	N	N	N	Y	Not approved	A
Thiophanate-methyl	Benzamidazole	Fungicide	U	1B	2	2	N	N	N	Y	Approved	B
Topramezone	Pyrazole	Herbicide	-	N	N	1A / 1B	N	N	N	N	Pending	#N/A
Triadimefon	Triazole	Fungicide	N	2	N	1B	N	N	N	N	Not approved	B
Triazophos	Organophosphorus	Insecticide, Acaricide, Nematicide	1B	N	N	N	N	N	N	Y	Not approved	A
Trichlorfon	Organophosphorus	Insecticide	2	1B	N	N	N	N	N	Y	Not approved	B
Tridemorph	Morpholine	Fungicide	2	N	N	1B	N	N	N	Y	Not approved	A
Zinc phosphide	Inorganic-zinc	Rodenticide	1B	-	-	-	N	N	N	Y	Approved	A
Zineb	Dithiocarbamate	Fungicide, Oomycide	U	N	N	1A / 1B	N	N	N	Y	Not approved	B

Specifically, as per the definition given in the *Guidelines on Highly Hazardous Pesticides* (FAO 2016b), a pesticide can be classified as an HHP if it meets one or more of the following eight criteria:

Criterion 1: Pesticides that are extremely or highly acutely toxic (Classes Ia and Ib of the *WHO Recommended Classification of Pesticides by Hazard*, 2009)

Criterion 2: Known or presumed carcinogens (carcinogenicity Categories 1A and 1B of the *Globally Harmonized System of Classification and Labelling of Chemicals* – GHS, 2015)

Criterion 3: Known or regarded to induce heritable mutations (mutagenicity Categories 1A and 1B of the GHS)

Criterion 4: Known or presumed human reproductive toxicant (reproductive toxicity Categories 1A and 1B of the GHS)

Criterion 5: Persistent Organic Pollutants (POPs listed in the Stockholm Convention in its Annexes A and B, 2017)

Criterion 6: Pesticide AIs and formulations that are listed in the Rotterdam Convention Annex III (2017) because they have been banned or are severely restricted for health or environmental reasons. These Pesticides require “prior informed consent” when traded internationally.

Criterion 7: Ozone depleting substances (listed by the Montreal Protocol, 1987)

Criterion 8: Pesticide AIs and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

GIZ procurement category	
A	NOT ALLOWED (very hazardous and/or banned by the International Conventions).
B	ALLOWED FOR USE ONLY IN EXCEPTIONAL CASES; specifying the reasons. Every particular case must be verified.
C	ALLOWED FOR USE ONLY BY AUTHORISED PERSONNEL, with all precautions and by using personal protective equipment (for small-scale farmers only after appropriate training)
D	ALLOWED FOR USE, following the appropriate precaution; be aware of potential danger

Annex III. List of active ingredients which are registered in India and which require exceptional authorisation for recommendation or procurement by GIZ

Pesticide Active Ingredients	Chemical Class	Use Type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU
1,3-dichloropropene	Fumigant	Nematicide	Danger	N	Y	Y	Not approved
Abamectin	Macrocyclic lactone - avermectin	Insecticide	HHP	N	N	Y	Approved
Acephate	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved
Allethrin	Pyrethroid	Insecticide	Danger	N	N	N	Not approved
Aluminum phosphide	Fumigant	Insecticide, Rodenticide	HHP	N	N	Y	Approved
Ametryn	Triazine	Herbicide	Danger	N	N	N	Not approved
Anilofos	Organophosphorus	Herbicide	Danger	N	N	N	Not approved
Atrazine	Triazine	Herbicide	Warning	N	Y	Y	Not approved
Bendiocarb	Carbamate	Insecticide	Danger	N	N	Y	Not approved
Benfuracarb	Carbamate	Insecticide	Danger	N	Y	Y	Not approved
Bifenthrin	Pyrethroid	Insecticide	Danger	N	Y	Y	Approved
Bioallethrin	Pyrethroid	Insecticide	Warning	N	N	N	Not approved
Bitertanol	Triazole	Fungicide	Danger	N	Y	N	Not approved
Butachlor	Amide	Herbicide	HHP	N	N	Y	Not approved
Captan	Phthalimide	Fungicide	HHP	N	N	N	Approved
Carbaryl	Carbamate	Insecticide	HHP	N	Y	Y	Not approved
Carbosulfan	Carbamate	Insecticide	Danger	N	Y	Y	Not approved
Carpropamid	Amide	Fungicide	Low hazard	N	N	N	Not approved
Cartap	Nereistoxin analogue	Insecticide	Warning	N	N	N	Not approved
Chlorantraniliprole	Pyrazole / diamide	Insecticide	Warning	N	N	Y	Approved
Chlorfenapyr	Pyrrole	Insecticide, Acaricide	Danger	N	Y	Y	Not approved
Chlorfluazuron	Insect growth regulator	Insecticide	Low hazard	N	N	Y	Not approved
Chlorothalonil	Aromatic fungicide	Fungicide, Oomycide	HHP	N	N	Y	Approved
Chlorpyrifos	Organophosphorus	Insecticide, Acaricide	Danger	N	N	Y	Approved
Clothianidin	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved
Copper hydroxide	Inorganic - copper	Fungicide, Oomycide, Bactericide	Danger	N	N	Y	Approved
Coumachlor	Coumarin	Rodenticide	Warning	N	N	N	Not approved
Cypermethrin	Pyrethroid	Insecticide, Acaricide	Danger	N	N	Y	Approved
Deltamethrin	Pyrethroid	Insecticide	Danger	N	N	Y	Approved

Pesticide Active Ingredients	Chemical Class	Use Type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU
Diafenthiuron	Thiourea	Insecticide, Acaricide	Danger	N	N	Y	Not approved
Diazinon	Organophosphorus	Insecticide	HHP	N	Y	Y	Not approved
Diclofop-methyl	Phenoxy	Herbicide	HHP	N	N	Y	Approved
Dicofol	Bridged diphenyl	Acaricide	Danger	N	Y	N	Not approved
Dimethoate	Organophosphorus	Insecticide	Danger	N	N	Y	Approved
Dinotefuran	Neonicotinoid	Insecticide	Warning	N	N	Y	Not approved
Diuron	Urea	Herbicide	HHP	N	N	Y	Approved
Ethion	Organophosphorus	Insecticide	Danger	N	N	N	Not approved
Ethiprole	Pyrazole	Insecticide	Warning	N	N	N	Not approved
Ethoxysulfuron	Urea	Herbicide	Warning	N	N	N	Not approved
Etofenprox	Pyrethroid	Insecticide	Danger	N	N	Y	Approved
Fenarimol	Pyrimidine	Fungicide	Warning	N	Y	Y	Not approved
Fenazaquin	Unclassified	Acaricide	Danger	N	N	Y	Approved
Fenitrothion	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved
Fenobucarb	Carbamate	Insecticide	Warning	N	N	N	Not approved
Fenpropathrin	Pyrethroid	Insecticide	Danger	N	N	Y	Not approved
Fenthion	Organophosphorus	avicide, insecticide	Danger	N	Y	Y	Not approved
Fenvalerate	Pyrethroid	Insecticide	Danger	N	N	Y	Not approved
Fipronil	Pyrazole	Insecticide	Danger	N	Y	Y	Not approved
Fluazifop-p-butyl	Phenoxy	Herbicide	Warning	N	Y	N	Not listed
Flufenoxuron	Insect growth regulator	Insecticide, Acaricide	Warning	N	Y	Y	Not approved
Glyphosate	Organophosphorus	Herbicide	HHP	N	N	Y	Approved
Hexaconazole	Triazole	Fungicide	Warning	N	N	N	Not approved
Hexazinone	Triazinone	Herbicide	Warning	N	N	N	Not approved
Hexythiazox	Thiazolidine	Acaricide	HHP	N	N	Y	Approved
Imazethapyr	Imidazolinone	Herbicide	Warning	N	N	N	Not approved
Imidacloprid	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved
Imiprothrin	Pyrethroid	Insecticide	Warning	N	N	Y	Not listed
Indoxacarb	Oxadiazine	Insecticide	Danger	N	N	Y	Approved
Iprobenfos	Organophosphorus	Fungicide	Danger	N	N	N	Not approved
Iprodione	Dicarboximide	Fungicide	HHP	N	N	Y	Approved
Iprovalicarb	Carbamate	Fungicide	HHP	N	N	Y	Approved
Isoprothiolane	Dithiolane	Fungicide, Insecticide	Warning	N	N	N	Not approved

Pesticide Active Ingredients	Chemical Class	Use Type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU
Kasugamycin	Antibiotic	Bactericide	Missing data	N	N	N	Not approved
Kresoxim-methyl	Strobilurin	Fungicide	HHP	N	N	Y	Approved
Lambda-cyhalothrin	Pyrethroid	Insecticide	Danger	N	N	Y	Approved
Lufenuron	Biochemical biopesticides - insect growth regulators	Insecticide	Warning	N	N	Y	Approved
Magnesium phosphide	Fumigant	Insecticide	HHP	N	N	Y	Approved
Malathion	Organophosphorus	Acaricide, Insecticide	HHP	N	Y	Y	Approved
Mancozeb	Dithiocarbamate	Fungicide, Oomycide	HHP	N	N	Y	Approved
Mandipropamid	Amide	Fungicide	Warning	N	N	N	Approved
Mepiquat chloride	Growth inhibitor	plant growth regulator	Warning	N	Y	N	Not listed
Metaflumizone	Semicarbazone	Insecticide	Warning	N	N	Y	Approved
Methabenzthiazuron	Benzothiazole	Herbicide, Algicide	Danger	N	N	Y	Not approved
Metiram	Dithiocarbamate	Fungicide, Oomycide	HHP	N	N	Y	Approved
Metolachlor	Amide	Herbicide	Danger	N	N	N	Not approved
Metribuzin	Triazinone	Herbicide	Danger	N	N	Y	Approved
Milbemectin	Milbemycin	Insecticide, Acaricide	Warning	N	N	Y	Approved
Novaluron	Insect growth regulator	Insecticide	Warning	N	N	N	Not approved
Oxadiargyl	Oxadiazolone	Herbicide	HHP	N	N	N	Not approved
Oxadiazon	Oxadiazolone	Herbicide	HHP	N	N	Y	Approved
Oxycarboxin	Amide	Fungicide	Warning	N	N	N	Not approved
Oxyfluorfen	Diphenyl ether	Herbicide	HHP	N	N	Y	Approved
Paraquat dichloride	Quaternary ammonium	Herbicide	Danger	N	Y	Y	Not listed
Permethrin	Pyrethroid	Insecticide	HHP	N	Y	Y	Not approved
Phenthoate	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved
Phosalone	Organophosphorus	Insecticide, Acaricide	Danger	N	Y	N	Not approved
Pirimiphos-methyl	Fumigant, organophosphorous	Fumigant, Insecticide, Acaricide	Warning	N	N	Y	Approved
Prallethrin	Pyrethroid	Insecticide	Danger	N	N	Y	Not listed
Pretilachlor	Amide	Herbicide	Danger	N	N	N	Not approved
Profenofos	Organophosphorus	Insecticide	Danger	N	Y	Y	Not approved
Propanil	Amide	Herbicide	Warning	N	Y	N	Pending
Propargite	Sulfite ester	Acaricide	HHP	N	Y	Y	Not approved
Propoxur	Carbamate	Insecticide	HHP	N	N	Y	Not approved
Pymetrozine	Organophosphorus - pyridine	Insecticide	HHP	N	Y	Y	Approved

Pesticide Active Ingredients	Chemical Class	Use Type	Hazard summary	Proposed POPs	Rotterdam notifications	PAN HHP list	Approved for use in the EU
Pyridalyl	Pyridalyl	Insecticide	Warning	N	N	Y	Approved
Quinalphos	Organophosphorus	Insecticide, Acaricide	Danger	N	Y	Y	Not approved
Spinetoram	Biochemical biopesticides - microbial extracts / fermentation products / enzymes	Insecticide	Warning	N	N	Y	Approved
Spinosad	Biochemical biopesticides - microbial extracts / fermentation products / enzymes	Insecticide	Warning	N	N	Y	Approved
Streptomycin	Antibiotic	Bactericide	Warning	N	N	N	Not approved
Sulfentrazone	Triazolone	Herbicide	Warning	N	N	N	Not approved
Temephos	Organophosphorus	Insecticide	Danger	N	N	Y	Not approved
Tetraconazole	Triazole	Fungicide	Warning	N	N	Y	Approved
Thiacloprid	Neonicotinoid	Insecticide	HHP	N	N	Y	Approved
Thiamethoxam	Neonicotinoid	Insecticide	Warning	N	N	Y	Approved
Thiobencarb	Thiocarbamate	herbicide	Danger	N	N	N	Not approved
Thiodicarb	Carbamate	Insecticide, Molluscicide	Danger	N	Y	Y	Not approved
Thiophanate-methyl	Benzamidazole	Fungicide	HHP	N	N	Y	Approved
Tolfenpyrad	Pyrazole	Insecticide	Danger	N	N	Y	Not approved
Triadimefon	Triazole	Fungicide	HHP	N	N	N	Not approved
Tri-allate	Thiocarbamate	Herbicide	Warning	N	N	Y	Approved
Trichlorfon	Organophosphorus	Insecticide	HHP	N	N	Y	Not approved
Trifluralin	Dinitroaniline	Herbicide	Danger	N	Y	Y	Not approved
Validamycin	Antibiotic	Fungicide	Missing data	N	N	Y	Not approved
Zineb	Dithiocarbamate	Fungicide, Oomycide	HHP	N	Y	Y	Not approved
Ziram	Dithiocarbamate	Fungicide	Danger	N	N	Y	Approved

Annex IV. List of the key pests of potato and tomato with the HHP and non-HHP active ingredients which are registered for their management

Target pest name	Crop	Active ingredients effective against target pests, which are registered and are not HHP	HHPs which are used to manage the target pest[1]
Tuber rot	Potato	No effective pesticide registered. Instead, practice crop rotation and plant certified seeds	Mancozeb (not effective against bacterial pathogens)
Early blight	Potato	Azoxystrobin (GIZ class : D) Boscalid (GIZ class : D) Difenoconazol (GIZ class : C)	Mancozeb
Late blight	Potato	*Bacillus subtilis* (not compatible with fungicides listed below, GIZ class : D) Ametoctradin (GIZ class : D) Cymoxanil (GIZ class : C) Difenoconazol (GIZ class : C) Dimethomorph (GIZ class : D) Famoxadon (GIZ class : D) Fenamidon (GIZ class : D) Fluopicolid (GIZ class : D) Copper oxychloridede (GIZ class : C) Propamocarb hydrochloride (GIZ class : D) Pyraclostrobin (GIZ class : D)	Mancozeb
Tomato leafminer (*Tuta absoluta*), *Spodoptera* sp. and other caterpillars	Potato	Azadirachitin (GIZ class : D) Bacillus thuringiensis ssp. kurstaki (GIZ class : D) Beauveria bassiana (GIZ class : D) Emamectine benzoate (GIZ class: D) Spodoptera litura nucleopolyhedrosis virus (only against Spodoptera litura; GIZ class: not listed)	Monocrotophos Thiodiarb
Damping off	Tomato	*Bacillus subtilis* (not compatible with fungicides listed below, GIZ class : D) *Trichoderma harzianum* (not compatible with fungicides listed below, GIZ class : D) Thiram (GIZ class: not listed) Metalaxyl (GIZ class: C) Propiconazole (GIZ class: C)	Copper sulfate
Early blight	Tomato	Azoxystrobin (GIZ class : D) Boscalid (GIZ class : D) Difenoconazol (GIZ class : C)	Carbendazim Mancozeb

[1] The list of HHPs includes those that farmers use / extension agents recommend, even if they are not registered.

