



Training Guide

on Integrated Pest Management in Tobacco

M Bateman, E Chernoh, K Holmes, J Grunder, M Grossrieder,
Y Colmenarez, D Babendreier, M Faheem, M Mulaa

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Contents

List of Figures and Image Credits.....	6
List of Tables.....	7
List of Acronyms.....	8
Acknowledgements and Disclaimer	9
1. Introduction to the Training Guide	11
1.1 The need for training on Integrated Pest Management in tobacco	11
1.2 Goals of the guide.....	12
2. National Training Program Development	14
2.1 Overview of steps for implementing a national IPM training program.....	14
2.2 Identifying training needs.....	15
2.3 Training of national master trainers	16
2.4 Training of trainers for field technicians.....	16
2.5 Field technician to farmer training.....	17
2.6 Farmer-to-farmer extension.....	17
2.7 Guidance for conducting participatory training	17
2.8 Other complementary approaches for knowledge exchange	18
2.9 Preparing a national training package and plan.....	19
3. IPM Core Training Topics and Activity Guides	21
3.1 Understanding IPM	22
3.2 General information about CPAs.....	38
3.3 Selecting CPAs.....	62
3.4 Personal safety and contamination.....	80
3.5 CPA handling and application.....	103
3.6 Post-spraying activities.....	152
3.7 CPA storage	164
4. Assessing the rollout, uptake and impact of training	175
4.1 Monitoring the training cascade	175
4.2 Planning for monitoring and evaluation	176
4.3 Data collection.....	177
4.4 Using M&E data	177
5. Useful references.....	179
6. Review games	182
7. Activity index	189
Appendices	192

List of Figures

Figure 1 Reaching large number of field technicians and farmers will generally require a training cascade whereby trainers are trained in stages	13
Figure 2 Main steps to be planned for in the development and rollout of the IPM training programme.	14
Figure 3 Economic threshold and economic injury level	33
Figure 4 Illustration of how a preventive fungicide works	56
Figure 5 Illustration of how a curative fungicide works	56
Figure 6 Illustration of information on CPA's primary display panel	64
Figure 7 Pictograms appearing on CPA labels which convey key safety information	66
Figure 8 How to make a home-made face shield	101
Figure 9 Examples of types of nozzle	128
Figure 10 More droplets from the same volume of water are produced if drop size is decreased.	129
Figure 11 Selection for knapsack sprayer	131
Figure 12 Illustration of droplets patters for different types of nozzles.....	132
Figure 13 Small pieces of water sensitive paper can also be placed on the plant.....	133
Figure 14 Illustration of good coverage, excessive run-off and coverage which is not uniform	133
Figure 15 Illustration of the layers in a simple biobed	163

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Erich Chernoh, CABI (Colombia)	2
Julien Grunder, CABI (Mexico)	22
Melanie Bateman, CABI (Sierra Leone)	38
Margaret Mulaa, CABI (Mozambique)	62
Margaret Mulaa, CABI (Mozambique)	64
Catia Anton Altintas, CABI (Turkey)	80
Erica Chernoh, CABI (Colombia)	103
Julien Grunder, CABI (Greece).....	152
Julien Grunder, CABI (Italy)	164

List of Tables

Table 1 Examples of pests and combinations of practices which can be used to manage the pest	25
Table 2 Positive and negative consequences of applying “good” and “bad” practices	26
Table 3 Economic thresholds for key tobacco insect pests	36
Table 4. Types of pesticides and the pests that they are active against.....	40
Table 5 List of common formulation types, grouped by physical state, application state and diluent	44
Table 6 Types of pesticides grouped by the pests they control.....	51
Table 7 Examples of common pesticides families (CPAs recommended by PMI are in bold)	52
Table 8 Classification and labelling of acute toxic chemicals by GHS	65
Table 9 Other GHS hazard symbols.....	66
Table 10 Criteria for CPA selection.....	72
Table 11 Toxicity classes used in the WHO Recommended Classification of Pesticides by Hazard (2009)	82
Table 12 Summary table of CPA-related activities, potential for environmental contamination, relative risk and means of mitigation	85
Table 13 Common sources of CPA exposure	86
Table 14 Examples of symptoms of acute CPA poisoning	89
Table 15 First aid for acute CPA poisoning	92
Table 16 Worksheet for calibration of backpack sprayer and dosage guide	108
Table 17 Examples of combinations of substitute products to illustrate chemical and physical interactions.....	124
Table 18 Nozzle flow rate	128
Table 19 General rules for Nozzle Selection and Drop size.....	130
Table 20 Nozzle type and Spray Volume for boom sprayer (in temperate climates)	130
Table 21 Format for recording whether a CPA can be used under a particular scenario.....	151
Table 22 Motivations behind guidelines for the disposal of empty CPA containers.....	159
Table 23 Table for planning empty CPA container disposal.....	160
Table 24 Five levels of measurement for monitoring and evaluation of training programmes.....	175

List of Acronyms

a.i.	Active ingredient
ALP	Agricultural Labour Practices
CORESTA	Cooperation Centre for Scientific Research Relative to Tobacco
CPA	Crop Protection Agent
CV	Flow coefficient
EC	Emulsifiable concentrate
EIL	Economic injury level
ET	Economic threshold
ETL	Economic threshold level
FFS	Farmer Field School
FRAC	Fungicide Resistance Action Committee
GR	Granules
GAP	Good Agriculture Practices
GHS	Global Harmonization System
HACCP	Hazard Analysis and Critical Control Points
HRAC	Herbicide Resistance Action Committee
IPM	Integrated Pest Management
IRAC	Insecticide Resistance Action Committee
M&E	Monitoring and evaluation
MRL	Maximum Residue Level
MRL + T	Maximum Residue Level plus Tolerance
PHI	Pre-harvest interval
PMI	Philip Morris International
PPE	Personal protection equipment
REI	Re-entry interval
RPU	Rational Pesticide Use
SMART	Specific, measurable, assignable, realistic and time bound
TLI	Tobacco Lot Integrity
US EPA	United States Environmental Protection Agency
VI	Vertically Integrated
WHO	World Health Organisation
WP	Wettable Powder
WSP	Water sensitive paper

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1. Introduction to the Training Guide

1.1. The need for training on Integrated Pest Management in tobacco

1.2. Goals of the guide

1.1 The need for training on Integrated Pest Management in tobacco

When used judiciously, crop protection agents (CPAs) such as insecticides, fungicides and herbicides can play an important role in plant protection, reducing the impact of pests¹ on the yield and quality of tobacco. By their nature, CPAs affect living organisms so there are also hazards associated with their use. When CPAs are not used appropriately, they can become a cause for concern due to the risks that they pose to the health and safety of farmers, farm workers and consumers as well as their potential impact on the environment. Likewise, indiscriminate use of CPAs can exacerbate pest problems through the loss of natural pest control mechanisms and the development of pest resistance. The public in general and consumers in particular are sensitive to these health and environmental concerns. Thus, the risks posed by CPAs must be managed by following strict guidelines for their use.

Certain circumstances and behaviours can contribute to unnecessary CPA use, selection of CPAs which are harmful and poor CPA management. For example, farmers and their workers do not always understand the risks associated with CPAs. Many lack knowledge about how to properly select, store, handle and apply CPAs.

Implementation of Integrated Pest Management (IPM) can help to address these issues. IPM is a shift in all parts of the supply chain to an eco-system approach, promoting best practices for the prevention and management of pests in tobacco and clove. IPM seeks to reduce the risk of harm to people and the environment. Attaining the objectives of IPM will depend in particular on changes in farmers' behaviour so that they reduce unnecessary CPA use, use the least hazardous CPAs which are registered for use in tobacco, and manage CPAs appropriately.

From one location where tobacco is grown to the next, there are often fundamental differences in language, infrastructure, national regulations and their enforcement. The CPAs that are registered, the means by which CPAs are obtained, and the tools used for CPA application also all differ. Likewise, farmers vary in terms of their education in general, their experience with tobacco and their experience with other crops. Even so, many challenges and training needs are shared across locations. Hence, the overall objectives and targets are the same for all suppliers, but the situation on the ground and the baseline from which they start differs from place to place. Training activities undertaken to support the implementation of IPM and the appropriate use of CPAs must take these differences into account and they must be tailored to the countries in which they are implemented.

A lack of knowledge on IPM amongst the farmers (and sometimes field technicians) can be a barrier to responsible CPA management and use. Hence, addressing any knowledge gaps is a necessary first step in order for changes in behaviour to take place. This Training Guide provides training material to address training needs and offers guidance on how to adapt the core material to local conditions through the national training programmes. This Training Guide focuses on the some of the key principles of IPM and appropriate use of CPAs. Through training on the topics in the Training Guide, farmers and field technicians will learn tactics for reducing unnecessary CPA use, they will find out how to select less toxic CPAs which are registered for use on tobacco, and in particular they will learn how to manage CPAs appropriately. While training alone will not solve all of the aforementioned challenges, it will help to put these goals within reach.

1. Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM 5, 2015).

1.2 Goals of the guide

This **Training Guide** (hereafter referred to as “the guide”) is targeted at the core training team in each country. The core teams will be responsible for leading the implementation of their national training programmes. The goal of the guide is to provide them with the necessary tools to design and implement a training programme to support the implementation of IPM and appropriate use of CPAs. The guide presents a core training package with detailed curricula to address all aspects of responsible CPA management. The guide provides background information to support technical understanding and, through activity descriptions with notes for the facilitators, it provides sufficient guidance for trainers to be able to lead trainings on the technical content. The guide also provides step-by-step guidance to support all stages of the implementation of the training programme.