Target pest name	Crop	Active ingredients effective against target pests, which are registered and are not HHP	HHPs which are used to manage the target pest[1]
Late blight	Tomato	*Bacillus subtilis* (not compatible with fungicides listed below, GIZ class : D) Ametoctradin (GIZ class : D) Cymoxanil (GIZ class : C) Difenoconazol (GIZ class : C) Dimethomorph (GIZ class : D) Famoxadon (GIZ class : D) Fenamidon (GIZ class : D) Fluopicolid (GIZ class : D) Copper oxychloridede (GIZ class : C) Propamocarb hydrochloride (GIZ class : D) Pyraclostrobin (GIZ class : D)	Carbendazim Mancozeb
Soil borne disease	Tomato	*Bacillus subtilis* (not compatible with fungicides listed below, GIZ class : D) *Trichoderma harzianum* (not compatible with fungicides listed below, GIZ class : D) Note: The management of soil borne diseases requires an appropriate crop rotation	Carbendazim Mancozeb
Nematodes	Tomato	*Paecilomyces lilacinus* (GIZ class : D) Note: The management of nematodes requires an appropriate crop rotation	Carbofuran
Cutworms	Tomato	Azadirachitin (GIZ class : D) *Bacillus thuringiensis* ssp. kurstaki (GIZ class : D) *Beauveria bassiana* (GIZ class : D) Emamectine benzoate (GIZ class: D)	Phorate
Leaf miners	Tomato	Azadirachitin (GIZ class : D) *Bacillus thuringiensis* ssp. kurstaki (GIZ class : D) *Beauveria bassiana* (GIZ class : D) Emamectine benzoate (GIZ class: D)	Triazophos

Annex V: Figures and Tables

Table 9 Comparison of the status of chemicals currently being used against specific pests with the GIZ procurement list

	Not allowed
	Only as exception, elaborate verification needed
	Only by authorised staff (strict protection); not for smallholder farmers
	Safe to Use

Recommended/used	Pest/Disease	Chemical	GIZ category
Recommended by extension officers in potato crop	Mite	Dicofol	B
	Late blight	Mancozeb	B
	Rotting of tuber	Mancozeb	B
	Spodoptera	Pheromone traps	D
		Neem oil	D
Recommended by extension officers in tomato crop	Soil-borne diseases	Chlorothalonil:	B
		Carbendezim	A
		Cymoxanil,	C
	Nematodes	Trichoderma	D
		Pseudomonas	D
		Paecilomyces	D
	Early/late blight	Copperoxy chloride	C
		Sulphur	D
		Potassium phosphonate	D
	Nematodes	Carbofuran	A
	Leaf miner	Triazaphos	A
		Cartap	B
	Downy mildew	Profenofos	B
		Chlorantraniliprole	B
	Sucking pest	acetamprid	B
		Acephate	B
		Carbosulfan	B
		Cypermethrin	B
		Spinosad	B
		Thiamethoxam	B
	Cutworm	Phorate	A
Farmer use; not recommended by extension officers	Sucking pests	Monocrotophos	A
		Imidacloprid	B
		Chloropyriphos	B
	Helicoverpa	Dichlorvos (DDVP)	A
		Dimethoate	B
Farmer practice tomato	Sucking pest	Imidacloprid	B
		Diafenthiuron	B
		Propyrisulfuron	B
		Spinosad	B
		Chloropyriphos	B

Recommended/used	Pest/Disease	Chemical	GIZ category
		Lambda-cyhalothrin	B
	Helicoverpa	Cypermethrin	B
	Blight	Bordeaux	D
		Difenoconazole	C
		Chlorothalonil	B
		Mancozeb	B
		carbendazim	A
		Cymoxanil	C
		Quinalphos	B
	Helicoverpa	Indoxocarb	B
	Damping off	Copper oxy chloride	C
		Thiamethoxam	B
		Acetamiprid	B
		Metalaxyl	C
	Leaf miner	Triazaphos	A
	Tospovirus	Chlorantraniliprole	B
		Fipronil	B
Farmer practice potato	Leaf miner	Sulphur	D
	Army worm	Monocrotophos	A
	Mite	dicofol	B
	Blight	Mancozeb	B
		Potassium phosphonate	D
		Cymoxanil	C
		Pyraclostrobin	D
		Metiram	B
		Dimethomorph	D
		Mandipropamid	B

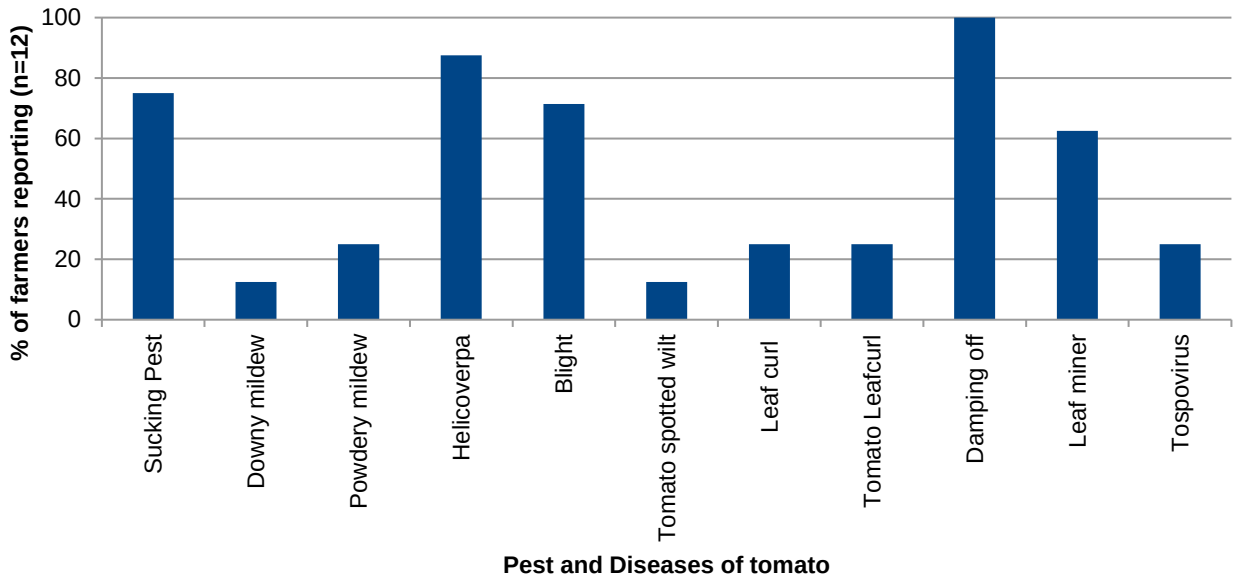

Figure 1: The pests and diseases of tomato as reported by the farmers.

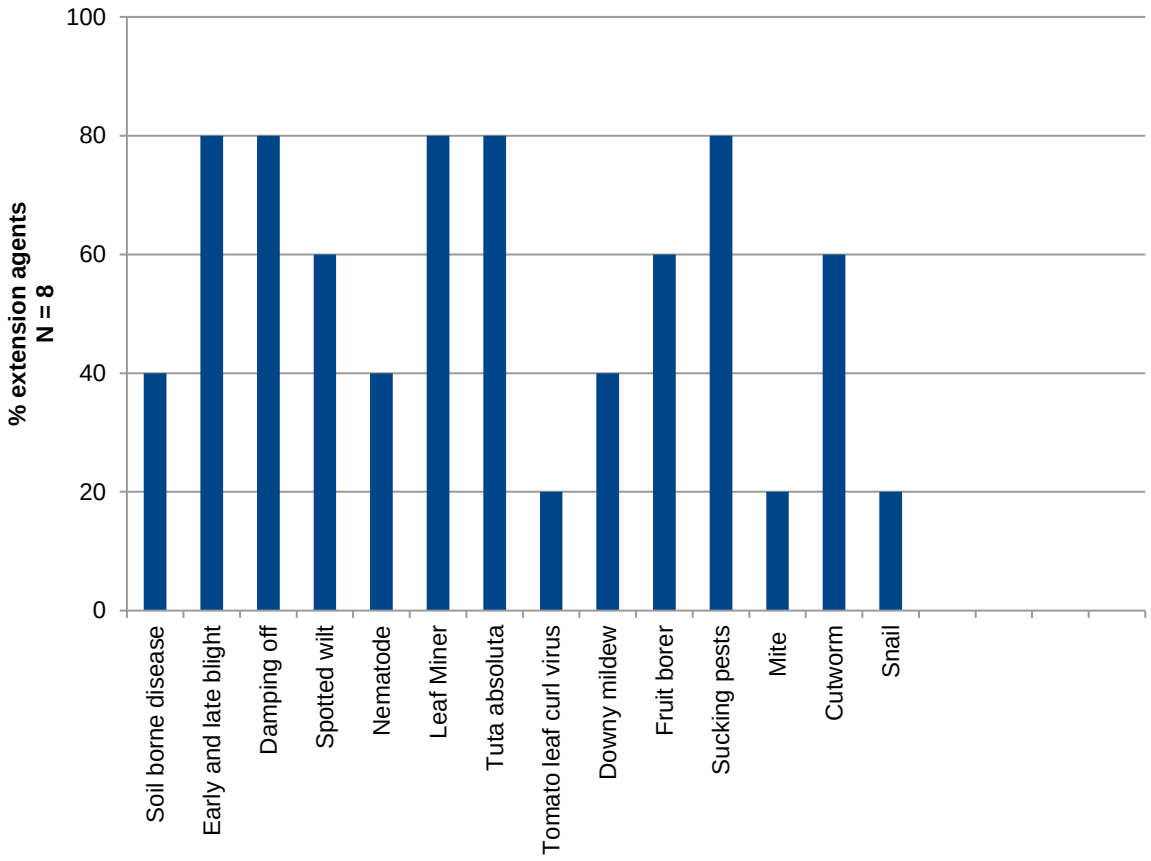

Figure 2: The pests and diseases of tomato as reported by the extension officers.

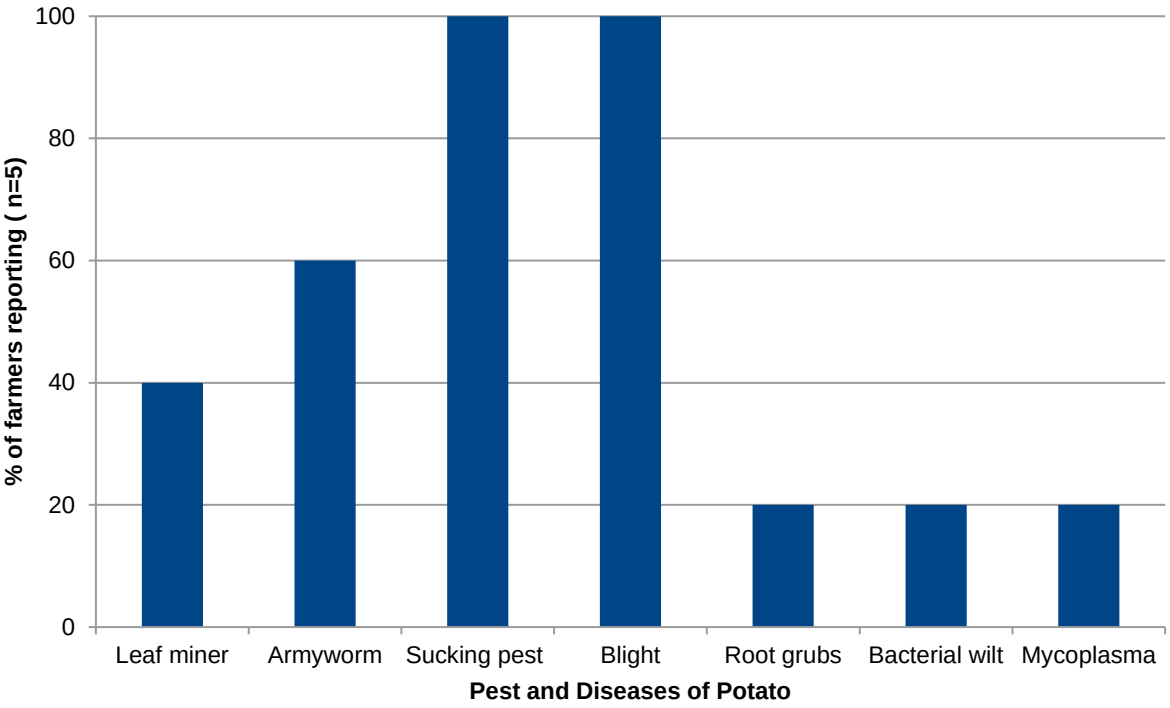

Figure 3: The pests and diseases of potato as reported by the farmers

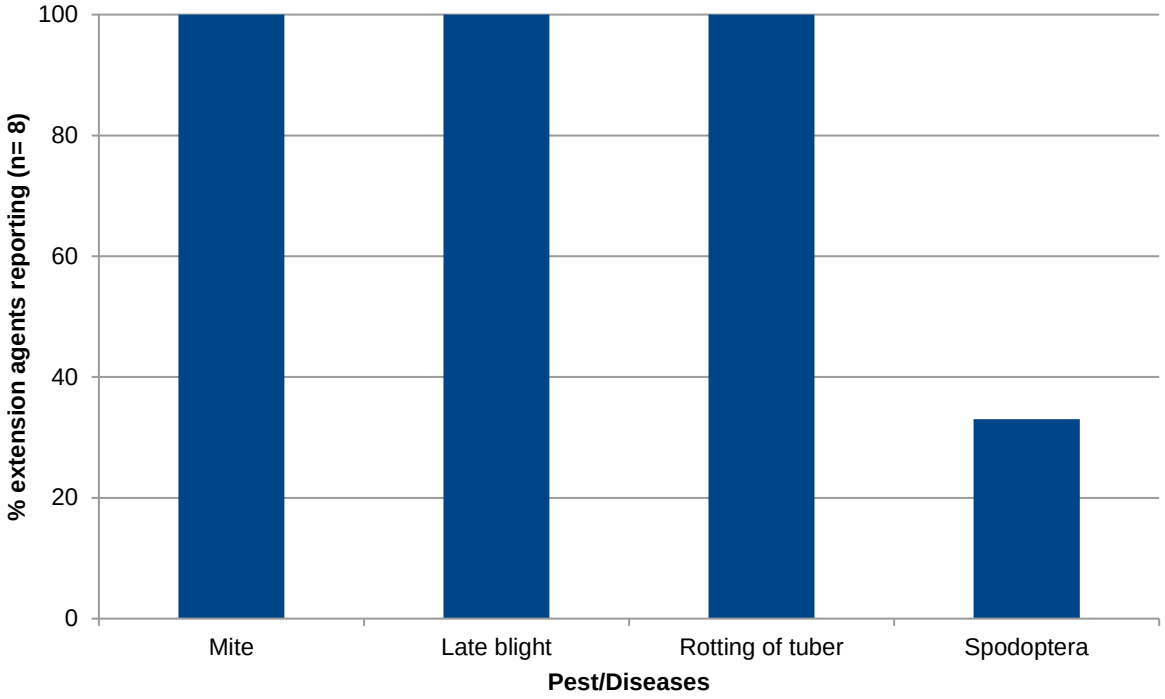

Figure 4: The pests and diseases of potato as reported by the extension officers

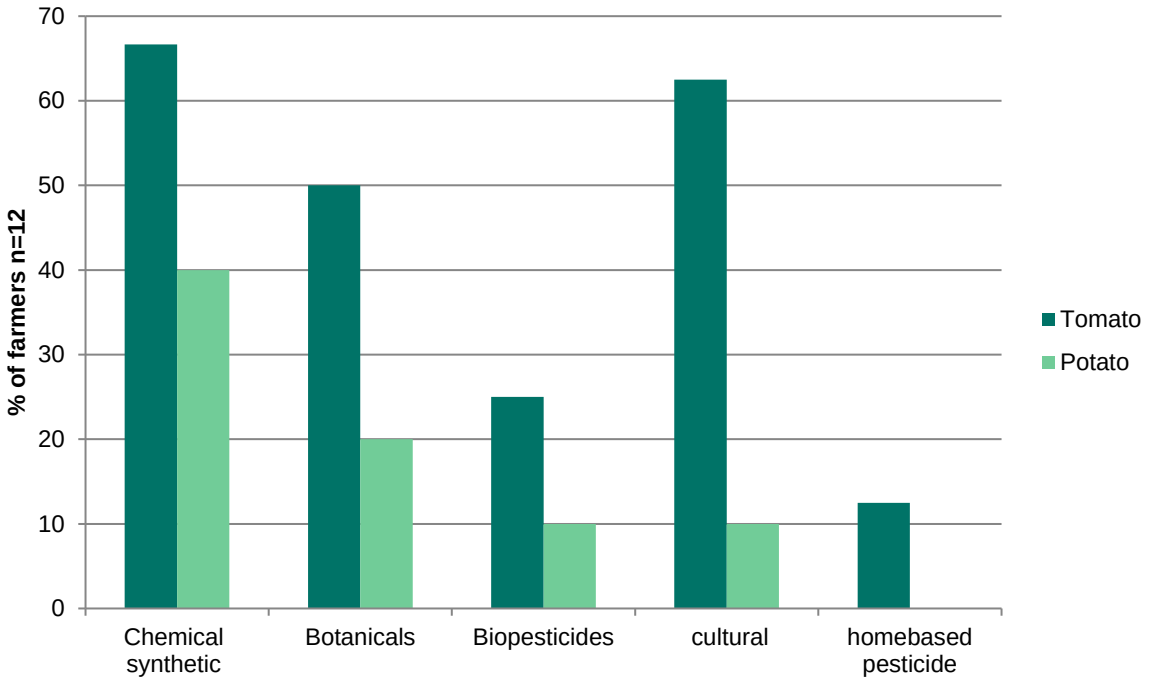

Figure 5: The management practices used for pest and diseases amongst farmers

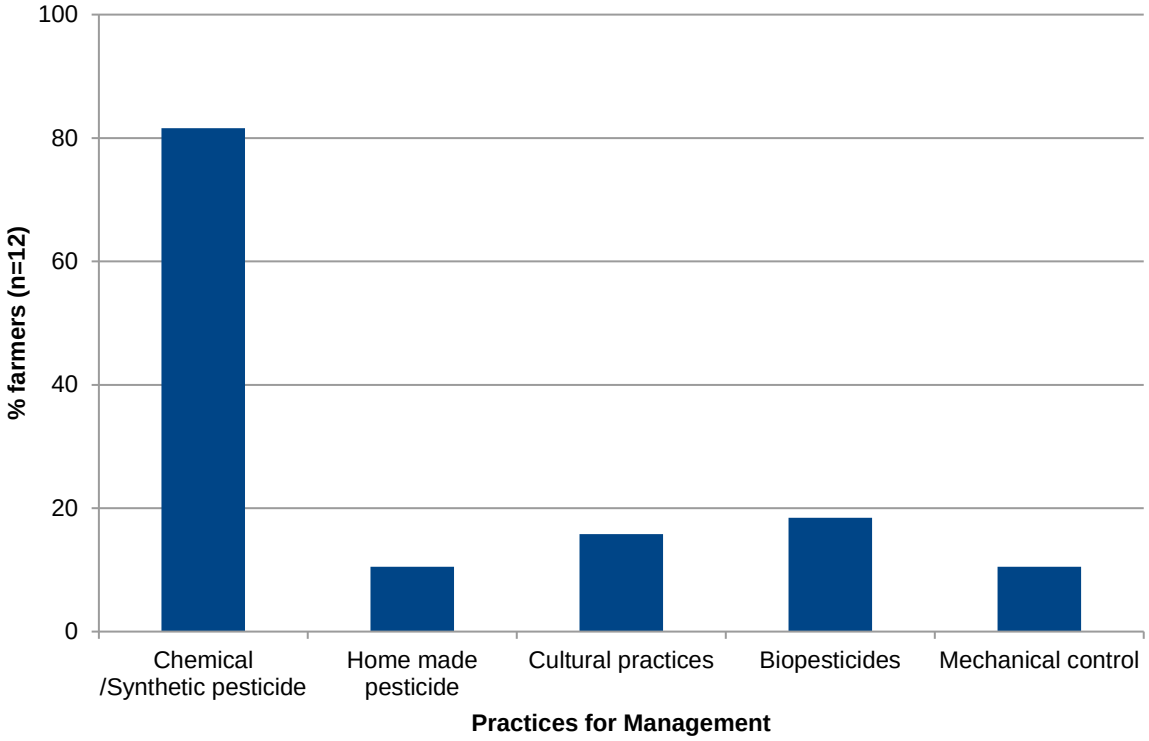

Figure 6: Management practices as adopted by the farmers and reported by extension officers

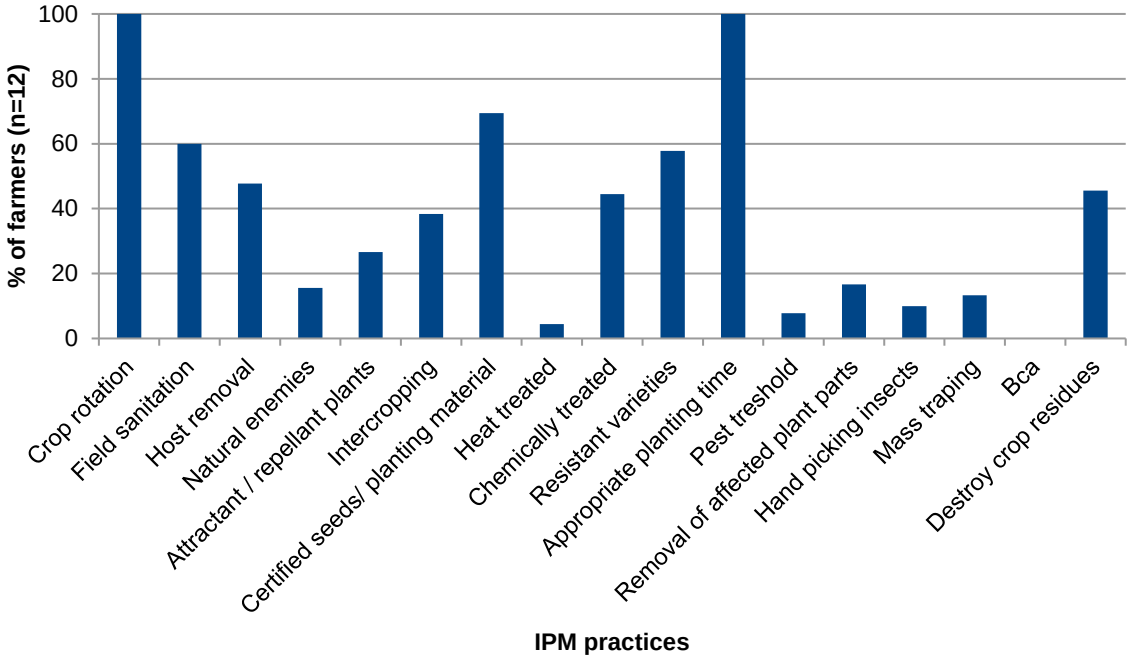

Figure 7: Other IPM strategies adopted by farmers, as reported by extension officers

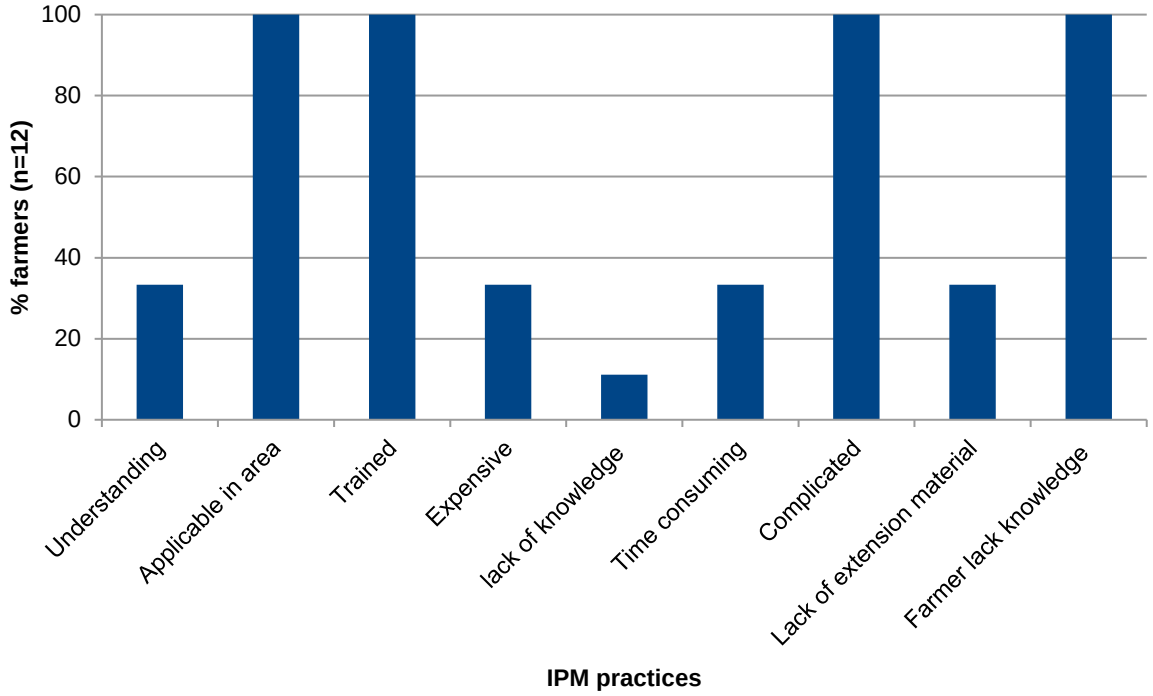

Figure 8: Relevance of IPM to farmers and barriers against adoption of the technology

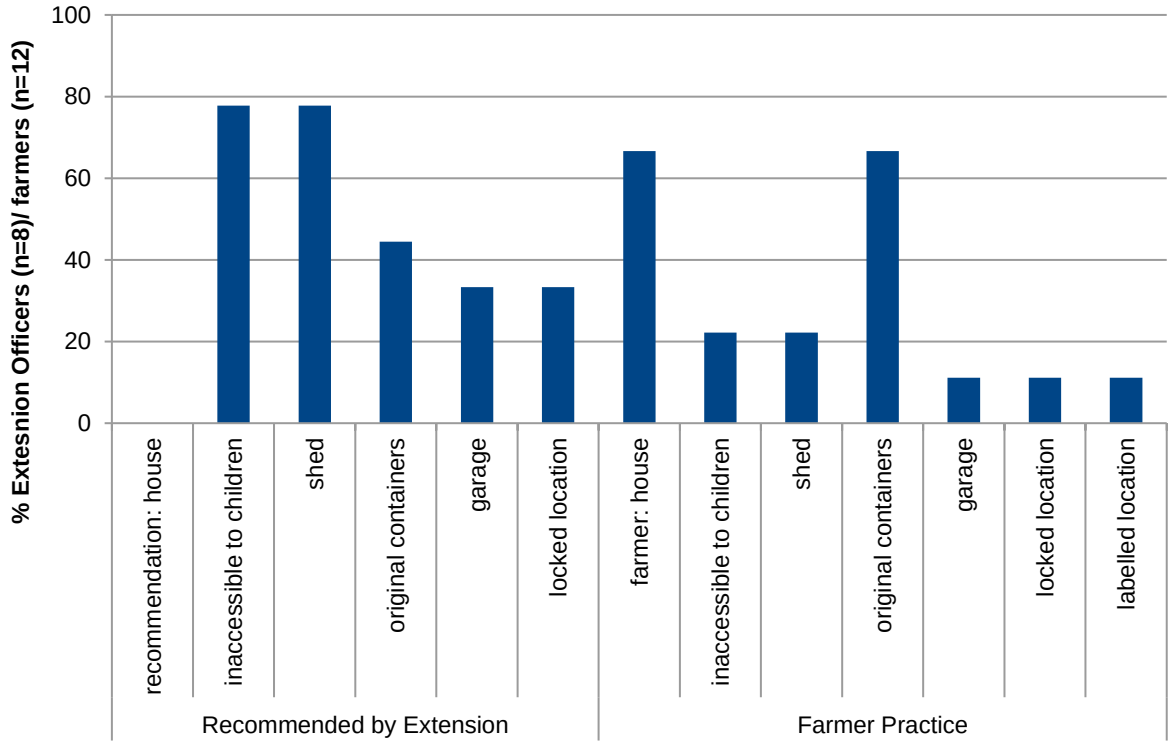

Figure 9: The percentage of extension agents recommending different storage methods for used pesticides at farm level, compared with actual farmer practices.

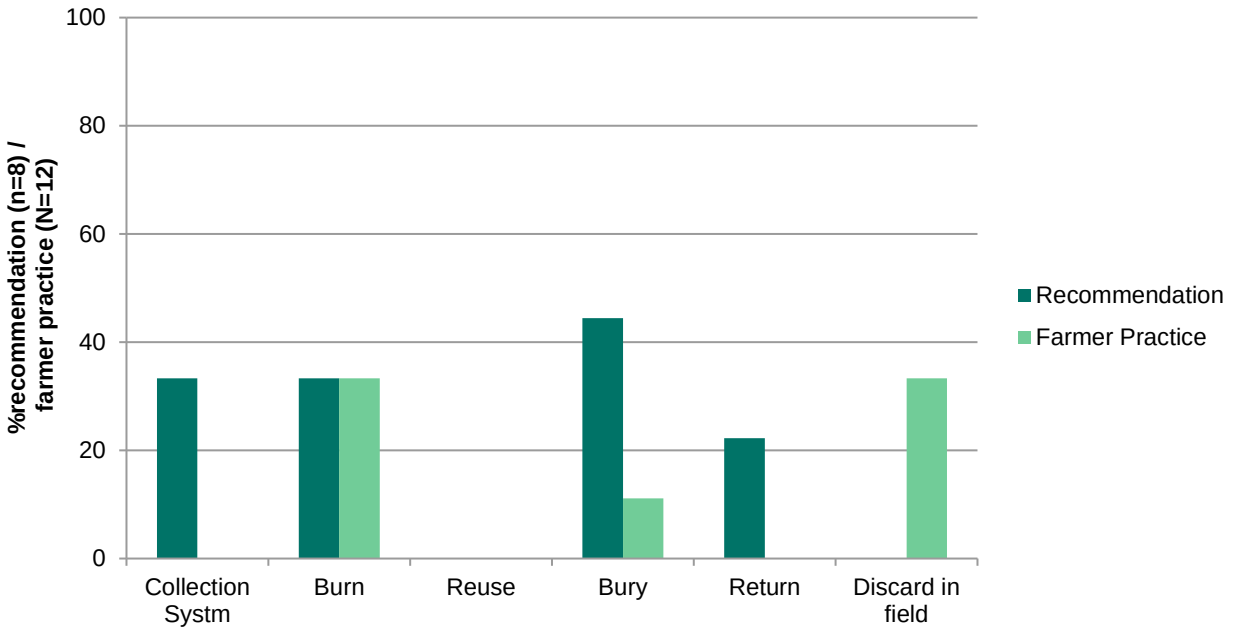

Figure 10: Advice given by extension agents versus actual practice by farmers in the disposal of used pesticide containers