Chapter 2 of this guide begins with an overview of the steps needed to design and implement a national training programme. Each step is then covered in detail in the subsequent sections. For example, descriptions are provided on how to plan for and conduct trainings of trainers (ToTs). In many countries where training is being implemented there will be two types of ToTs; trainings for national master trainers, and trainings for field technician trainers. These two groups are the main examples covered. Key competencies and responsibilities for the trainers at each level are described. Chapter 2 also provides guidance on how to identify training needs, design an approach for addressing these needs, and plan for the implementation of the training programme for field technicians and farmers. A description of a modular training approach is complemented with information on other approaches for knowledge transfer such as video and radio. These other approaches can be used to re-enforce messages presented in the modular core training package. There is also a section with tips on how to facilitate participatory trainings. Chapter 2 concludes with guidance for national adaptations of the core training package. The core training team will be responsible for working with the CABI IPM country coordinators and other relevant partners to customise the materials. Once adapted as necessary to national context and priorities by the core training team, the material extracted from Chapter 3 can be provided to the national master trainers and field technicians who will facilitate training.

In Chapter 3, all of the topics in the core training modules are presented in detail along with descriptions of practical activities. Each topic is introduced by a description of the rationale for conducting training on the topic and the topic’s learning objectives. The target group for the topic is identified, and essential background information is also provided. The training exercises are described and the materials needed for each training activity are listed. The training programme presented here is highly participatory and activity driven; there are no PowerPoint presentations. Guidance is provided on how to lead the training on each topic.

Chapter 4 deals with the process of monitoring, evaluating and assessing the impact of the national training programmes. As stated in the previous section, the training programme contributes to enabling changes in practices that are necessary in order to reach the training programme goals. In order to achieve these goals, the following requirements must be met:

- successful rollout of the programme through training of the target field technicians and farmers;
- field technicians and farmers have to learn from the training;
- they subsequently have to put their new knowledge into practice; and
- these changes in behaviour must make a contribution towards the desired outcomes.

Activities to monitor and evaluate the training programme against these requirements must be planned for at the same time that the training programme itself is being planned.



2. National Training Program Development

- 2.1 Overview of steps for implementing a national IPM training program
- 2.2 Identifying training needs
- 2.3 Training of national master trainers
- 2.4 Training of trainers for field technicians
- 2.5 Field technician to farmer trainings
- 2.6 Farmer-to-farmer extension
- 2.7 Guidance for conducting participatory training
- 2.8 Other complimentary approaches for knowledge exchange
- 2.9 Preparing a national training package and plan

2.1 Overview of steps for implementing a national IPM training program

TRAINING CASCADE

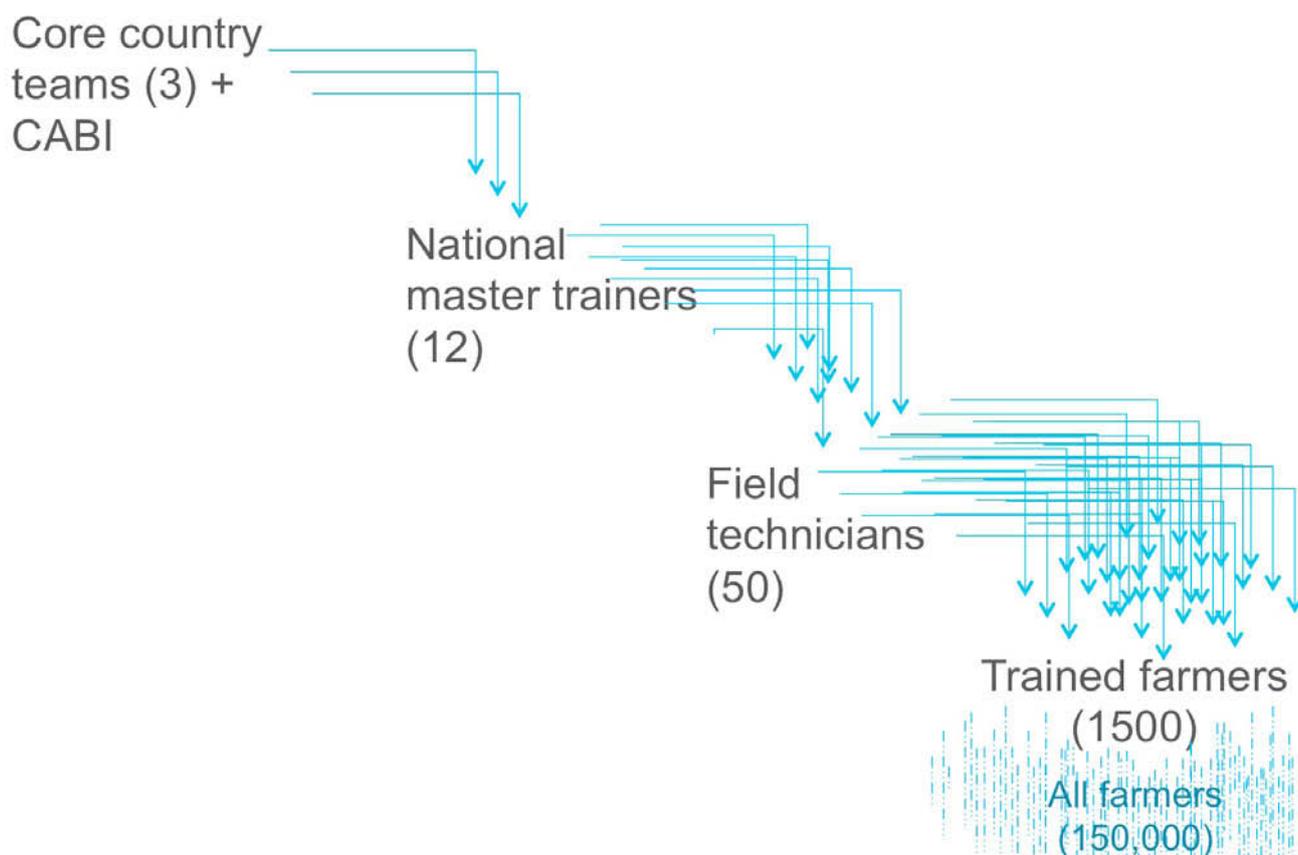


Figure 1 Reaching large number of field technicians and farmers will generally require a training cascade whereby trainers are trained in stages.

Developing a training programme requires several steps in order to establish a cadre of trainers with the necessary technical knowledge and facilitation skills. Where it is necessary to reach a large number of field technicians and farmers, then training will usually follow a cascade approach in which successive groups are trained to train others. Figure 1 illustrates a possible pathway by which the core team is responsible for organising the training of a group of national master trainers. These master trainers will then lead the training of field technicians and the field technicians will in turn carry out farmer trainings in the communities where they are based. Depending on the country and the

number of farmers who grow tobacco, field technicians may train only a subset of “lead” farmers. These lead farmers may in turn train others either within the same producer club or more broadly in their community. Monitoring should take place across all stages (see Chapter 4 for more information on monitoring).

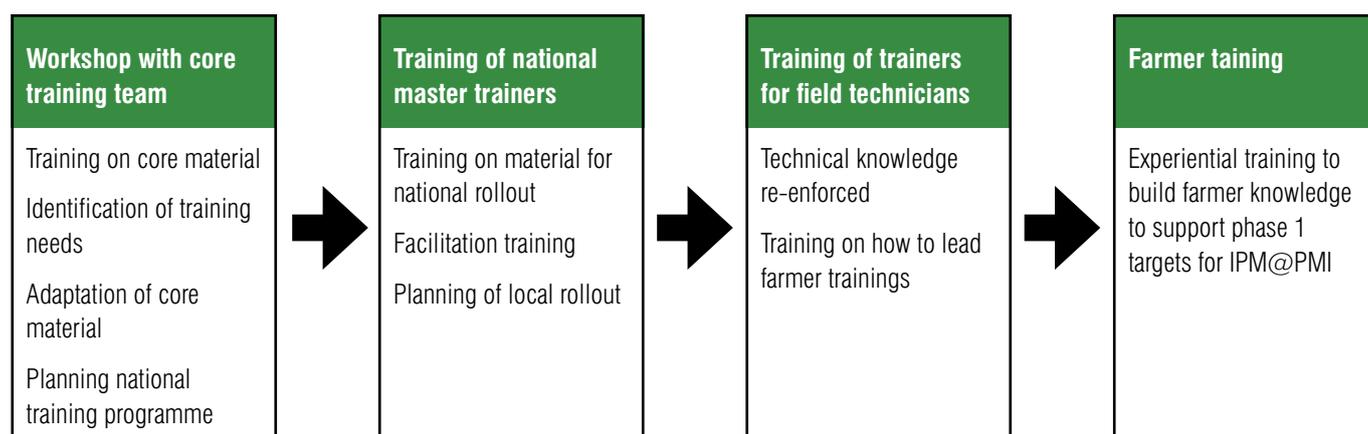


Figure 2 Main steps to be planned for in the development and rollout of an IPM training programme.

Each level in the training cascade represents a step which must be planned for as part of the implementation of the training programme (Figure 2). In the initial first step, the core team for each country will be formed. This group will be the “core” of the training programme in each country, driving the design and implementation of the programme. They will be responsible for all aspects of the development of the national training programme. The core team must already be knowledgeable about tobacco, and they must have a good understanding of Rational Pesticide Use (RPU), the CPAs recommended by PMI and the market requirements for tobacco.

Once the core team for each country is formed, they will work together to identify the training needs in their country. They will then review materials in Chapter 3 of this guide, extract relevant topics and activities, and adapt the material into a national curriculum which addresses the field technicians’ and farmers’ gaps in knowledge, awareness and skills. Once the nationally adapted training curriculum has been established, the core team will plan for all of the steps to follow.

Following the initial development of the national training programme, the core training team will then be responsible for training a group of national master trainers on the national curriculum and the approach to be taken for its implementation. This step can also be used to validate the proposed curriculum and to make any adjustments as necessary. Upon completion of this ToT, the national master trainers will lead the rollout of the training in the communities for which they are responsible. The national trainers will be responsible for providing technical training to field technicians as needed and for training field technicians to be trainers of farmers.

Once the field technicians have been trained as trainers, they will then train farmers. In some instances lead farmers will subsequently be expected to train other farmers. As indicated in Figure 2, each of the steps should be monitored (for more information on monitoring, see chapter 4).

2.2 Identifying training needs

In order to develop a successful national training programme, the core team of master trainers will have to consider what changes are needed in order for farmers to be seen to be using CPAs responsibly. What are the key measures that farmers fail to apply? What stands in the way of farmers improving their practices? Does a lack of awareness, gaps in knowledge or inadequate skills contribute to these issues? Are field technicians able to provide farmers with the support that they need? Where are the gaps in field technician knowledge? Are there any perceptions that need to be addressed through awareness-raising on certain issues?

A systematic process for identifying training needs is given in Appendix 1. The matrix in Appendix 1 lists the targets of phase 1 and the corresponding perception, knowledge and skills which are generally required for farmers and field technicians to be able to meet these targets. This information can then be cross checked against information sources such as the baseline study finding and Good Agricultural Practice (GAP) audits in order to prioritise topics for training.

Any available baseline data on farmers' understanding, and implementation of the skills described, can be used to assess whether training on a topic is needed or not. Likewise, consultation with colleagues can provide additional information. The core team should work together to complete this exercise.

The topics which are highlighted by this process will serve as the basis for the curriculum used in the national training programme. The core training materials for these topics will subsequently be adapted to national conditions (see section 2.9 of this chapter).

2.3 Training of national master trainers

Once the training curriculum has been developed and the training materials have been adapted to local conditions, the core team will organise the training of national master trainers. These national master trainers will be responsible for leading the trainings of field technicians, both to build their understanding of key concepts and to enable them to become farmer trainers. Much of the training of field technicians by the national master trainers will be achieved through organised training sessions, but it could also be possible to establish a mentoring system. The national master trainers, with support from the core training team, will also contribute to monitoring and quality assurance of the training programme.

Key competencies for the national master trainers include a technical knowledge about tobacco production and RPU; good problem-solving, communication and facilitation skills, particularly on technical subjects; the ability to get along well with other trainers and field technician trainees; a concern for the programme objectives; and a responsible work attitude.

In the cascade described in Figure 1, the master trainers are the “up-stream” source from which capacity building of field technicians and farmers will flow. Unless these master trainers are well prepared to train, the “mid-stream” field technicians who lead farmer trainings will be weak as trainers and will subsequently not be able to provide good training to farmers. It is thus crucial that the master trainers are properly trained right from the beginning and are able to play their role effectively. This will be achieved through the training of master trainers.

The responsibilities and specific follow-up tasks of the master trainers include:

- Organising and conducting ToTs for field technicians;
- Planning and preparing the ToT courses, including the operational/logistical requirements and;
- Obtaining the training materials required.

2.4 Training of trainers for field technicians

The national master trainers organise and carry out the training of trainers for the field technicians. Following training of the field technicians, the materials may be reviewed and updated, according to any feedback received from training activities.

Key competencies of the field technicians are similar to the national master trainers, with a clear focus on technical knowledge about tobacco, together with an understanding and ability to apply appropriate training methodology. In addition, they will be able to further adapt the training content to the local context.

The responsibilities and specific follow-up tasks of the field technician trainers include:

- Selecting appropriate farmer training sites and fulfilling the operational/logistical requirements, including the required supporting training materials, equipment and facilities.
- Assessment of field technician knowledge before and after training (see Chapter 4).
- Continuing to assist farmers through follow-up visits to provide advice and backstopping.
- Emphasis in these courses is to be placed on helping the field technicians to be prepared to lead their own trainings with farmers.

2.5 Field technician to farmer training

Field technicians will organise individual or group training, depending on the approach adopted by the specific country. This training should be carried out using the hands-on participatory learning methodology described in the national curriculum. Emphasis should be on discovery learning exercises.

Field technicians will also contribute to the internal quality assurance initiatives for the technical training program. For example, they will assess farmer knowledge before and after the training course. These activities are described in more detail in Chapter 4.

2.6 Farmer-to-farmer extension

Many extension services choose farmers to work with them in implementing their programs. Under this model, farmers provide extension advice to other farmers, often through the creation of a structure of farmer-trainers. The advantages of using farmer-trainers include the fact that they are based in the community; they communicate in local languages; and they are more sensitive to local cultures, farming practices, and farmers' needs.

Those farmers selected to lead "farmer-to-farmer" extension are often called "lead farmers". They are usually chosen according to their agricultural expertise and/or the leadership role that they hold in their respective communities. In addition to their farming expertise, lead farmers should also be selected based on their skills and passion for sharing knowledge. Other potential selection criteria include availability, accessibility, trainability, acceptability, ability to communicate and literacy. Women as well as men should be encouraged to become lead farmers.

The groups that the lead farmers will serve (formal or informal farmer associations) should play a key role in selecting lead farmers. This helps increase local ownership and makes the programmes more accountable to the groups that they serve. Input from these groups should also be sought in monitoring and evaluating the lead farmers.

Farmer-trainers need strong linkages with, and support from, the field technicians who train and backstop them. Farmer-trainers should serve as a complement to existing systems, rather than being a substitute for them. Simple and appropriate reference materials should be made available to the farmer-trainers.

2.7 Guidance for conducting participatory training

Participatory training acknowledges that adults learn differently. They already have their own experience, skills, knowledge and perceptions. In a participatory training it is necessary to make use of this experience and motivate farmers to exchange and learn from each other. Learning is best achieved through hands-on activities, especially activities that are relevant to their every-day lives.

In participatory training, trainers are facilitators; they are responsible for providing a structured experience which allows farmers to learn experientially. Farmers must be allowed to actively participate and share experiences during the training. Local knowledge must play a role in decision-making.

Participant reflection on what they have learned is an important part of participatory training. At the end of a session on a topic, debriefings can be used to summarise and discuss. For example, the facilitators can ask the farmers what they learned, what new realisations or discoveries they have made, and whether they have any lingering doubts or questions.

Some characteristics of effective facilitators of participatory trainings include the following:

- motivated to improve farmers' understanding of, appreciation and enthusiasm for IPM;
- organised;
- appears confident but not arrogant;
- respects participants and their opinions and encourages their opinions;
- able to take-up inputs from participants and further develop these contributions towards the training objective;
- able to watch, listen and learn;
- able to improvise;
- makes eye contact;
- speaks clearly;
- keeps discussion lively (have plans to restart discussions that become stalled);
- manages time well;
- self-evaluates and learn from mistakes; and
- shares the leadership (ensure that no one, not even the facilitator to a certain degree, dominates the discussion; find ways to encourage silent participants to contribute ideas).

2.8 Other complementary approaches for knowledge exchange

Session-based modular trainings are best accompanied by other complementary methods to reinforce the messages given and to ensure continued learning. In some countries with large numbers of farmers, reaching all farmers will depend on using at least some of these complementary mass extension methods. Some information and recommendations are readily communicated through mass media channels such as video, newspapers and radio. Meanwhile, other topics require observation over time in order to convince farmers to change their practices. Some complementary approaches for knowledge exchange are described below. This list is not definitive and many other methods are possible.

Video

Video can present scenarios in detail. It can be used for transmitting uniform messages and information. It can also be used as another way to share experiences, for example through interviews with farmers who have had success applying a technique (or suffered the consequences of failing to adopt a practice).

Radio

Community radio is one of the primary ways that rural people in many countries obtain information thus it can be instrumental in distributing educational and informative programming on farming.

Tobacco app

The tobacco app can be downloaded to phones or tablets. The packet of materials available through the app includes factsheets with key messages for each of the core training topics as well as green and yellow lists. Country-specific factsheets and green and yellow lists are available.

Call centres

In some countries where tobacco is grown, call centres have been established. Farmers can call a free telephone number for tobacco related issues. Their questions are logged by the call centre and followed up on by the VI affiliate or leaf supplier.

Model farms

Experimental farms can be used to demonstrate improvements in agricultural techniques, efficiency, etc. They are a particularly relevant tool for topics which are not easily conveyed by mass media channels. They allow for observation over time in order to convince farmers of the effectiveness of a practice.

Farmer field schools

A farmer field school (FFS) is a season-long non-formal education programme conducted on a crop in farmers' fields. This is a group-based learning process that has been used by a number of governments, NGOs and international agencies to promote IPM. FFS bring together concepts and methods from agroecology, experiential education and community development. A group of farmers gets together in one of their fields to learn about their crops. During the learning activities in FFS, hands-on field practice is favoured. The FFS approach empowers farmers to develop solutions to their own problems. They learn how to improve their practices by observing, analysing and trying out new ideas on their own fields.

The FFS approach aligns well with many of the targets that will be addressed in phase 2 of the programme (Full IPM). Detailed guidance on FFS will be provided in the master trainers' implementation guide for phase 2.