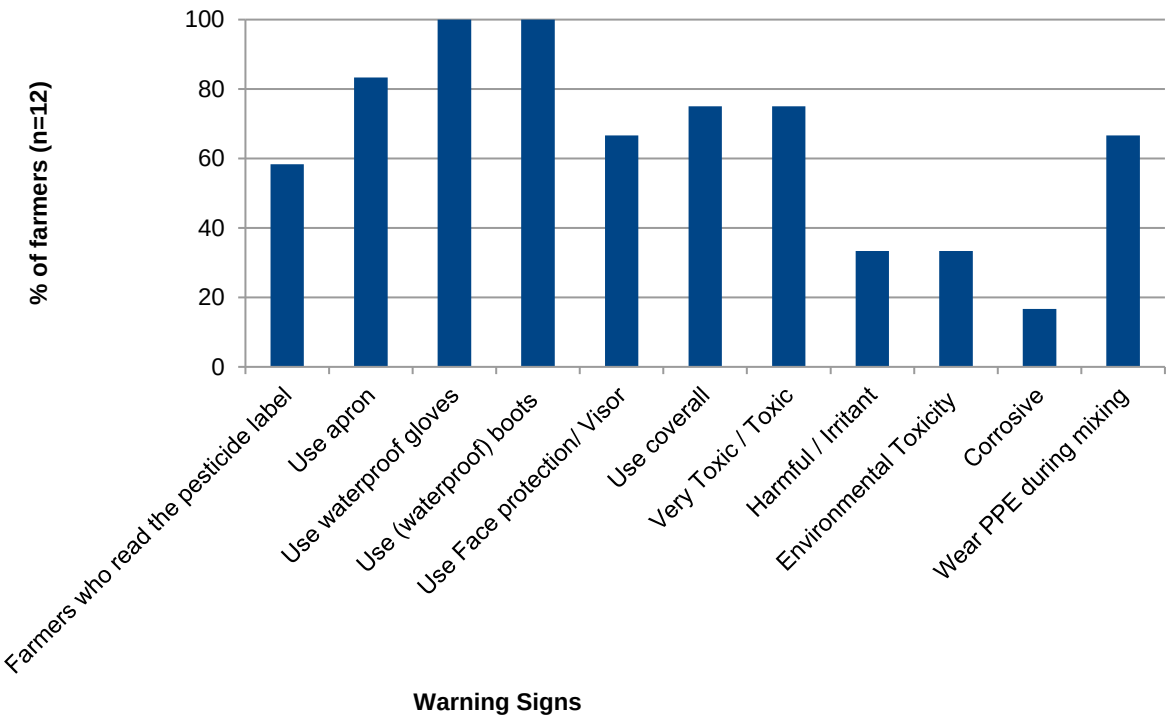

Figure 11: Warning signs understood by farmers

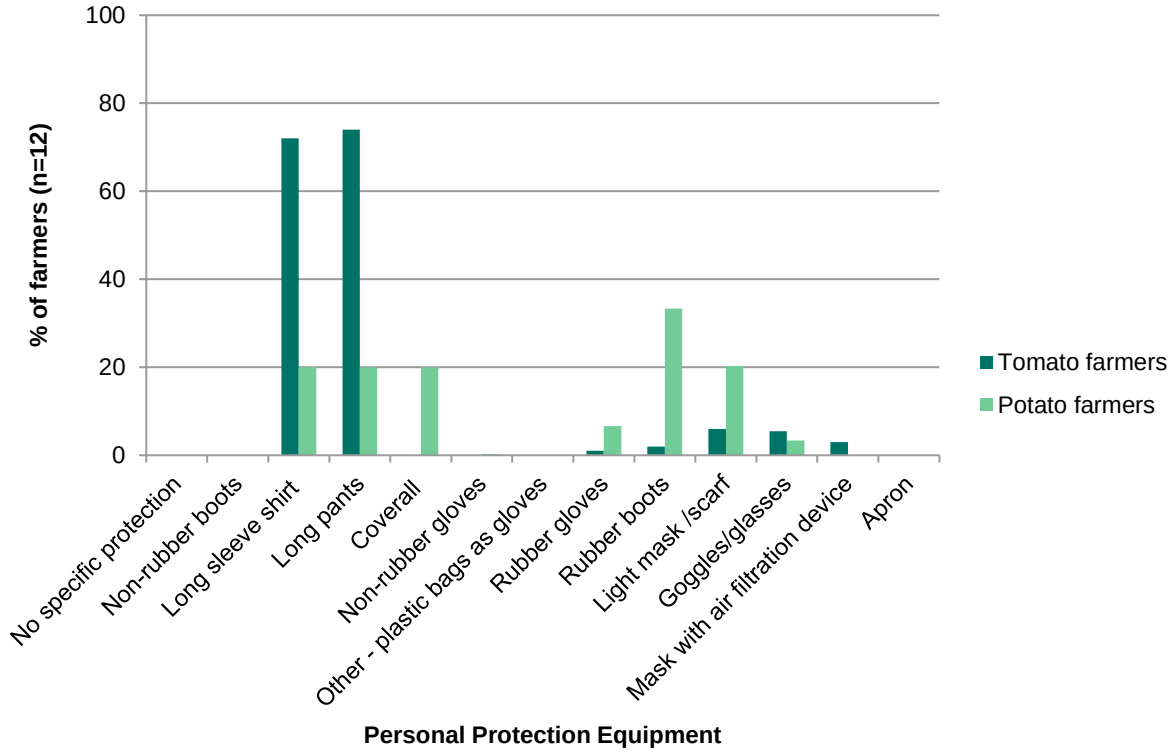

Figure 12: The types of PPE used by tomato and potato farmers

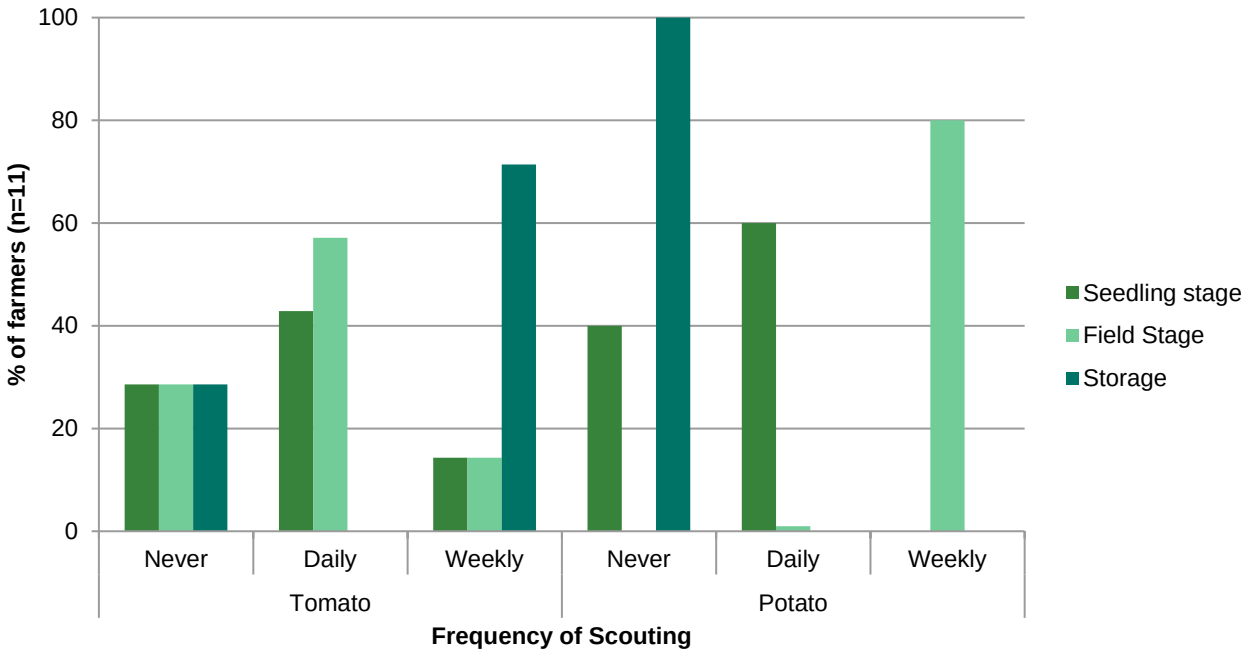

Figure 13: Scouting patterns at the different crop stages by farmers in tomato and potato production

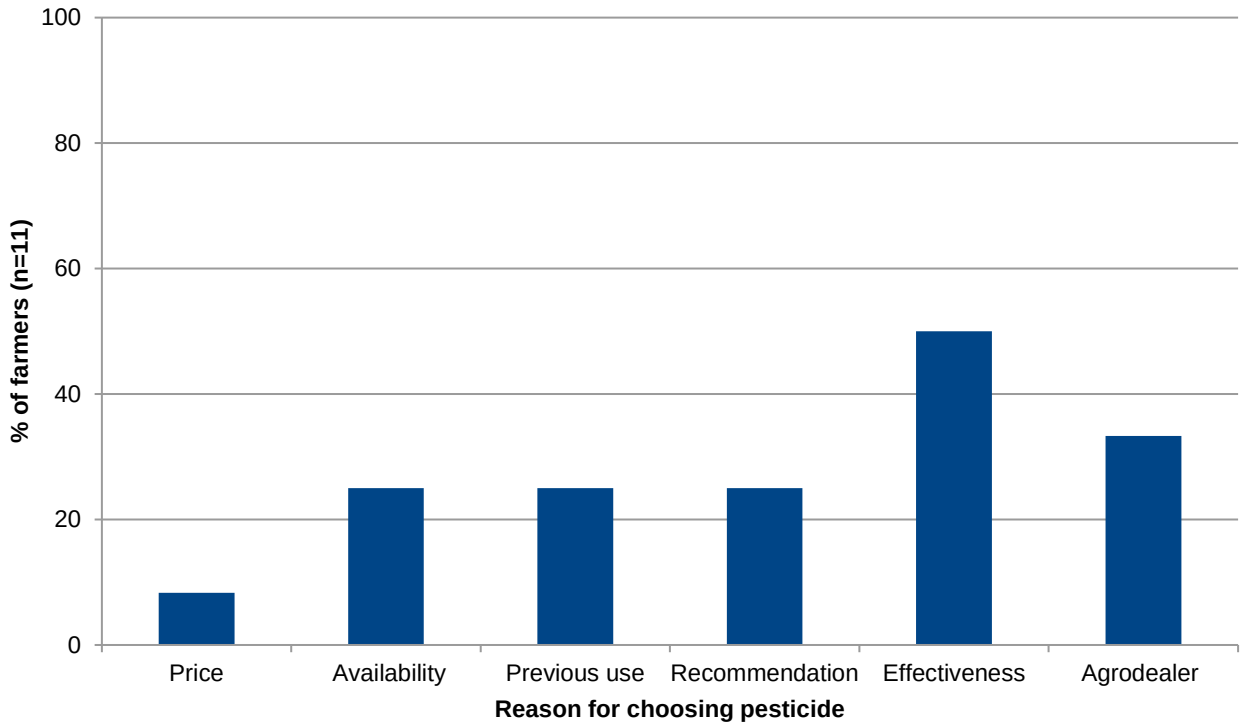

Figure 14: Reasons given for farmers' choice of pesticide

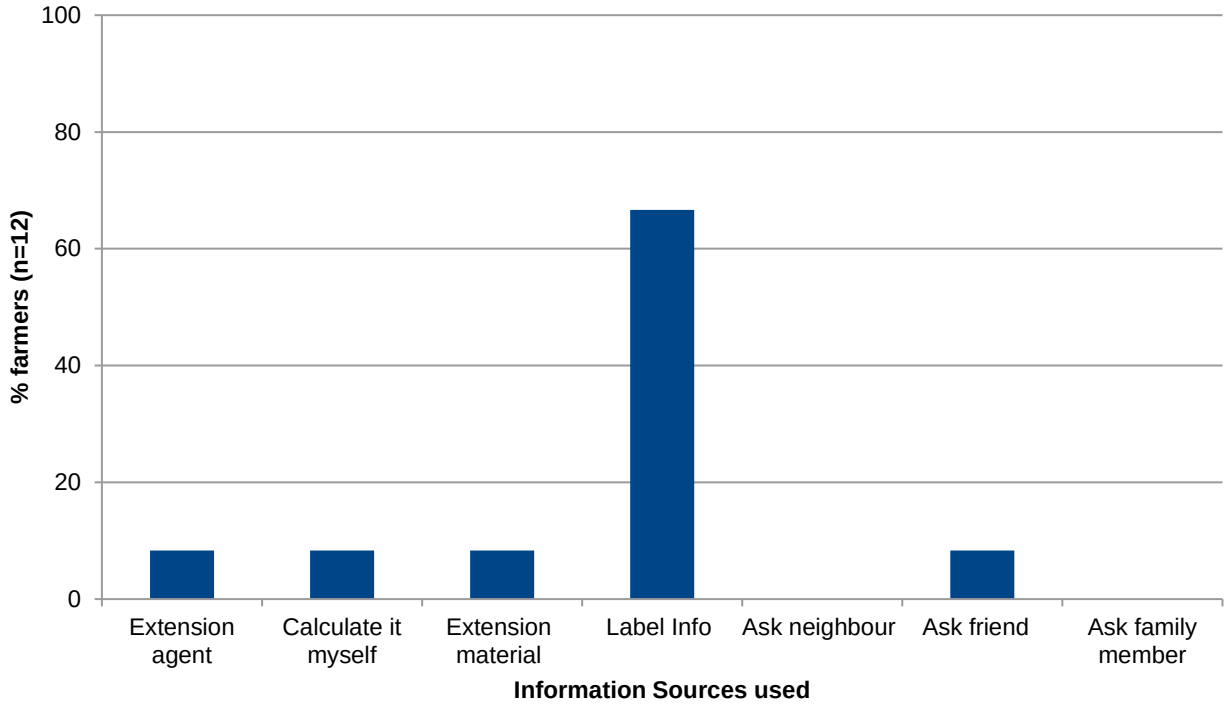

Figure 15: The different information sources used by farmers when deciding pesticide dosages

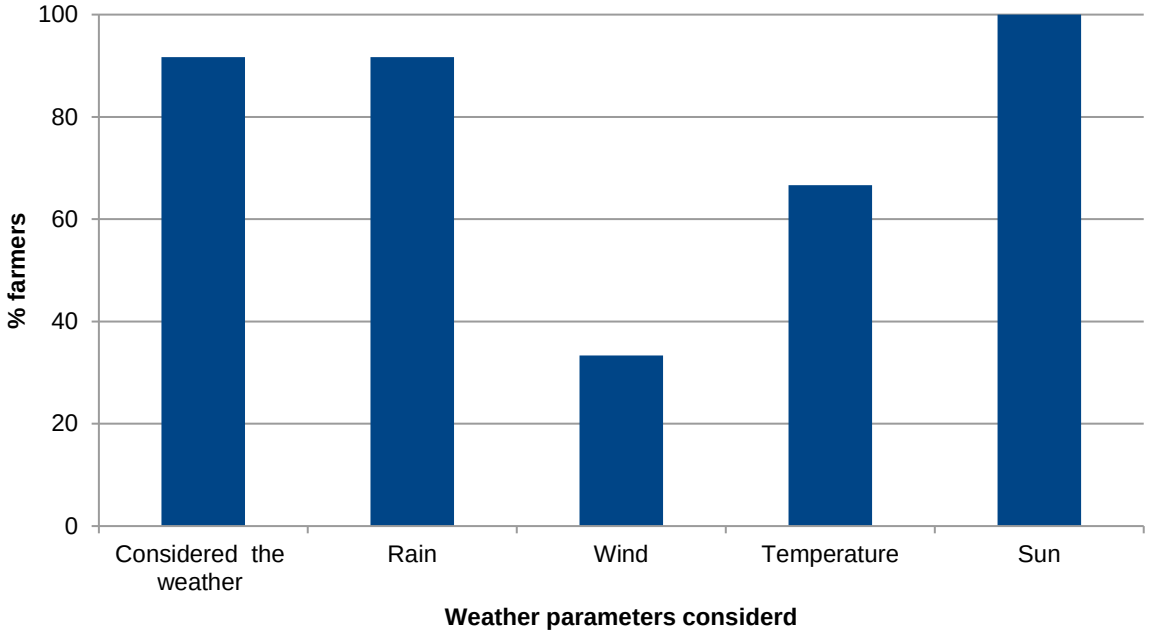

Figure 16: Weather parameters used by farmers when making the decision to apply pesticide.

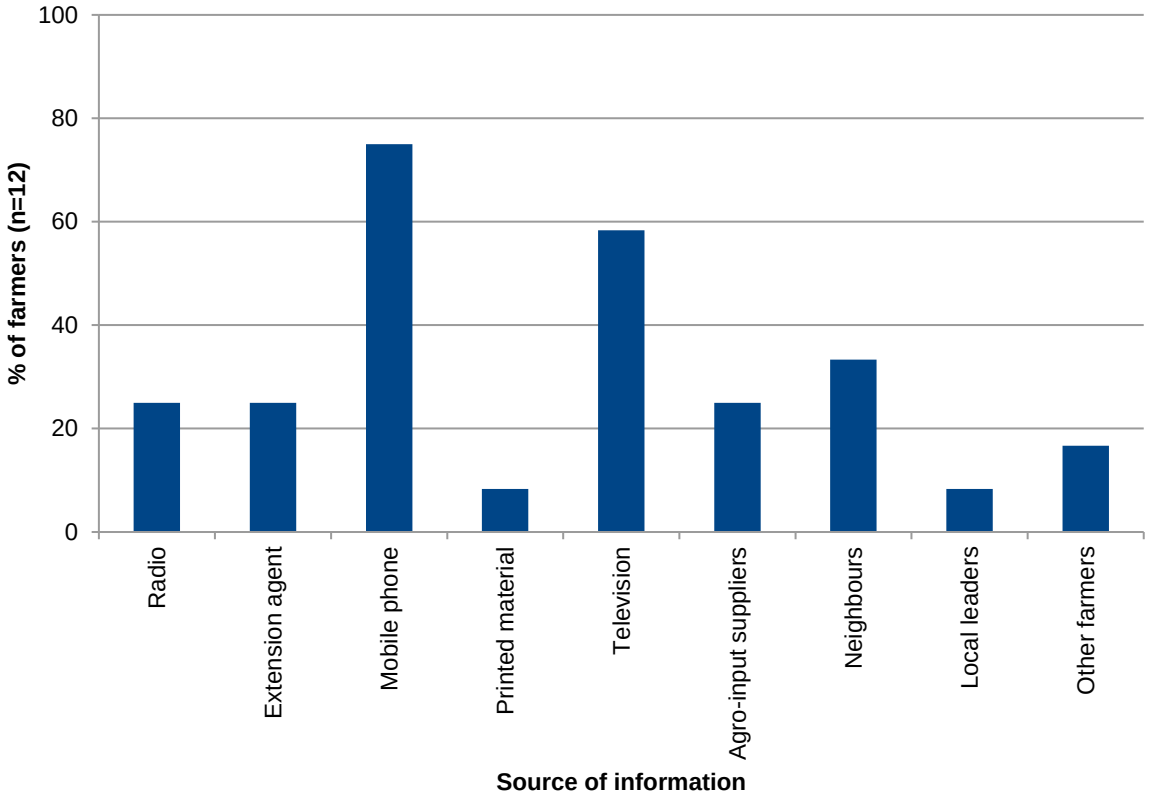

Figure 17: Different sources of information used by farmers to decide on agricultural practices