Some other examples of complementary approaches for knowledge exchange include Whatsapp groups, other social media, newsletters, SMS and theatre.

2.9 Preparing a national training package and plan

The core training teams should discuss the steps and chart out the details of the specific work plans, including identifying which team member is responsible for which tasks, how and when the tasks will be performed as well as the expected outputs. The worksheet in Appendix 2 should be filled in to facilitate the planning process.

Establish targets and a structured approach for roll out of the training programme. The number of ToTs of field technicians, training events of farmers and farm workers should be agreed for each year of the programme. The specific areas and venues for the trainings must also be identified. The number of trainers and participants at each event needs to be agreed. Will trainers work on their own or in teams? How many training workshops for farmers are field technician trainers expected to lead?

Prepare locally adapted curriculum and training materials. The topics identified as training needs (Appendix 1) can be addressed through the corresponding training topics in Chapter 3. The core training material in Chapter 3 should be adapted to local conditions. For example, local terminology should be used, and exercises should involve the locally available equipment and registered CPAs. More guidance on how to adapt the material is given in Appendix 3. Agendas should be prepared for each type of training workshop that take into account the time required to complete each activity. Activities should not be unduly rushed; time should be left for discussions. Topics can be addressed through multiple training sessions. Topics presented in a given session should be grouped logically according to theme, season, requirements and location of practical exercises, etc. Consideration should be given to how to incorporate complementary forms of knowledge transfer.

Plan and prepare operational and logistical requirements. Besides getting the training curriculum and training materials ready, it is also necessary to ensure all other operational and logistical requirements are in place. For each type of training, a check-list should be prepared to ensure all training materials and logistics needed are on hand. If necessary, arrangements should be made for participant transport to the training location and accommodation provided.

Trainers should visit the training venues and field sites prior to the training workshops to ensure that everything is in order. During the ToTs, all participants should be provided with the agenda, a nationally adapted training package and a field kit with the key supplies needed to implement the trainings of field technicians.

3

3. IPM Core Training Topics and Activity Guides

- 3.1 Understanding IPM
- 3.2 General information about CPAs
- 3.3 Selecting CPAs
- 3.4 Personal safety and contamination
- 3.5 Handling and application
- 3.6 Post-spraying activities
- 3.7 CPA storage

Chapter 3 constitutes the core “IPM” training package. Each of the seven main areas of the core training package present several related topics grouped stepwise by theme. To decide which of these topics to include for the technical training of field technicians and farmers, the core training team should refer to section 2.2 of Chapter 2 and fill in the worksheet in Appendix 1. Most topics are accompanied by several possible activities. It is up to the national training teams to decide which activity or combination of activities is most appropriate for the national context.

Each of the main areas presents material to raise awareness about issues or concerns pertinent to the topics so that trainees have a clear understanding of why the training matters and why it is relevant to them. The main concepts and key terminology are also introduced so that trainees have the necessary knowledge base. Each area covered also includes practical exercises to help build trainee skills so that they can apply the concepts learnt in a real world setting. Finally, through interactive discussions and activities the trainees are asked to examine their own practices and to identify what changes they need to make in order to manage CPAs responsibly.

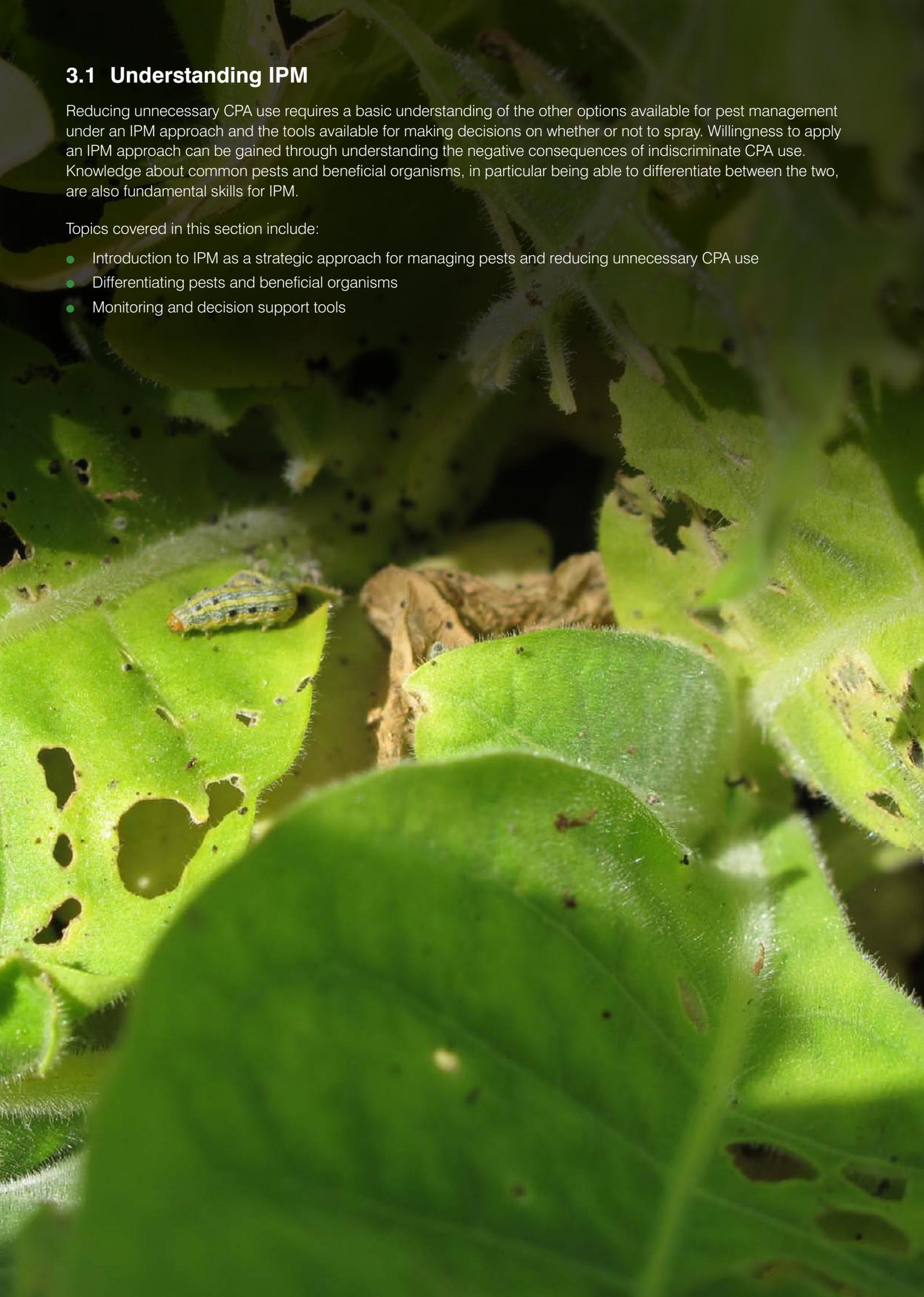
For each topic presented here, there is information on the rationale for conducting training on the topic, the learning objectives, the target group, the recommended training location (e.g. field or in a classroom setting), the key points to be covered when conducting training on the topic, and a detailed description of the procedures for leading practical activities to support learning on the topic. The estimated time required for each training activity is also provided. The descriptions of the activities include information on the duration of the activity, the materials needed and notes for the facilitators. For some topics, alternative means of sharing information are also listed.

3.1 Understanding IPM

Reducing unnecessary CPA use requires a basic understanding of the other options available for pest management under an IPM approach and the tools available for making decisions on whether or not to spray. Willingness to apply an IPM approach can be gained through understanding the negative consequences of indiscriminate CPA use. Knowledge about common pests and beneficial organisms, in particular being able to differentiate between the two, are also fundamental skills for IPM.

Topics covered in this section include:

- Introduction to IPM as a strategic approach for managing pests and reducing unnecessary CPA use
- Differentiating pests and beneficial organisms
- Monitoring and decision support tools



Introduction to IPM as a strategic approach for managing pests and reducing unnecessary CPA use

Rationale: Interviews with farmers indicate that many farmers are unaware of, or only have a vague notion of what IPM is. They were not aware that many of the practices recommended to them can be applied strategically as a package to manage pests and produce a high quality crop. Similarly, some farmers are unaware of the issues associated with indiscriminate CPA use. In particular, they do not fully realise that indiscriminate and irresponsible CPA use is in contravention to GAP requirements and can put the market for their tobacco in jeopardy.

Introducing the IPM principles and highlighting how this combination of approaches can contribute both to a good yield and producing a crop that meets market requirement can help to raise awareness about the direct relevance of IPM to their work and its success. It can also stimulate the farmers' interest in learning more, thus setting the stage for the rest of the training programme.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Learn what IPM and its principles are;
- Recognise the value of IPM as a strategic approach for pest management and for reducing unnecessary CPA use;
- Be aware of practices that they already apply which fall under the umbrella of IPM;
- Understand IPM's relationship to GAP and market requirements.

BACKGROUND INFORMATION

What is IPM?

Broadly, IPM is defined as “an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of CPAs” (FAO). Pests are “any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products”. Thus, not every insect, plant or microorganism occurring in a crop is a pest.

IPM principles:

- **IPM uses a combination of strategies.** IPM is a holistic approach to managing pests; a number of processes - chemical, cultural and biological – can assist in reducing crop loss. The emphasis is on reducing the reliance on a single method of intervention, particularly CPAs. Pests are viewed as part of the ecosystem, rather than an isolated problem.
- **IPM is a tailored approach.** The design and implementation of an IPM programme will depend on the conditions in which it is applied. It will be influenced by the crop's pests and the environment as well as societal, economic and regulatory considerations.
- **Prevent pest problems before they occur.** Prevention is the first line of defence in IPM. Preventive practices make the habitat unsuitable for pest build-up and more suitable for natural enemies or competitors that suppress pest populations. Selecting preventive practices involves consideration of the type of crop, when and how it is planted, as well as the environment that is subsequently created. Examples of preventive practices include the use of resistant or tolerant varieties, intercropping, use of trap crops, crop rotation, plant density, tillage methods, planting time, phytosanitation (which includes clean planting material), physical barriers, management of soil fertility and water, and the protection or enhancement of populations of beneficial organisms. These practices can prevent crop losses by delaying pest colonisation of the crop; creating conditions that reduce the survival of pests; and modifying the crop in such a way that pest infestation causes less damage (e.g. a tolerant variety is grown).

- **Monitor for pests:** Systematic and regular monitoring is a fundamental component of IPM. This involves identifying pests and assessing their prevalence, and evaluating the damage they are causing or are likely to cause. Detecting and identifying the pests that are present is necessary in order to decide how to proceed. Monitoring methods involve visual inspection of the crop and its surroundings as well as the use of devices such as sticky traps or pheromone traps. For some pests, other factors such as weather conditions should also be considered.
- **Apply direct control measures as needed:** Direct control measures should be applied only when the pest in question reaches an appropriate threshold. The aim of direct control measures is not to completely eradicate the pest but rather to manage it so as to reduce its impact to an acceptable level. Attempting to remove the entire pest population could result in selection for resistant individuals or could kill off natural enemies. Direct control practices include methods like roguing, hand-picking, topping, parasitoid releases, mating disruption, trapping and CPAs.).
- **CPAs are used rationally:** IPM uses all appropriate pest management options including the cautious use of CPAs. CPAs are only used if less risky controls do not achieve control at an acceptable level. CPA usage is kept at the lowest effective level. Ideally, CPAs should be as specific as possible for the target pest and have the least side effects on human health, non-target organisms and the environment. Broadcast spraying of broad spectrum CPAs is to be avoided if at all possible. Proper timing and precision of CPA applications ensures greater efficacy and selectivity.

Who uses IPM?

The principles listed above include a wide range of agricultural practices, tools and techniques, some of which will not be appropriate for all pests, crops or farmers. Thus, IPM can be considered a continuum, some aspects of which are used by almost all farmers, but there will be some practices that are only used by a subset of farmers. A farmers' choice to use a control measure will depend on factors such as the availability and cost of the control measure, crop value, other market considerations, etc.

What is “GAP” and how does it relate to IPM?

GAP stands for “Good Agriculture Practices” which are practices that address environmental, economic and social sustainability for on-farm processes, and result in sustainably produced tobacco. PMI defines sustainable tobacco production as the efficient and competitive production of quality tobacco in conditions that limit as much as possible the impact on the natural environment and that improves the socioeconomic conditions of the people and communities involved in its production. GAP is mandatory for all suppliers of tobacco to PMI.

IPM is an integral part of PMI's overall GAP program. In PMI's GAP program, there are three focus areas (pillars): Crop, Environment and People. The “Crop” pillar calls for implementation of IPM to break pest and disease cycles. Measurable standards for IPM implementation include practices such as crop rotation; destruction of seedbeds; destruction of stalks and roots after harvest; use of economic thresholds; use of attractant/repellent plants; trapping; biological control; use of low-toxicity and selective CPAs; and record keeping. Regulations for CPA use should be followed. Likewise, the Crop pillar also calls for residues being below PMI tolerance levels for CPAs. An IPM approach ensures that CPAs are used judiciously. Implementation of IPM also supports the delivery of aspects of GAP's Environment pillar, such as reducing pollution of soil and water. The People pillar states that exposure to health risks should be limited and that only people who have been trained to do so should use, handle or apply CPAs. IPM's emphasis on judicious use of the least toxic CPAs also supports delivery of this GAP standard.

ACTIVITY: Awareness-raising of farmers of their current implementation of IPM



30 minutes



Farmers who are unfamiliar with IPM and are unaware that some of the practices they already apply can be part of an IPM approach



Classroom

MATERIALS

- Paper (Notebook paper or flip chart paper)
- Colored pencils or markers

PROCEDURES

Ahead of time, prepare sheets of paper with some of the practices which could be included in an IPM approach for pests in the area under consideration (see below for examples). Each sheet should list one practice. If possible, draw a picture to represent the practice. Also, prepare sheets with example pests. If possible, draw or include a picture of the pest. Otherwise list the pest name.

Some examples of practices that figure in an IPM approach are given below (though others could be added):

- Resistant/tolerant varieties
- Floating seedbed system
- Clipping of seedlings
- Destroying seedbeds
- Early planting
- Crop rotation
- Removal of alternative host plants for disease management
- Hand-picking
- Attractant/repellent plants
- Improving habitats for natural enemies
- Needs-based fertilisation
- CPAs
- Weeding
- Topping
- Destroying stalks and roots after harvest

Arrange the sheets of paper on the ground, a wall, etc. For each of the practices ask farmers which of these practices they carry out on their farms. This can be done through a show of hands (write the number of hands raised on the sheet for each practice) or by asking the farmers to put a tick mark on the posters with the practices that they apply. Once there are counts recorded for each practice, ask volunteers to explain why they apply each of the practices. What benefits have they seen?

Explain to the group how different practices can be applied together as an IPM package. Using a pest that the participants are familiar with as an example, group some of the practices to illustrate how they can be combined in an IPM approach. The pests and the associated practices will vary by country. Some possible groupings are given in Table 1.

Table 1 Examples of pests and combinations of practices which can be used to manage the pest

Pest	Practices
Caterpillars (e.g. hornworm and budworm)	Disking soil to destroy pupae, early planting; avoid applying excess fertiliser; topping and sucker control; crop rotation with non-host plants; hand-picking; apply Bt; apply other recommended CPA; destroy crop residues
Aphids	Early planting; avoid applying excess fertiliser; topping and sucker control; removal of alternative host plants; apply systemic CPA
Flea beetles	Crop rotation – avoid planting tobacco close to potato, tomato or other vegetables; weed; destroy crop residues; apply recommended CPA
Nematodes	Plant resistant varieties; rotate with crops like maize or sorghum; avoid planting beans, soy or other legumes; destroy crop residues
Tobacco Mosaic Virus	Use resistant varieties; disinfect tools and wash hands; remove weeds; remove infected plants

Divide the participants into small groups. Give each group a picture of a pest, or symptoms of a pest. Ask the groups to work together to list practices that could potentially be used together in an IPM approach for managing the pest. They can select from the illustrated examples or they can pick their own. Each group should then present their “IPM package” for the pest.

QUESTIONS FOR DISCUSSION

- Q Why did they select the practices in the IPM approach that they presented?
- Q Why not apply just one control?
- Q Why is it better to use a combination of practices?

ACTIVITY: Explore the benefits of applying IPM



1 hour



Farmers who feel there are no benefits to applying IPM



Classroom

MATERIALS

- Flip chart and markers (in four different colours) or coloured cards (tape or blue tack will be needed for sticking the cards on the wall)
- Green and yellow lists for key pests to serve as a reference

PROCEDURES

Often, farmers are aware of both the best practices and the practices which are prohibited, but feel that there is little reward for applying the best practices and few consequences for not complying with prohibitions.

This activity involves a systematic examination of production practices in the seedbed and field which can be used to manage pests, with the aim of identifying the underlying rewards and risks associated with each.

This activity can be done either in plenary or in break out groups (if the group is large) using flipcharts or a wall. Prepare for the activity by creating three columns following the format provided in Table 2. The facilitator will use the first column to list / draw production practices in the seedbed and field. In the next column, for each practice, the facilitator will take note of positive consequences for implementing the practice. In the third column the facilitator will note the potential negative consequences.

Table 2 Positive and negative consequences of applying “good” and “bad” practices

Production practices	Negative consequences	Positive consequences
seedbed		
field		

Begin the activity by selecting a target pest (or pests if the activity is being carried out in break out groups). The participants can select the target pest(s), or the facilitators can already have the target(s) selected in advance.

Ask the group what are some “good” practices which can be applied early (at land preparation and in the seedbed)

to avoid problems with the pest. For example, for aphids they could potentially list things like early planting, applying imidacloprid in the seedbed and eliminating alternative hosts. Ask them if there are any “bad” practices which will increase the likelihood of having the pest. Use one colour (e.g. green marker or card) for “good” (recommended) practices and another colour (e.g. orange marker or card) for “bad” practices which are not recommended but may be commonly applied by some farmers. If using flipcharts, the facilitator should write down the ideas. If using coloured cards, these can be distributed to participants and they can put them on the wall under the appropriate headings (seedbed or field).

Next, ask them for examples of “good” practices which can be applied in the field. For aphids, for example, this could include avoiding using too much nitrogen; monitoring the plants and applying thresholds; using CPAs such as spirotetramat or neem when threshold has been reached; topping in a timely fashion. Ask the participants to list some examples of “bad practices”. Examples for aphids could include applying more than the maximum number of applications of CPAs; failing to observe pre-harvest interval (PHI); or applying something which they use in another crop which is not recommended for tobacco.