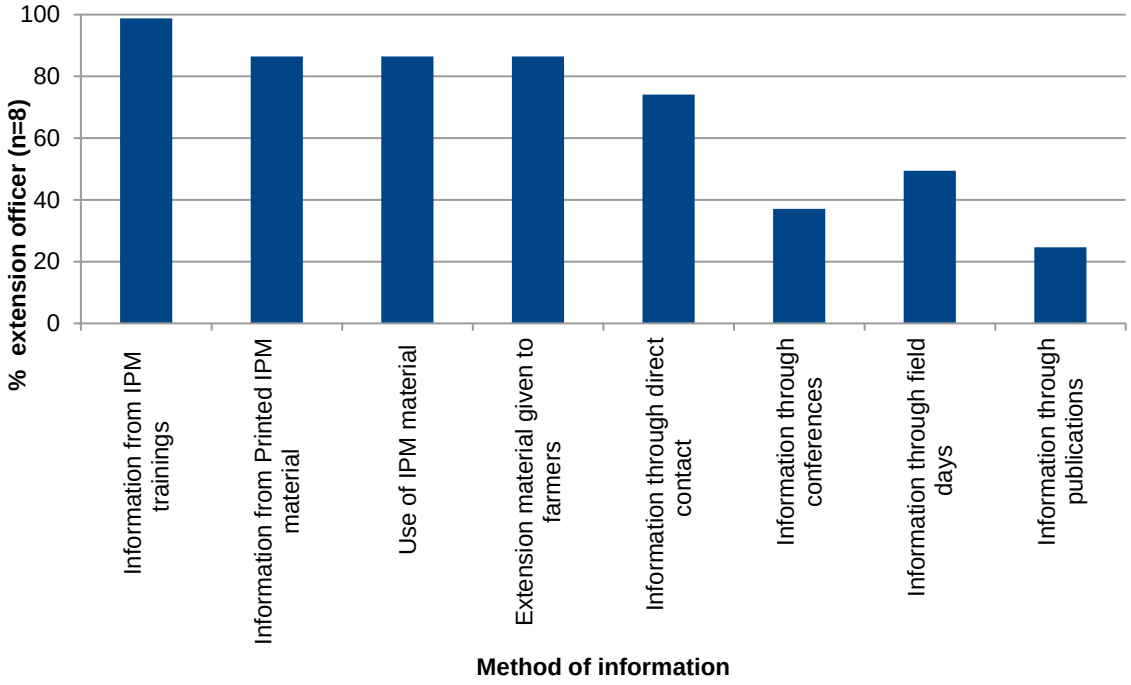

Figure 18: How extension officers acquire their knowledge about IPM techniques

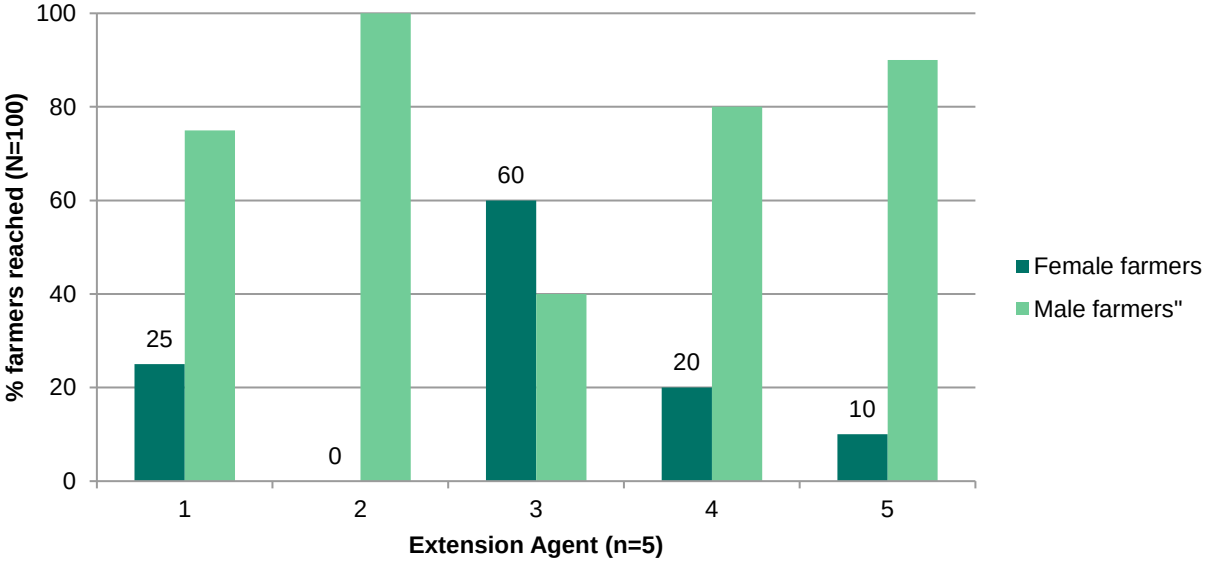

Figure 19: Extension agents' communication with male and female tomato farmers

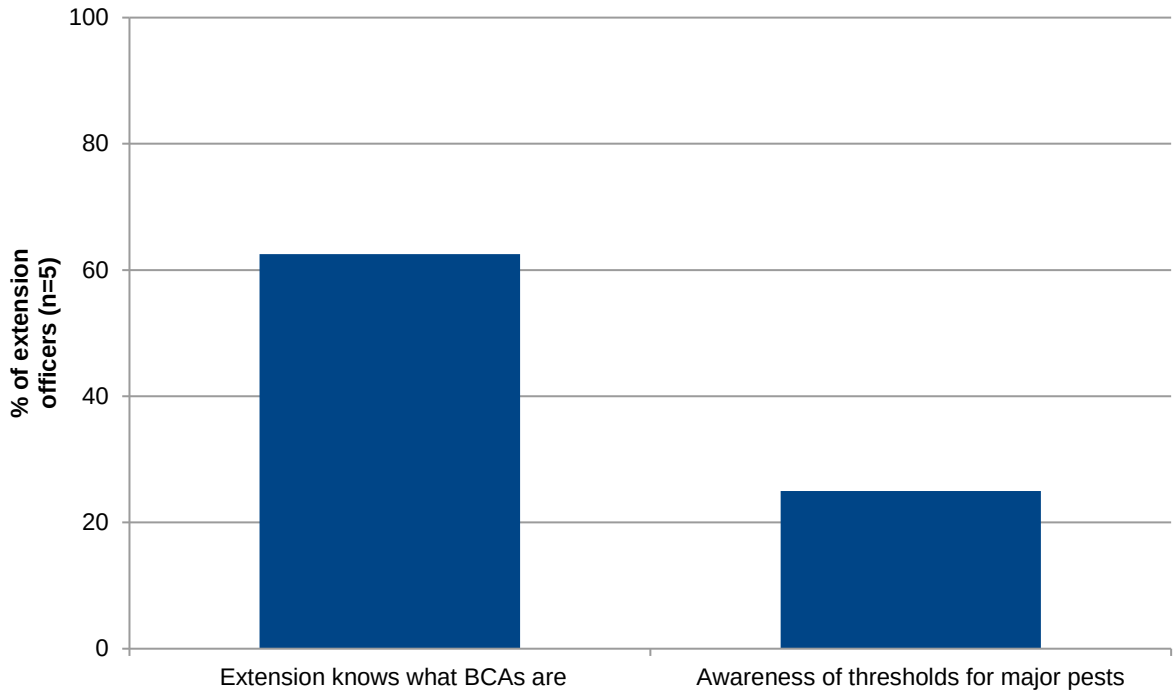

Figure 20: The awareness of biological control and action thresholds amongst the extension workers

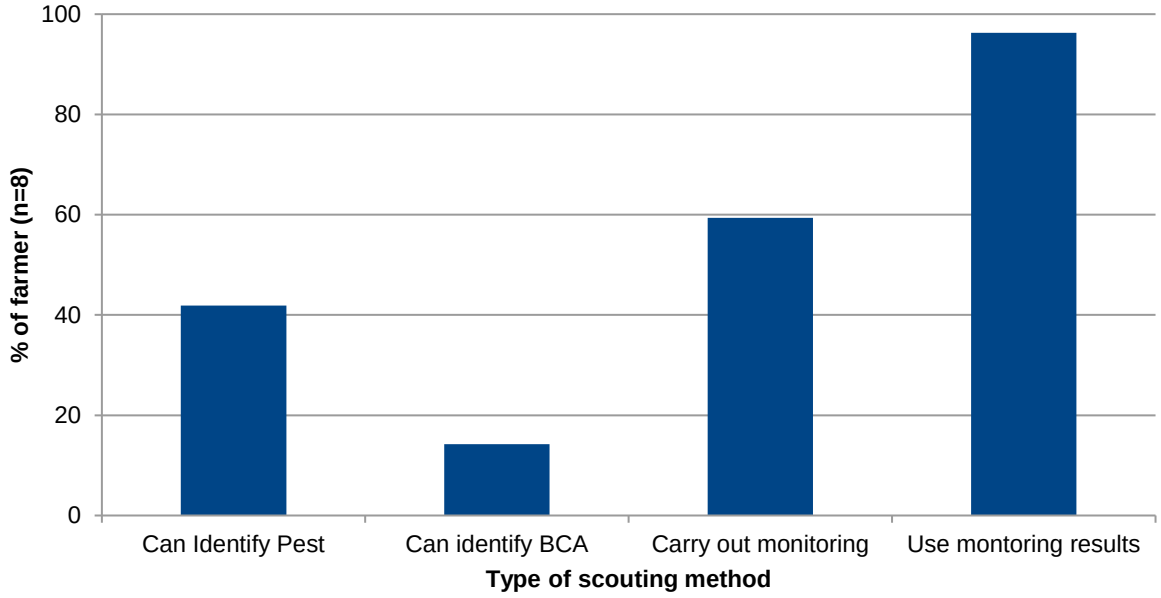

Figure 21: Farmers scouting methods and knowledge of BCAs and pests according to the extension officers

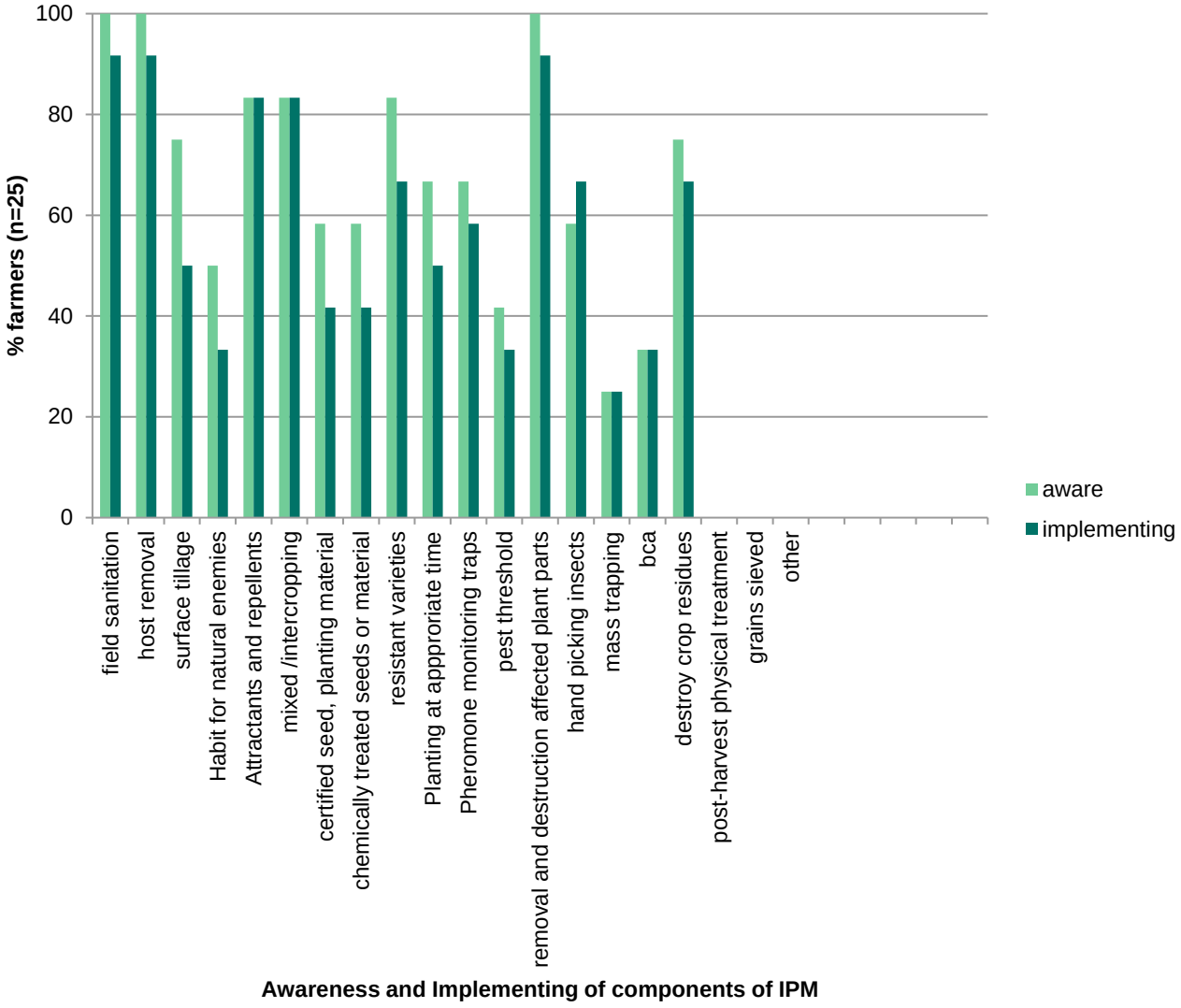

Figure 22: Farmer awareness of, and implementation of IPM practices as reported by extension officers.

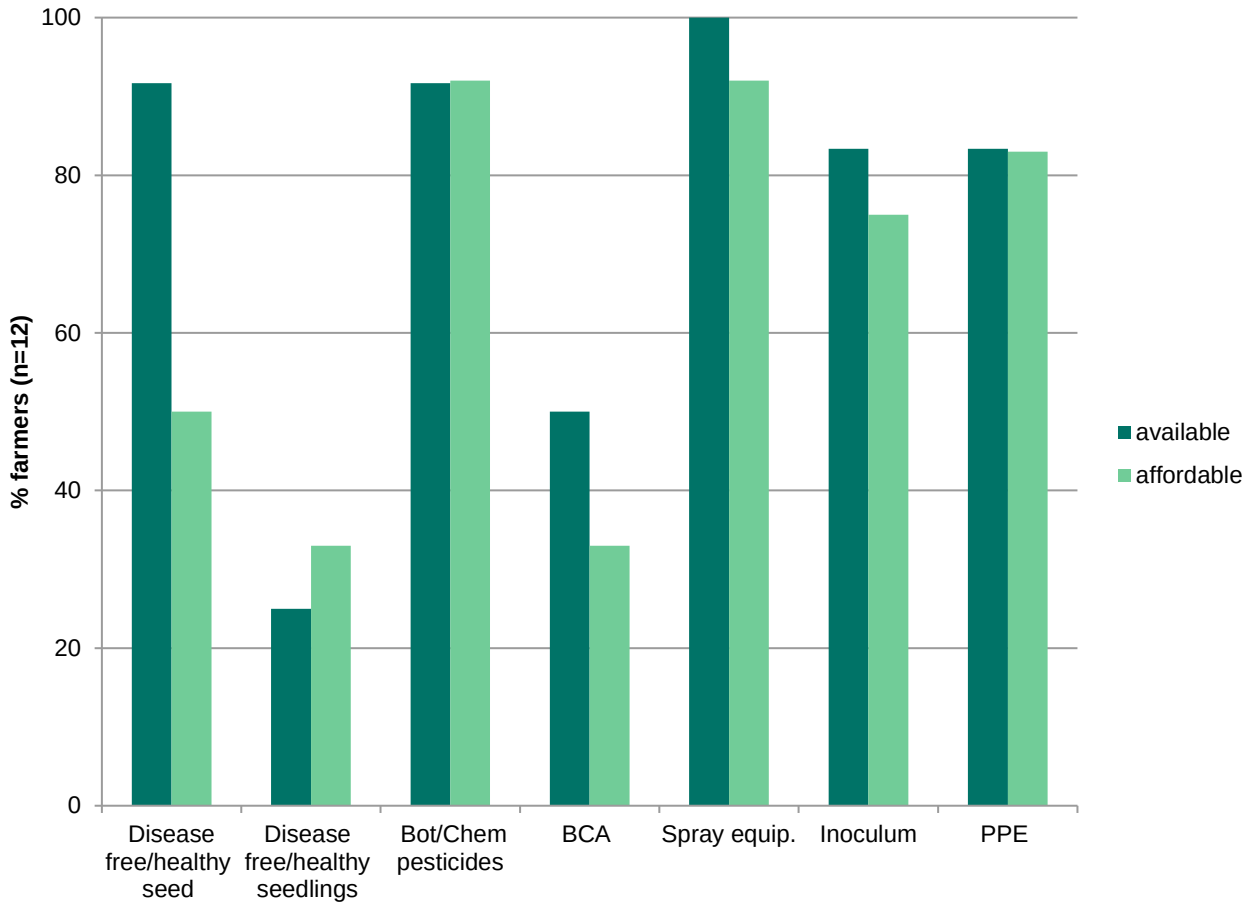

Figure 23: The availability and affordability of IPM resources as reported by the farmers

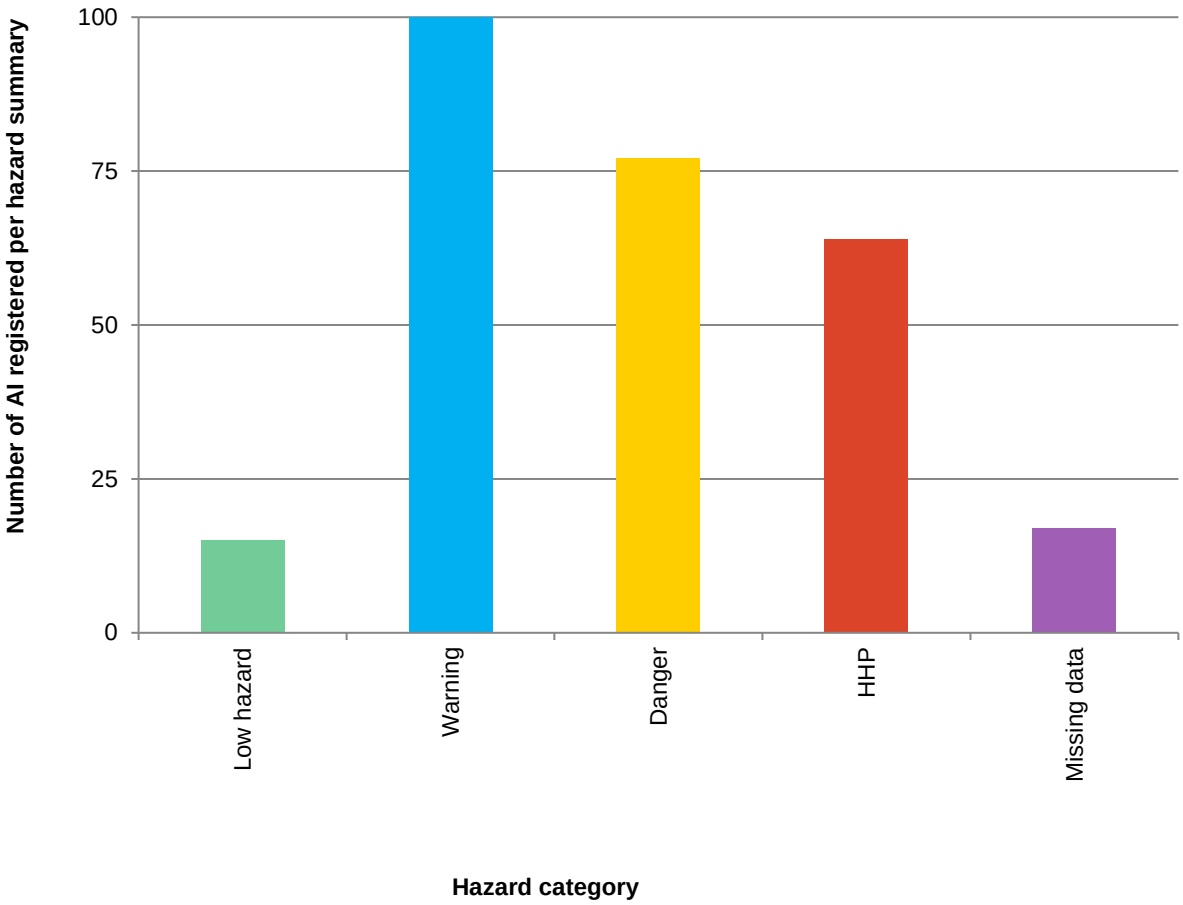

Figure 24: Number of AI in each hazard category

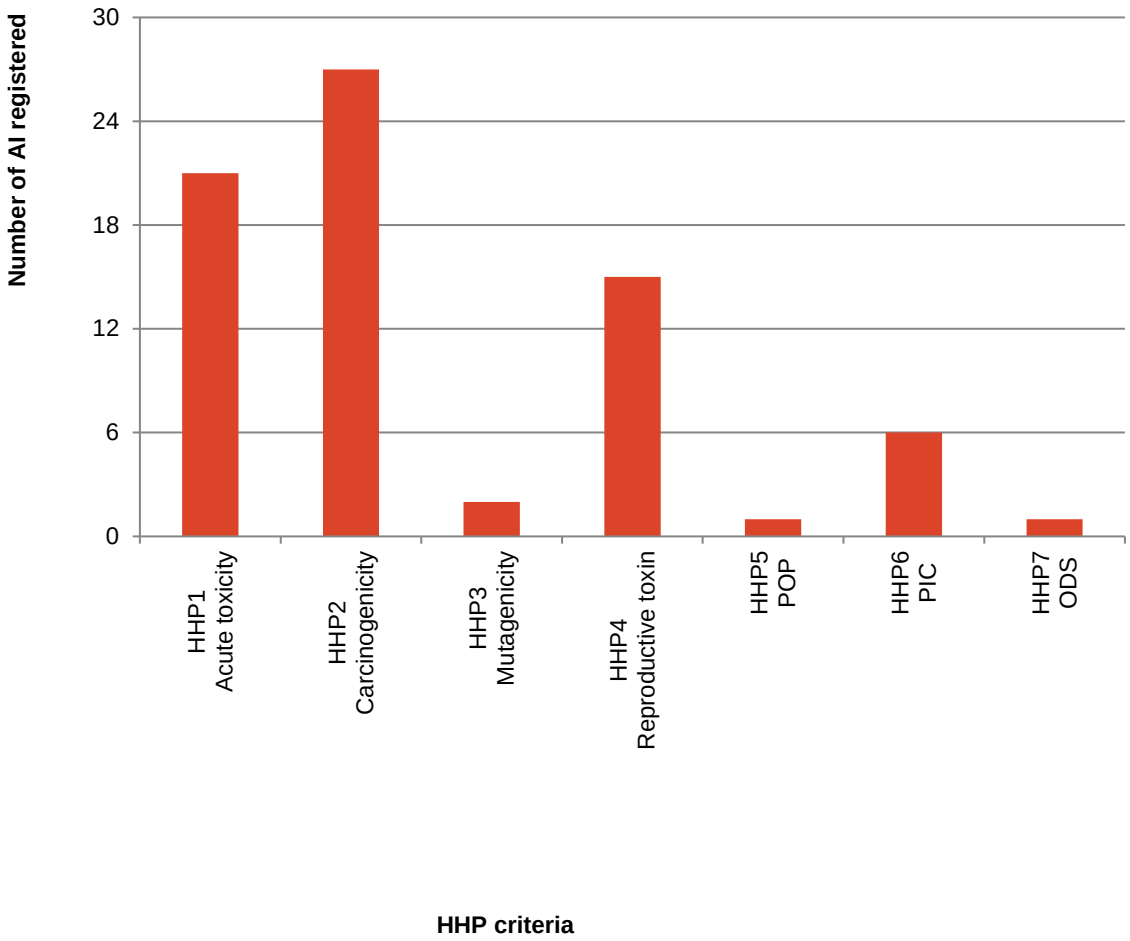

Figure 25: Number of HHP AI allowed for use per HHP criteria

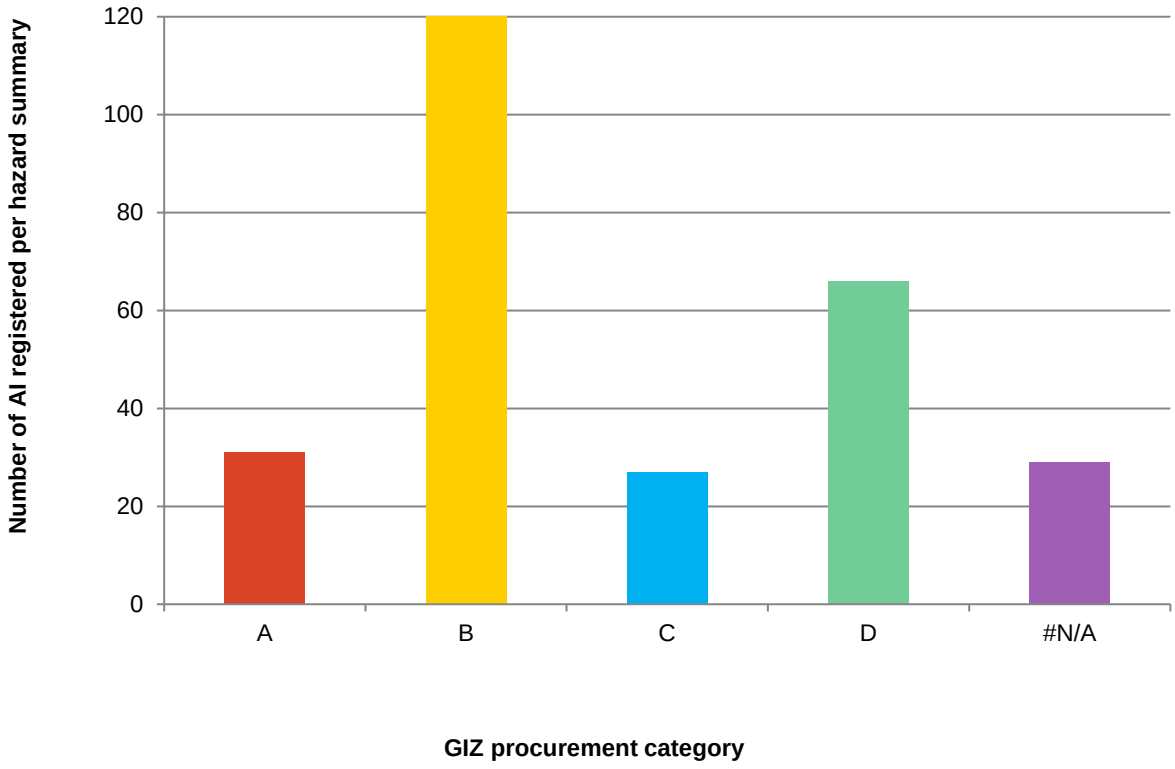

Figure 26: Number of AI per GIZ procurement category

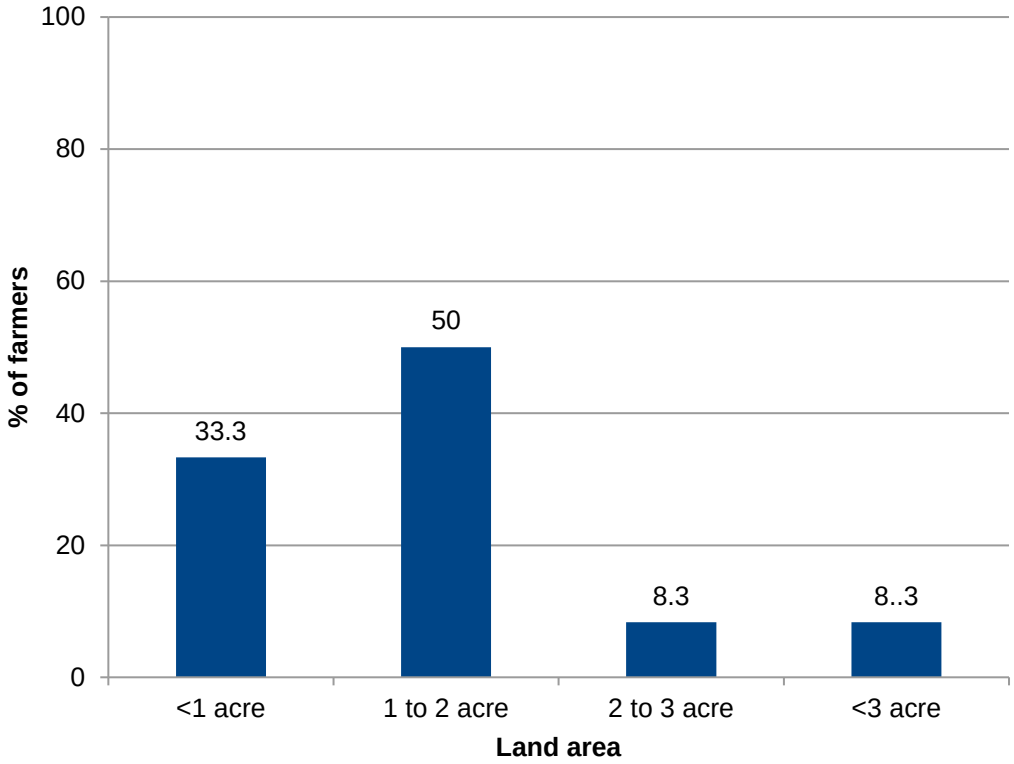

Figure 27: The crop area of land cultivation with farmers interviewed

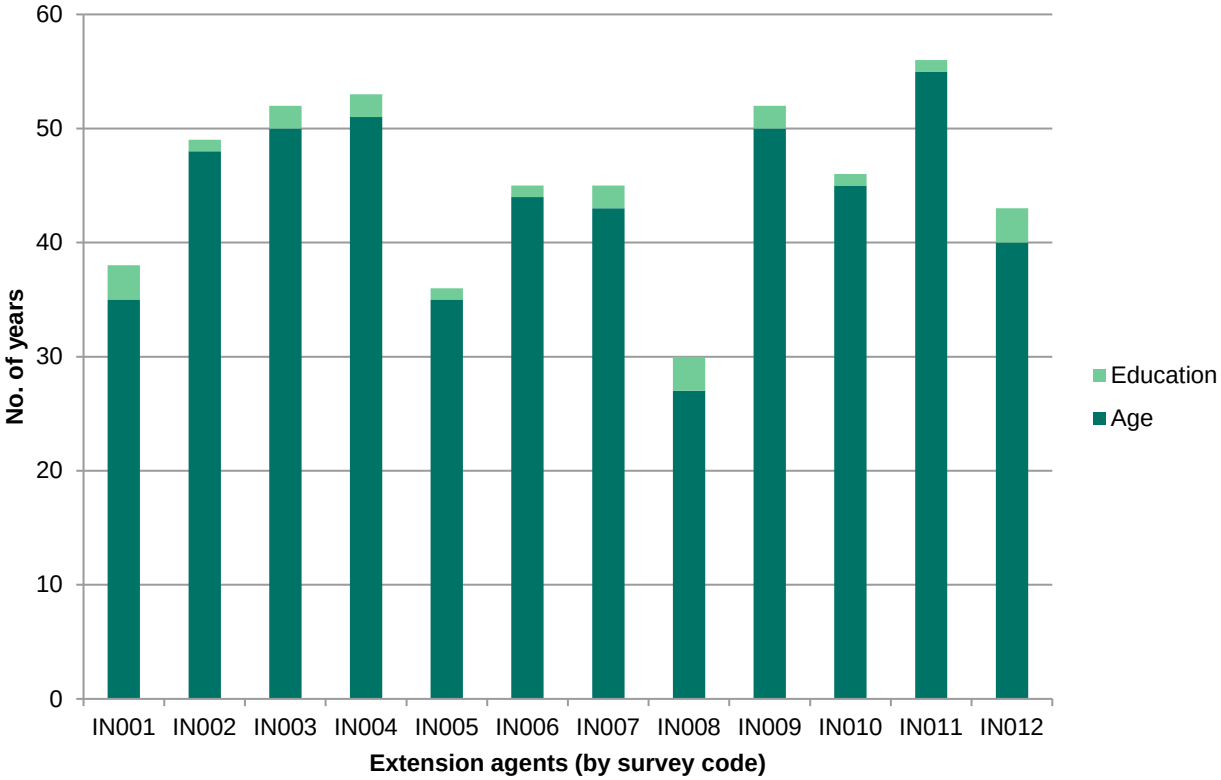

Figure 28: The demographic data of farmers interviewed

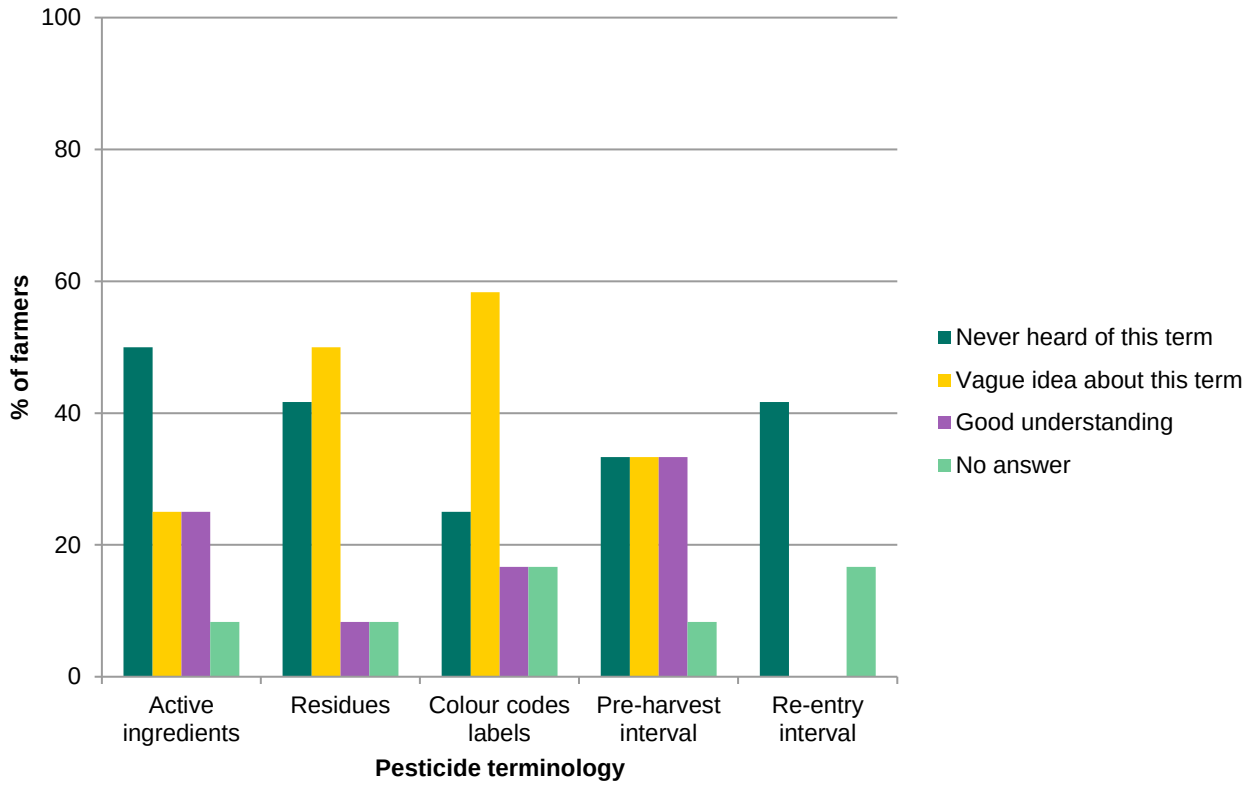

Figure 29: The level of understanding amongst the farmers on pesticide terminology