Once the group has a fairly comprehensive list of good and bad practices, ask them what might be positive and negative consequences for each – for example, if they plant early, there may be less pest pressure. Meanwhile, if they apply the wrong CPA or fail to observe PHI, then their tobacco may be rejected due to residue problems. Write positive consequences in a third colour (e.g. blue marker or card) and negative consequences in the last colour (e.g. red marker or card). If using flipcharts, the facilitator should write down the ideas. If using coloured cards, these can be distributed to participants and they can put them on the wall under the appropriate headings (positive or negative).

Once the positive and negative consequences of applying each of the listed practices have been filled in, look at the lists of “good” and “bad” practices as a whole. Ask the group how they would weight each column.

If this activity was carried out in break out groups, wrap-up in plenary. Have the groups briefly summarise their conclusions and have a wrap-up discussion

QUESTIONS FOR DISCUSSION

- Q Are there more rewards for applying good practices and an IPM approach?
- Q Are the scenarios cumulative? Do the good/bad practices add up?
- Q Are there some particularly dire consequences for applying bad practices?
- Q Based on this analysis, which types of practices would the farmers choose to apply?

ACTIVITY: Identification, evaluation and control of hazards



1 hour



Field technicians



Classroom

MATERIALS

- Paper (flip chart paper and cards)
- Flip charts or another work surface
- Tape or pins
- Coloured pencils or markers
- CPA residue data

PROCEDURES

In this activity, field technicians will conduct a mini-HACCP. HACCP stands for Hazard Analysis and Critical Control Points. HACCP is systematic approach to the identification, evaluation, and control of hazards. The aim with HACCP is to identify steps in a production process that can lead to problems and to prevent these problems before they occur. In tobacco production, this analysis can be applied to the chemical hazard which is posed by CPAs and CPA residues. This activity asks participants to examine where in the production process CPA hazards are introduced and what steps can be taken to reduce the risk posed by these hazards.

Working in small groups, ask the participants to undertake the following steps:

- Ask the participants to make a flow diagram to illustrate the steps of tobacco production through to the buying of the tobacco. The purpose of a flow diagram is to provide a clear, simple outline of the steps involved in the process. The scope of the flow diagram must cover all the steps in the process which are directly under the control of the farmer (and can thus be influenced by the field technician). Facilitators should verify that groups have not omitted any key steps.
- Participants should then analyse the hazards. For each step in the production process, the groups should brainstorm a list of potential CPA hazards. Participants should focus not only on where hazards are introduced, but they should also identify instances where hazards may be increased (e.g. late in the season when PHI becomes an issue) or controlled (e.g. if planting happens early there will be less insect pressure, reducing the need to apply CPAs later in the season). As a reference, provide the recipients with information on CPA residues which are found in tobacco produced in the region.
- Once the groups have listed the hazards associated with each step in the production process, they should then proceed to evaluate them in terms of severity and likelihood. Ask the group to put a star beside the hazards that could have the most severe consequences and to circle the hazards which are most likely to occur.
- Critical control points are the steps at which control can be applied and where it is essential to prevent or eliminate a hazard or reduce it to an acceptable level. For the highest risks (the hazards which pose a threat and are likely to occur), ask the groups to brainstorm some potential control points, taking note in particular of IPM practices which can help reduce risks.

Once the analyses have been completed, ask the groups to present their findings.

QUESTIONS FOR DISCUSSION

- Q What are the implications of this analysis?
- Q How can field technicians help farmers to take the necessary steps to eliminate or reduce hazards?
- Q When do farmers need support the most?

TOPIC

Differentiating pests and beneficial organisms

Rationale: Some farmers are unaware of what beneficial organisms are; in interviews, some even went as far as to say that they did not believe that any insect could be beneficial. Also, some farmers do not associate the crop damage they see with the pests that actually cause this damage. When farmers are unable to recognise the causal agents of damage or believe that all insects are bad, then this is a fundamental problem. Awareness needs to be raised that while some insects are indeed pests, feeding on plant parts, there are some that feed on insect prey, some that live inside other insects, while others come from weeds or neighbouring crops, and are simply resting on the crop.

BACKGROUND INFORMATION

Insect / disease zoos are small observational studies made by farmers (with help from facilitators) to learn specific aspects of the pests or their natural enemies, e.g. life stages, nature of injury and damage symptoms, specific behaviour (e.g. oviposition) of natural enemies, etc. They can be used to deal with general topics such as plant/insect relationships, pest-natural enemy relationships, disease transmission process, etc. They can also focus on locally identified pest problems, e.g. to associate damage with the pest that causes it. In general, they help to increase farmers' understanding of ecological principles in the crop agro-ecosystem.

The first insect zoo activity described below is aimed at raising awareness of the different types of insects and their roles. The second example of an insect zoo can be used to demonstrate the role of natural enemies in reducing pest populations. The third is an example of a more targeted look at damage caused by a particular pest and how it appears at different stages in its development. Depending on the training needs identified for the farmers, similar exercises can be designed based on the 'Insect/disease zoo' methodology, but these will require some time for preparation and testing in the field.

LEARNING OBJECTIVES

Through trainings on this topic trainees will:

- Increase their understanding of ecological principles in the agro-ecosystem
- Be able to differentiate between pests and beneficial organisms
- Discover the importance of beneficial organisms and their role in controlling pests
- Examine insect feeding patterns and understand which insect causes which damage symptoms

ACTIVITY: Insect zoo 1 – insect pest or natural enemy?



2 hours, if possible follow up session some days later to include discussion on longer term observations



Farmers who are not familiar with different types of insects



Tobacco field and somewhere to keep the insect zoos

MATERIALS

- Small plastic vials or empty water bottles containers
- Plastic bags
- Plastic buckets (transparent if available), large enough to hold tobacco leaves and plant parts of various sizes
- Tobacco leaves, stems, etc.
- Tissue paper
- Camel or fine hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Optional: insect collection box and pins

PROCEDURES

Introduce and discuss the concepts of pests (“enemy of the farmer”), natural enemies (“friends of the farmer”) and neutral (“a visitor”). Very early in the morning, participants should carefully collect unknown and known insects from the field plot using a sweep net or by capturing them in plastic vials/bottles. Be careful when handling the insects to be studied, as they will not feed if they have been roughly handled. Ask participants to study the insects and give the local name of each. Discuss what the insects might feed on.

To set-up the insect zoos, line the plastic buckets with tissue paper to avoid condensation. Put some leaves or other plant parts in each bucket and label each bucket with the (local) name of the insect that you want to study. Put different insect species in different zoos. Participants can be divided into groups to observe the different zoos. To find out whether an insect is a pest, put it on free tobacco in a bucket and cover the bucket with muslin cloth / screen, secured with a rubber band / piece of string. Keep the buckets out of direct sunlight. Observe whether the insect feeds and the feeding symptoms. Check again after some time; how long does the insect survive? Another way to build an ‘insect zoo’ is to sleeve tobacco in the field with plastic bags that have screen windows (make sure that there are no holes in the plastic or screen windows). Insert the insects to be studied and observe the zoo daily.

At the end of the exercise, participants should present their observations to the wider group. Findings are recorded on poster paper, include the following:

- Local names of the insect(s) collected
- Where the insects were collected
- What they fed on
- Whether they changed development stages
- How long they remained in certain development stages. They should illustrate their observations with drawings.

Following the presentations, make sure to wrap-up the exercise with a discussion.

It is a good idea to build up a reference collection of some pests and natural enemies. To make a reference collection, pierce or glue studied, dead insects on insect pins or fine tailor pins through the thorax (the middle part of the body). Add a small paper label with details of the collection date, place and crop. Very small insects may be kept in glass vials with alcohol.

QUESTIONS FOR DISCUSSION

- Q Did the insect feed in the zoo? If not, why not (was the insect damaged, not hungry, or is the insect not a pest of tobacco)?
- Q How long did the insect survive in the zoo?
- Q Was the insect a “friend” of the farmer, a “visitor” or an “enemy” of the farmer?
- Q How could the information about feeding patterns help you in managing pests?

ACTIVITY: Insect zoo 2 – Predators in action



2 hours, if possible follow up session some days later to include discussion on longer term observations



Farmers who are not aware of the role of predatory insects in controlling other insect pests



Tobacco field and somewhere to keep the insect zoos

MATERIALS

- Small plastic vials or empty water bottles containers
- Plastic bags
- Plastic buckets (transparent if available), large enough to hold tobacco leaves and plant parts of various sizes
- Tobacco leaves, stems, etc.
- Tissue paper
- Camel- or fine-hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Optional: insect collection box and pins

PROCEDURES

If this insect zoo follows immediately after the first one, the insects identified as predators can be used in this activity.

As in the previous session, explain the objective of the exercise and ask participants to collect insects. Ask participants to study the insects and give the local name of each. Discuss what the insects might feed on, for example, tobacco or other insects.

To set-up the zoos, line the plastic buckets with tissue paper to avoid condensation. Put leaves in a bucket and label each bucket with the local name of the insect you want to study. Place an expected predatory insect (a “natural enemy” or “farmer’s friend”) together with an expected prey insect in a zoo (for example, ladybird beetles with aphids or praying mantis with a leaf-feeding caterpillar). Make sure that different species of predators are not put together as they might attack each other. Label each bucket with the local name and number of insects in each zoo.

Divide participants into groups to observe the zoos. Each zoo should be kept by one participant, in a place out of direct sunlight. Observe the interactions between prey and predator for the following 5 to 10 minutes and then exchange with others to observe a different zoo. If possible, observe regularly every day for 3-5 days and note information on the following:

- Number of surviving pests and prey in each zoo
- Development of pest symptoms both in the zoo with predators and in the zoo without predators

At the end of the exercise, groups should describe and draw their observations on poster paper and make a presentation to the whole school.