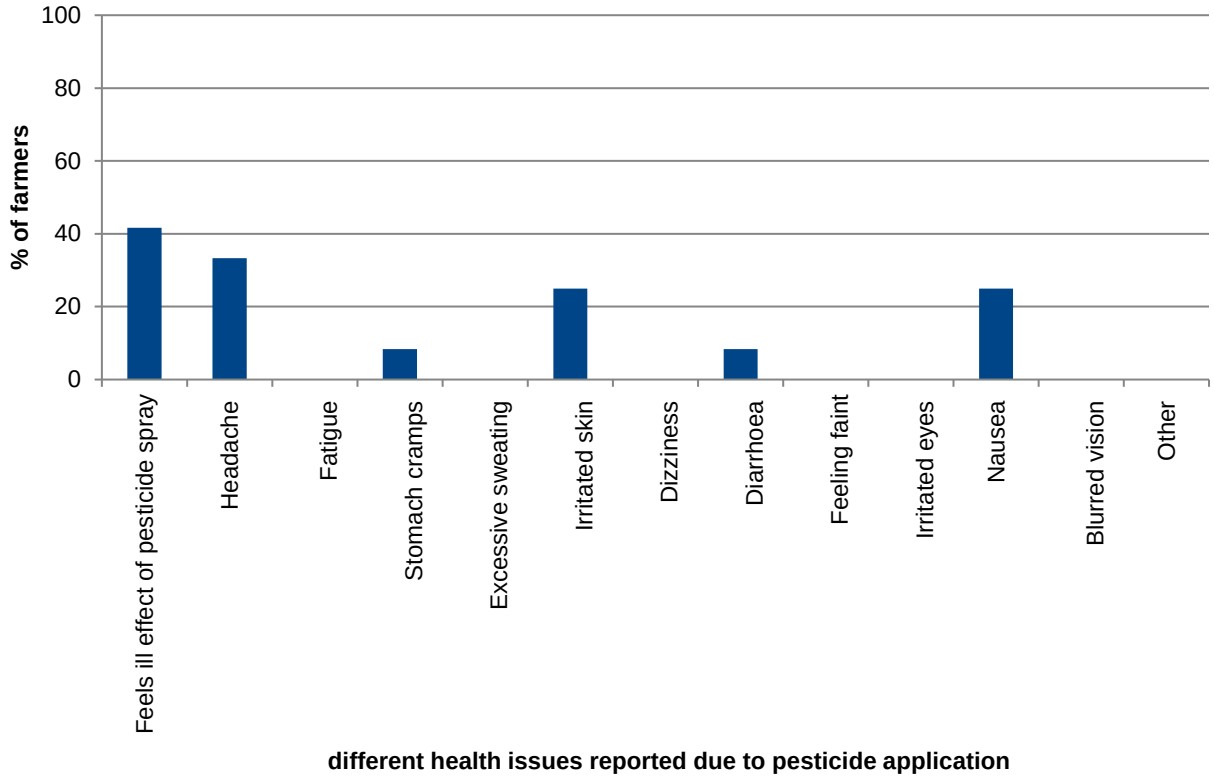

Figure 30: Impact of pesticide application on farmers' health

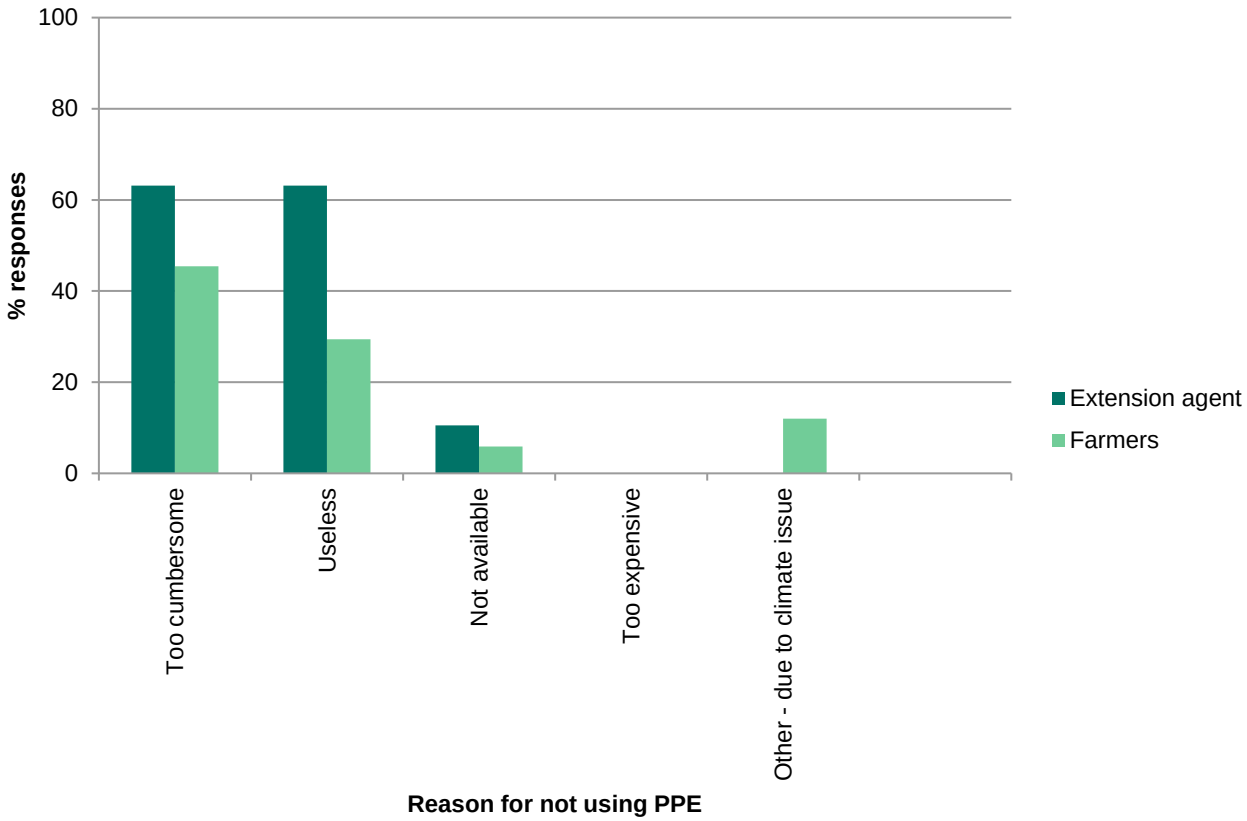

Figure 31: Reasons given for farmers not using PPE

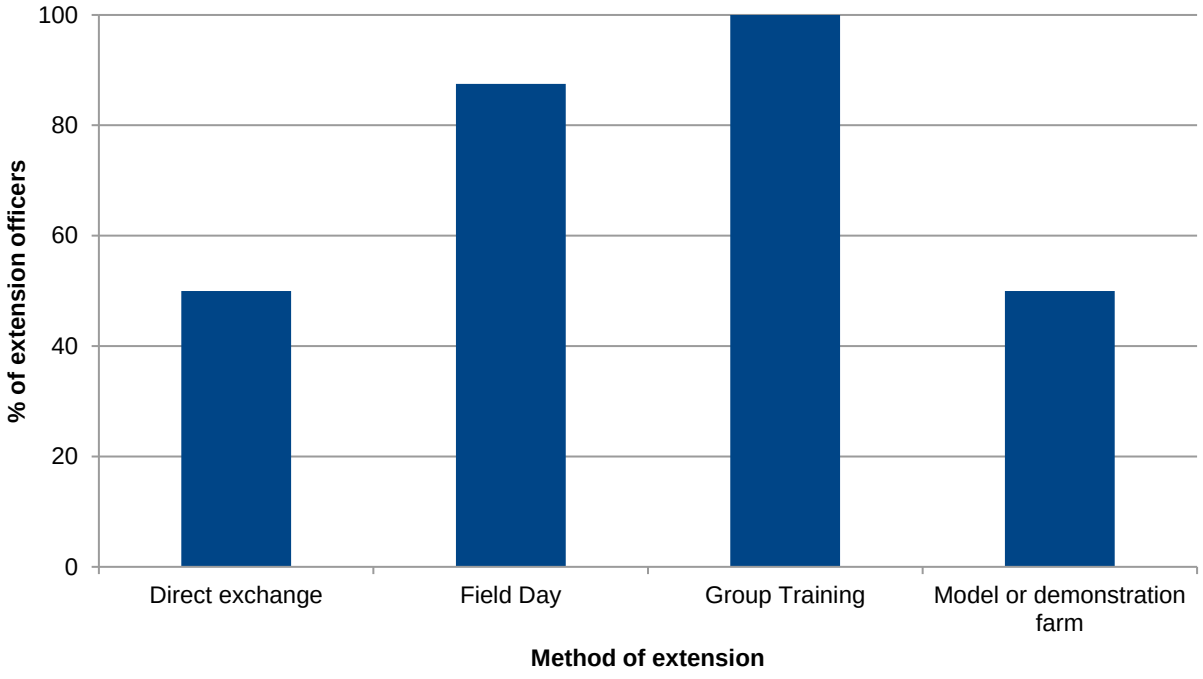

Figure 32: The mechanism of delivery of extension approach by extension officers to the farmer

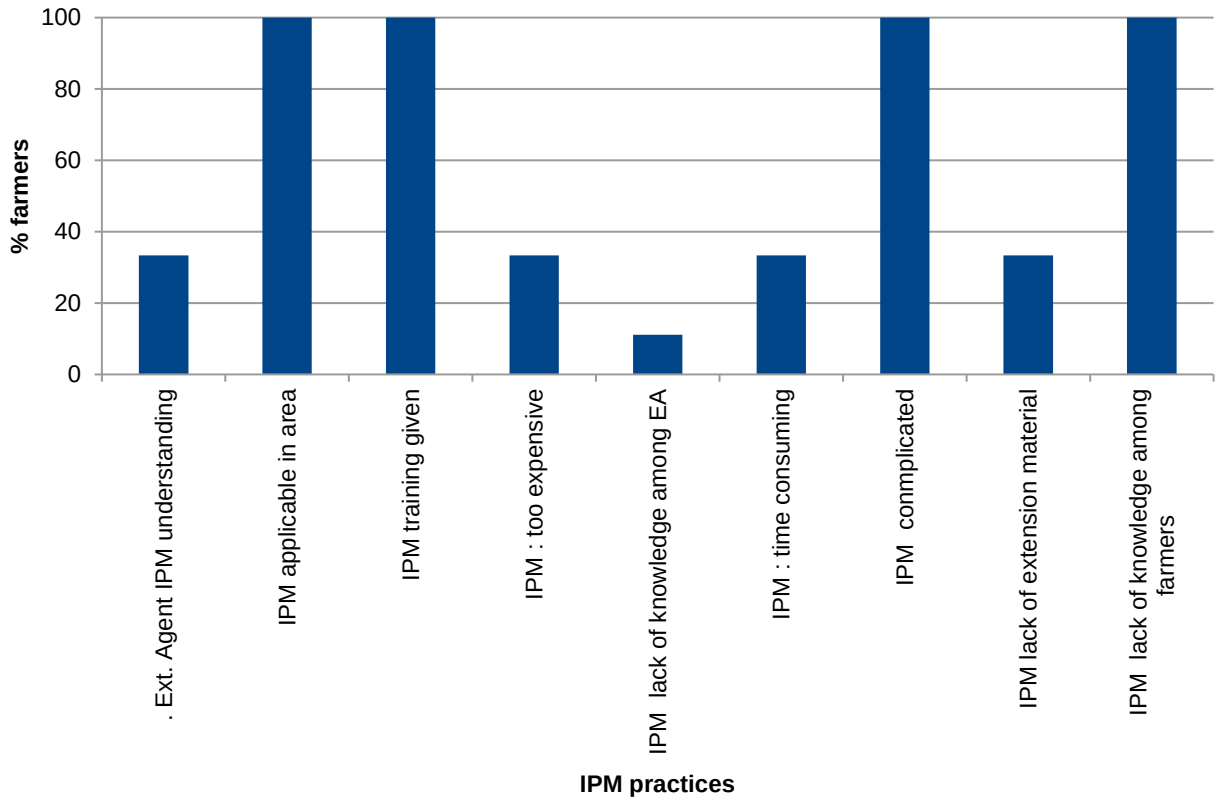

Figure 33: IPM awareness and practice amongst extension officers

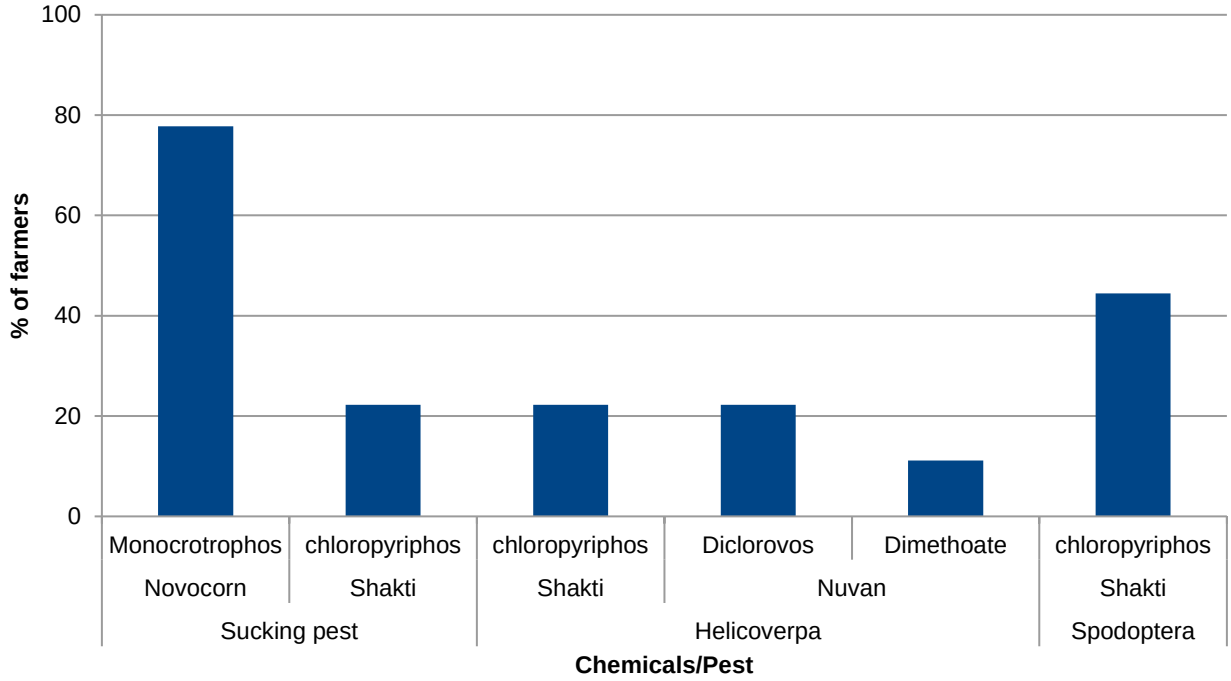

Figure 34: The use of banned chemicals amongst the farmers as reported by extension officers