QUESTIONS FOR DISCUSSION

- Q Was the studied insect(s) a ‘friend’ of the farmer or an ‘enemy’ of the farmer?
- Q What would be expected to happen to the farmers’ ‘friends’ when insecticides are used to control pests?
- Q How can farmers conserve their ‘friends’ in the field?

ACTIVITY: Insect zoo 3 – Disease symptom development



30 minutes for set-up



Farmers who have trouble diagnosing the cause of a particular problem



Tobacco field and somewhere to keep the disease samples

MATERIALS

- Several samples of infested plant parts freshly collected from the field
- Transparent rearing jar or container
- Muslin cloth
- Rubber band
- Hand lens
- Some fresh leaves

PROCEDURES

Collect several samples of disease infected plant parts. Place the infested plant parts in the container. Place some fresh tobacco leaves over the infested plant part. Double-check to make sure the leaves are clean and that there are no insects on them. Add moist tissue paper and cover the container.

Observe the container daily to check the development of both the diseased and the fresh tobacco leaves.

Describe the leaves and make drawings, measure the size of lesions and note any other damage observed.

QUESTIONS FOR DISCUSSION

- Q** How did the disease develop?

ACTIVITY: Plant doctor simulator



30 minutes for introduction



Field technicians who need to build their pest diagnosis skills



Self-study can be carried out anywhere, as long as the tablet is charged

MATERIALS

- Tablet
- Plant doctor simulator app

PROCEDURES

The *Plant Doctor Simulator* is an app which is available for download from Google Play. This game aims to build field technicians' ability to carry out symptom-based diagnosis of pests while also gathering data during game play as a measure of diagnostic performance. Through game play, field technicians will be better able to fulfil their duties in identifying pests and giving feedback to farmers. Data gathered by the game such as an exam score can also be used to generate statistical insights into the field

TOPIC

Monitoring and decision support tools

Rationale: Many farmers spray against all pests following a calendar-based schedule, without considering whether there is a need to spray or not. This practice is often uneconomical and not environmentally friendly. The use of economic thresholds in deciding when to spray ensures that insecticides are applied only when they are needed. This approach eliminates unnecessary CPA applications, helping to protect the environment from avoidable contamination and also saving farmers money.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Understand the concept of economic thresholds, their application and benefits.
- Learn how to assess pest levels in a tobacco field.

BACKGROUND INFORMATION

An economic threshold (ET) refers to the population density at which control action should be initiated to prevent an increasing pest population (or injury) from reaching the economic injury level (EIL, see figure below). Some workers refer to the ET as the action threshold or damage threshold to emphasize the true meaning of the ET. The ET is a practical, operational rule for when to take action, i.e. whether or not to apply a treatment in any given situation. The ET is ideally derived from the EIL which can be put as:

$$\text{Economic injury level (pests/m}^2\text{)} = C \div (V \times D \times K)$$

Where

C = cost of control including application (**\$/ha**)

V = crop value (**\$/tonne x estimated number of tonnes/ha**)

D = damage per pest (**t/ha for every pest/m²**, this is the critical information to be obtained through research)

K = efficiency of the CPA application (e.g. 0.7)

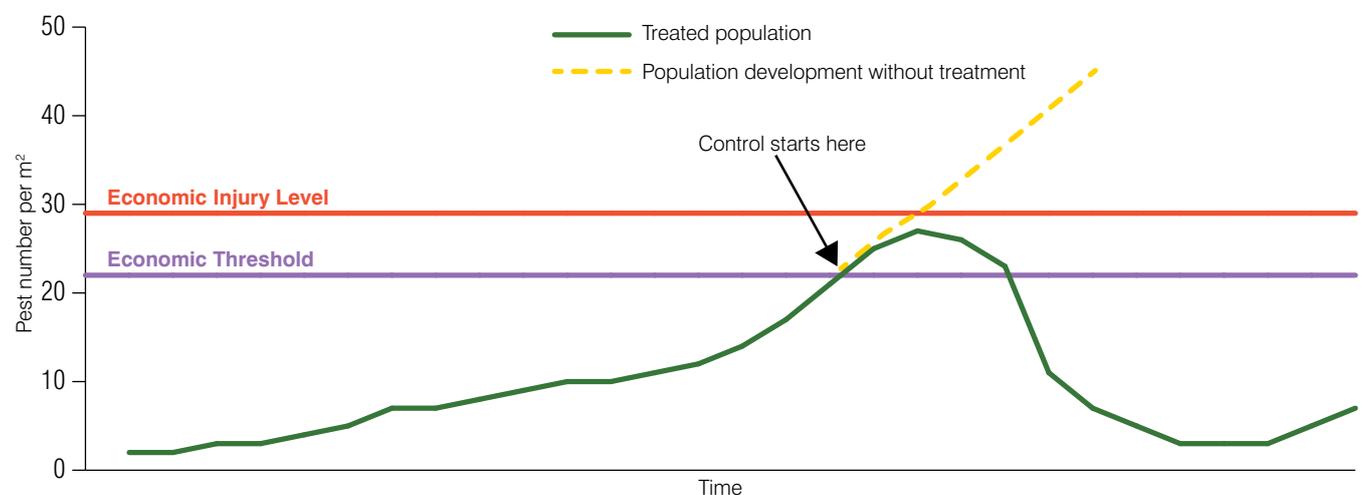


Figure 3 Economic threshold and economic injury level (adapted from Grains Research and Development Corporation)

In developing ETs, several approaches, representing different levels of sophistication, have been devised. Most of these approaches can be grouped into two broad classes: subjective determinations and objective determinations. Objective determinations of ETs are based on EILs and thus require data collection on pest and host phenology,

population growth and injury rates, time delays associated with IPM tactics utilised, etc. This requires a significant amount of data and may take years to determine.

Subjective determinations are a more pragmatic approach to ET development. They are based on a practitioner's experience, not on a calculated economic injury level (EIL). Subjective thresholds represent the majority of ETs found in extension publications and verbal recommendations. Although they are possibly not very accurate, conducting subjective determinations is better than using no ET at all since they still require pest population assessment to be carried out. Despite their drawbacks, the use of subjective thresholds can often result in reductions in the numbers of pesticide applications, provided stakeholders were not overly conservative in developing these ETs.

The PMI GAP programme calls for the establishment and use of ETs for all key pests. This will involve identifying key pests and diseases, understanding their life cycles and using that information to establish thresholds based on local conditions. The ETs which are established should take into consideration the prices the farmer receives for tobacco together with the cost of cultural, chemical and biological control measures. Ideally, pest thresholds should be established that also consider the level of beneficial insect populations. When determining ETs, it is important to bear in mind that the level of pest presence and the damage that can be tolerated will be determined by many factors and may fluctuate throughout the season. Some examples of factors that should be considered include: stage of plant development; whether infested or damaged plant parts are marketable; time until harvest or sale; market conditions; and effectiveness and/or speed of action of the pest control method.

ACTIVITY: Subjective threshold development



2 hours



IPM coordinators, agronomy teams, select field technicians in countries where ETLs for some of the major pests have not been established and/or should be re-assessed



Classroom

MATERIALS

- Flip charts and markers
- List of the major pests and any ETs that exist for those pests
- Data and references for control costs, crop value and pest damage (if available)

PROCEDURES

Facilitators should begin by discussing the concept of ETs with the group to make sure there is a common understanding of the definition. Inform the group that subjective economic thresholds will be determined case-by-case based on:

- Thresholds already available
- Field experience, e.g. of field technicians

Ask the participants to work in small groups with each group focusing on one of the major pests for which there is no economic threshold established. Ask the groups to answer the following questions:

- Do economic thresholds already exist in other countries? What are they?
- What information is available on control costs and crop value?
- When does the pest inflict feeding injury?
- How much injury is tolerable?
- What are the expected losses of the crop if controls are not used?
- What is the most vulnerable pest stage for management?

- When is treatment possible (PHIs etc.)?

The groups should present their conclusions in plenary. Ask each of the groups whether all of the information which is needed is available and if not how it could be found. For the answers that they were able to fill in, ask them how it has a bearing on the ETs which will be established (e.g. different ETs may be needed for early and late season).

Next, facilitators should note that, regarding pest monitoring, the pest situation on one farm is not always reflected on the neighbour's farm. Thus, a regional approach to pest monitoring is not going to be practical in all cases. At the same time, field technicians cannot regularly monitor on behalf of all their farmers. Therefore, farmers need to be active in monitoring and applying ETs.

QUESTIONS FOR DISCUSSION

- Q To what extent is monitoring practiced currently and what is the attitude of farmers towards it? What does a feasible monitoring for the farmer look like?
- Q What can be done to encourage farmers to carry out monitoring?
- Q How could economic thresholds be introduced and implemented on the farms, e.g. through a model farm approach?

ACTIVITY: Using economic thresholds as a basis for deciding to apply CPAs



2 hours



Farmers who do not apply economic thresholds which are in place for key tobacco pests; field technicians who are not aware of and/or do not advise farmers to apply the established economic thresholds



Tobacco field

MATERIALS

- Tobacco field infested with pests for which there are established economic thresholds (e.g. budworms, hornworms, flea beetles, aphids or cutworms)
- Record books
- Pens
- List of recommended CPAs and their current prices
- Factsheet with guidelines for using economic thresholds

PROCEDURES

Before the session, trainers should observe the tobacco field themselves to be certain that the field is infested with the pest which is being targeted through the exercise.