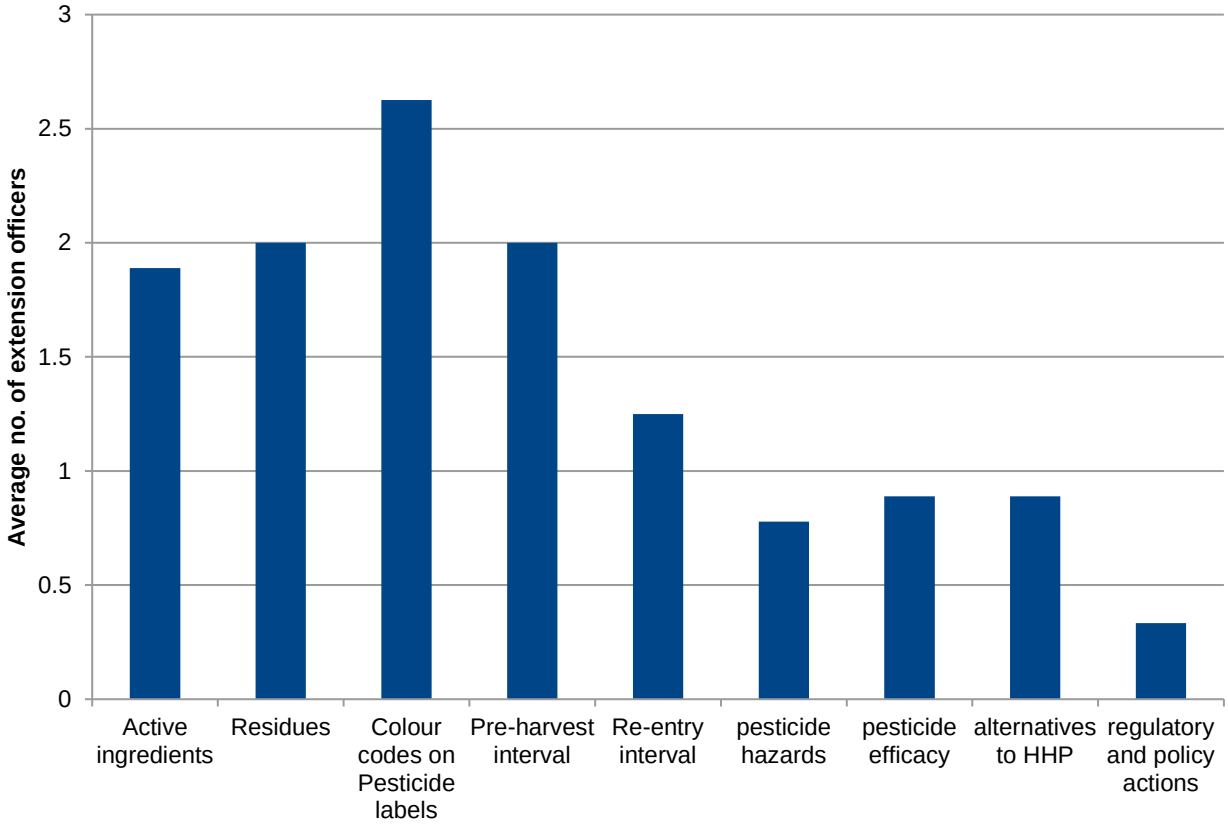

Figure 35: The level of understanding of pesticide terminology amongst the extension workers

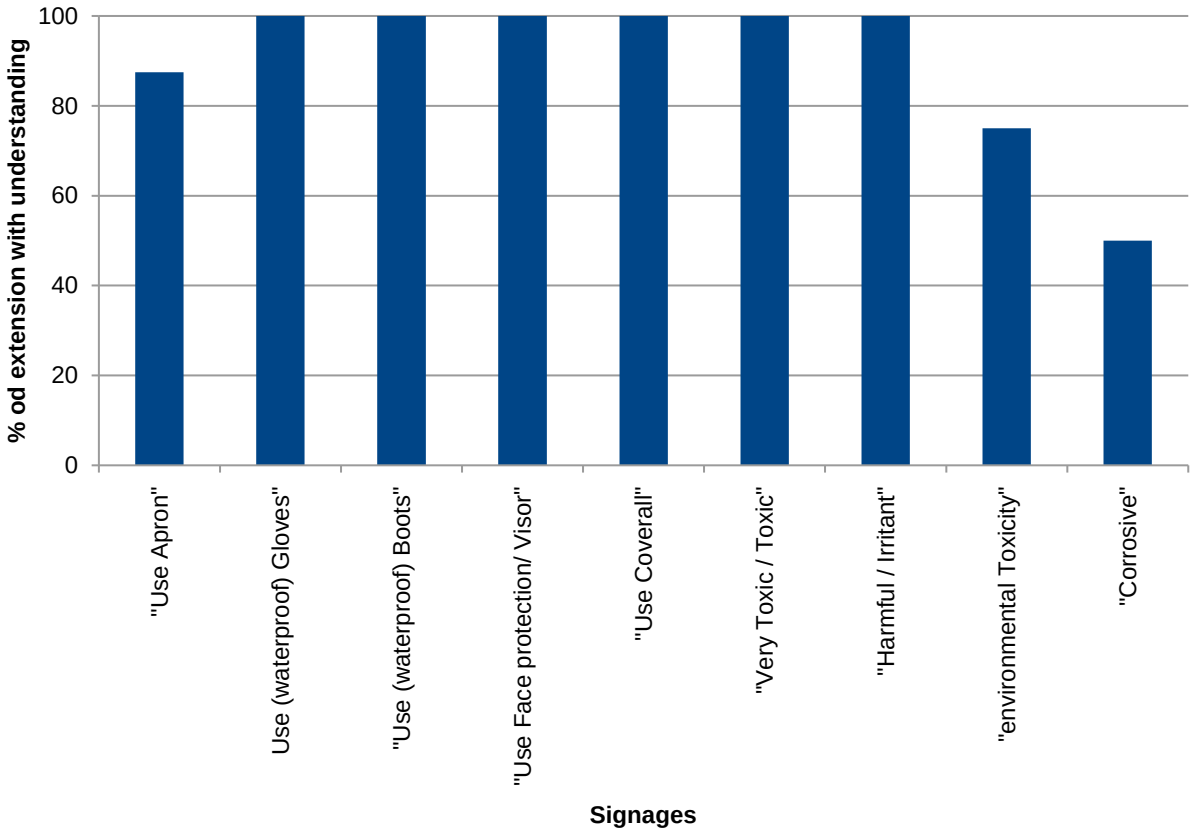

Figure 36: The level of understanding of hazard symbols and advice pictograms on pesticide labels amongst the extension officers

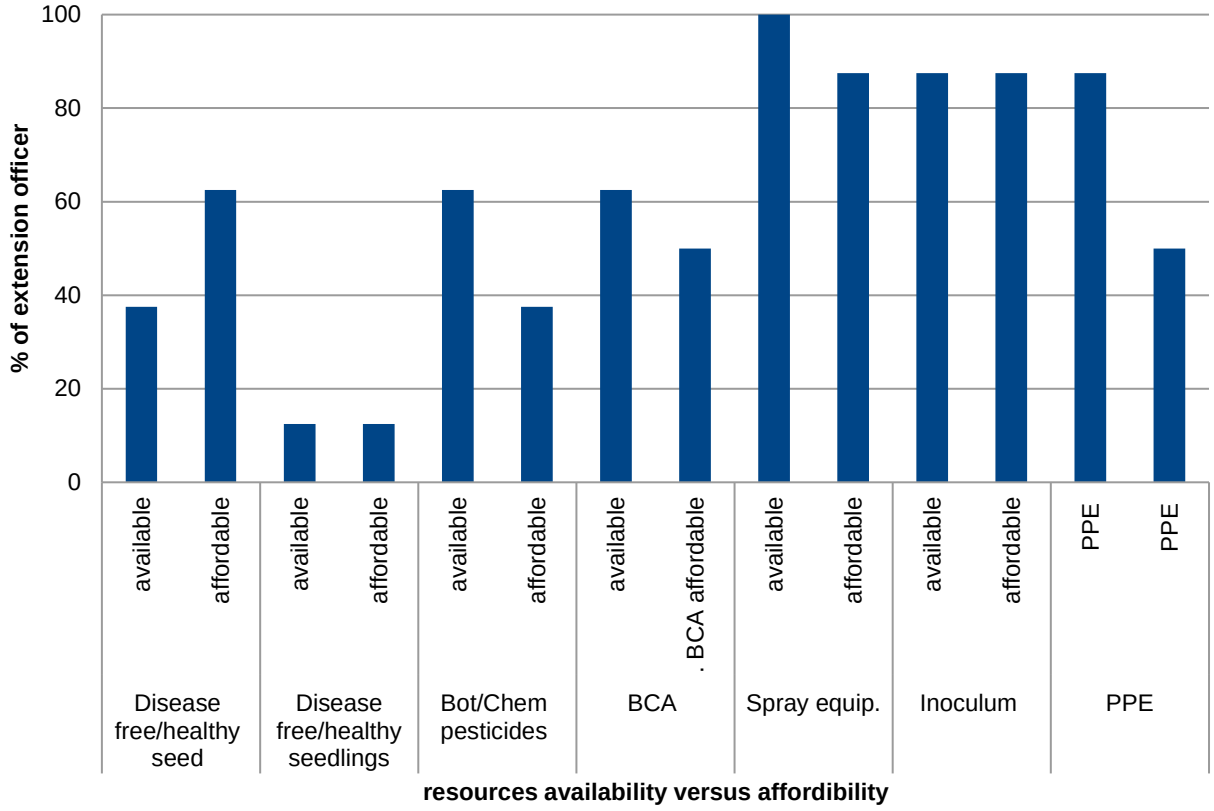

Figure 37: The perception amongst the extension workers on the feasibility of use of resources for farm management

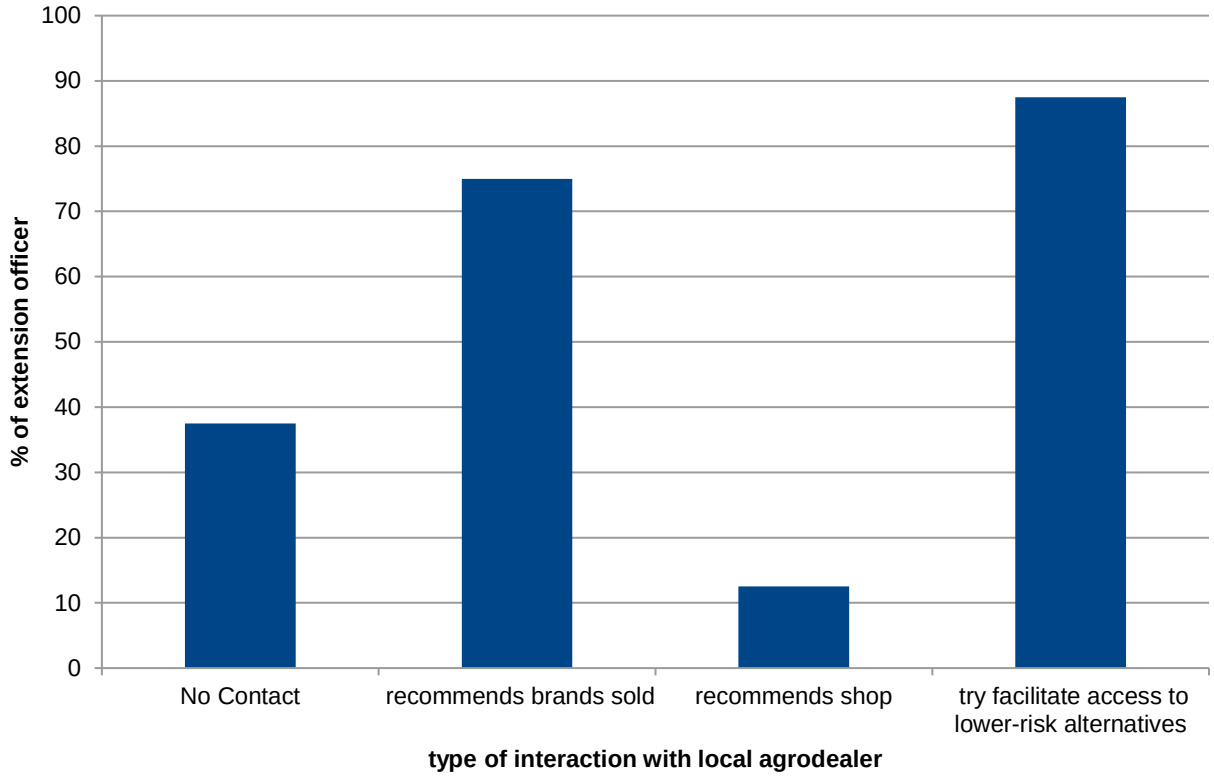

Figure 38: Kind of interaction between the agrodealer and extension worker in making the product available to the farmer

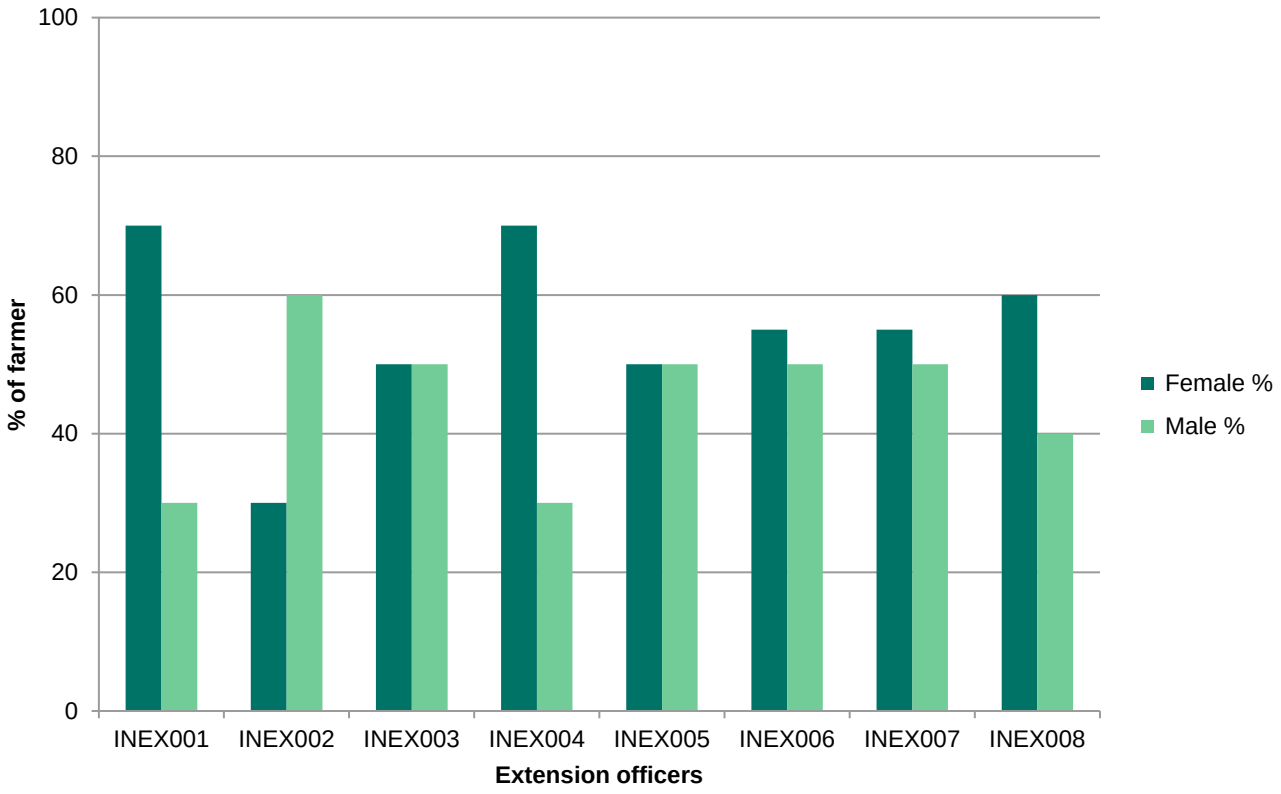

Figure 39: The extent of participation of women farmer in crop production of tomato and potato

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