Begin the session with a discussion on the importance of the focal pest. Ask participants what they do (or would recommend to be done) to control the pest.

Ask the participants to list the pest signs and symptoms that they know about. Suggest any symptoms that have been overlooked and if they list any symptoms which are ambiguous or misleading, work with the participants to clarify and refine the symptom description.

Lead a discussion on the concept of thresholds by asking the following questions:

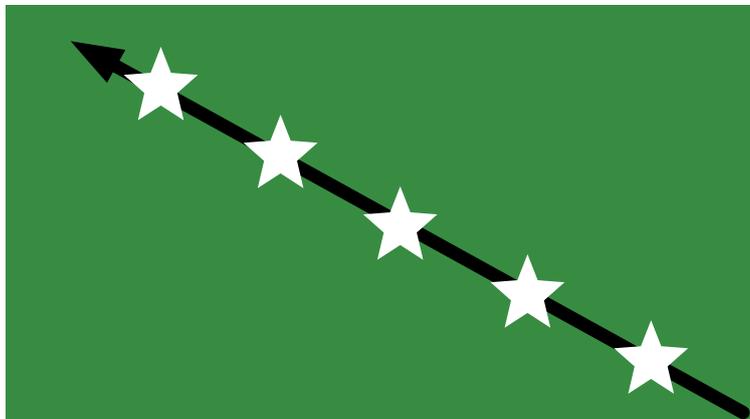
- Is it necessary to spray CPAs every time you notice the pest or its symptoms on or around tobacco plants?
- How do we determine whether we need to spray and how much to spray?

Agree on the definition of economic threshold as the level of damage by the pest at which it makes economic sense to spray CPAs.

Divide the tobacco field into 4 equal sections. Divide the participants in four groups, and assign each group to one of the four sections.

Each group should do the following:

- Walk through their section of the field (e.g. diagonal transect, see below).



- Each group should make at least five stops at several representative locations to check for insects. (The groups should avoid stopping *only* at locations with signs of infestation or *only* at locations without signs of infestation.)
- At each stop, the group members should check ten plants in a row for insects.
- Table 3 explains what should be recorded for each type of pest (e.g. numbers of caterpillars for hornworm and budworm, numbers of infested plants for aphids). Have the participants record the appropriate data for the target pest.
- Using the criteria in Table 3, each group should decide whether or not to spray CPAs to manage the pest. If local ETs are available, use these instead.

Table 3 Economic thresholds for key tobacco insect pests. Based on a minimum of 40 randomly selected plants per field (for fields less than 2 ha). Reference: 2014 Flue-Cured Tobacco Guide. North Carolina Cooperative Extension Center. Use local thresholds if available.

Insect Pest	Monitoring Period	Economic Threshold
Tobacco budworms	Before button stage	10% infested plants. Do not count damaged plants where budworm is not present as infested.
Tobacco hornworms	All season	1 or more larvae at least 1 cm long per 10 plants; parasitized larvae count a 1/5 of larva
Flea beetles	Post-transplant	4 or more beetles per plant
	Pre-harvest and harvest	60 or more beetles per plant
Cutworms	Post-transplant	5% or more small plants killed or injured
Aphids	Pre-topping	10% of plants with 50 or more aphids on the upper leaves

Once all groups have carried out their assessment, bring them back together for presentations of their findings and discussion.

QUESTIONS FOR DISCUSSION

- Q What differences exist in the level of pest infestation within each plot and between the plots?
- Q What are the advantages or disadvantages of using economic thresholds to make a decision about spraying?
- Q At what stage can spraying save an infested plant from further damage?
- Q If the plot observed is sprayed now, are the plants likely to be saved from damage?
- Q What have the participants learned from this exercise?

ACTIVITY: Decision steps for deciding to apply a pesticide



30 minutes



Farmers who apply CPAs on a calendar basis; field technicians who only advise farmers to apply CPAs on a calendar basis



Classroom

MATERIALS

- Paper (8 ½" x 11" or flip chart paper)
- Coloured pencils or markers

PROCEDURES

Many farmers are accustomed to applying CPAs on a calendar basis and field technicians may not always advise them to do otherwise. Farmers should be presented with a straightforward thought process for deciding whether or not to apply CPAs. This process should incorporate principles of IPM and RPU. The activity below can build on previous exercises to differentiate pests and natural enemies and to recognise signs of damage caused by different pests. Or it can be presented as a standalone “refresher” for farmers and field technicians who are aware of these considerations but may not always consider them systematically in a stepwise fashion.

Ahead of time, prepare sheets of paper with each of the 6 decision-making steps (see below). Each sheet should list one or more questions a farmer should ask before deciding to use a pesticide. If possible, draw a picture to represent the step.

The decision steps to appear on the sheets are as follows:

1. See if there is a problem: Is there a problem on my farm?
2. Find out what you are trying to control: What is causing the problem? (Insect, animals, disease, not enough water, too much water etc.?)
3. Decide whether the problem is serious: Is the pest problem serious? Should I act now, or watch and wait?
4. Decide whether you need to use CPAs: Is using a CPA the best way to control this pest? If so, do I have the right CPA for the job?
5. Select the right CPA: Am I using a suitable product for tobacco? Is there enough time to apply the CPA before harvesting time?
6. Apply the CPA correctly and safely: Have I been trained on how to use CPAs? Am I following all the instructions on the label? Am I wearing the right clothing and protective wear?

Arrange the 6 sheets of papers in any order (but not in the above order) on the ground, a wall, etc. Ask farmers working in small groups to put them in the right order and to discuss what action a farmer should take at each step. Ask 2-3 groups to report their discussion.

Wrap-up the session by reviewing the decision steps to make sure that farmers are aware of all of the questions they need to ask themselves at each step.

3.2 General information about CPAs

Selecting and using CPAs appropriately requires a general understanding of what CPAs are and how they work. This section provides a general introduction to CPAs. Knowledge of basic concepts supports selection of appropriate CPAs and their judicious use. This section also delves into some of the regulations which will have an impact on CPA use. Farmer's willingness to apply an IPM approach can be gained through understanding the negative consequences of indiscriminate CPA use.

Topics covered in this section include:

- What is a pesticide?
- What's in a CPA
- Advantages and disadvantages of common pesticide formulations
- How do CPAs work?
- Legislation, key regulations and contractual obligations related to CPA life cycle management



TOPIC

What is a pesticide?

Rationale: Covering this topic will ensure that there is a common understanding of what pesticides are. It sets the stage for discussions and activities that follow

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand what the term “pesticide” means
- Be able to list different CPA types
- Know which pests the CPAs are effective against
- Know what a biopesticide is

ACTIVITY: Interactive discussion on what pesticides are and the types of pesticides



20 minutes



Farmers who have not had prior training on pesticides and RPU



Classroom

MATERIALS

- Flip chart and markers

PROCEDURES

For each of the questions below, lead an interactive discussion, writing the participants answers in one column of a flipchart.

First, start with the question **“What is a pest?”**

Ask the group for examples. Write their examples in the first column. Explain this definition after a few responses have been given: **A pest is “Any harmful, noxious, or troublesome organism. Pests include weeds, insects, fungi, bacteria, viruses, rodents, or other plants or animals”**

Then ask, **“In your opinion, what is a pesticide/CPA?”** (In the discussion, use the term which is most familiar to farmers.) Ask for examples of types of CPAs.

Write the answers in a second column as the same flipchart used above.

Then explain that a pesticide is **“an agrochemical that is used for crop protection to prevent, destroy, repel or control pests such as insects, diseases and weeds.”**

Finally, ask **“What is a bio-pesticide?”**

Explain that bio-pesticide is **“a type of pesticide derived from plants or animals.”** Bio-pesticides include fungi, bacteria, viruses, nematodes, plant-derived chemical compounds and insect pheromones. Some bio-pesticides (for example, nicotine and *Tephrosia*) can be very toxic. Commonly used bio-pesticides include neem tree extracts (*Azadirachta* spp.), *Pyrethrum*, and extracts from garlic or chili.

Once the facilitators have defined “pests” and “pesticides”, they can continue by explaining that there are different pesticide types for each type of pest. Take a pen and on the flipchart used above draw a line between each pest and its associated pesticide. Again, make this interactive and ask the participants to help brainstorm types of pests and the pesticides that work against them.

Table 4. Types of pesticides and the pests that they are active against

Pesticide category	Activity
Attractant	Attracts pest animals
Fungicide	Fungus disinfection
Fumigant	Gas or smoke against pests or fungi in storage products
Herbicide	Kills or inhibits growth of weeds
Plant Growth Regulator	Modifies the rate of growth or maturation of plants
Insect growth regulator	Modifies insect development stages or growth
Insecticide	Kills or harms insects (e.g. aphids)
Miticide or acaricide	Kills or harms mites (or spiders)
Molluscicide	Kills snails and slugs
Nematicide	Kills nematodes
Repellent	Keeps away pest animals
Rodenticide	Kills rats, mice, rodents

QUESTIONS FOR DISCUSSION

- Q What pesticides do the farmers use in their fields?
- Q What types of pests do the pesticides work against?
- Q What types of pesticides are they (i.e. insecticides, fungicides)?

ACTIVITY: Pest and pesticide matching



45 minutes



Farmers who have not had prior training on pesticides and RPU



Classroom

MATERIALS

- Pictures of major pests (e.g. hornworm, budworm) or pest damage symptoms (e.g. diseased plants or leaves with flea beetle damage)
- CPA containers or pictures of containers which are allowed for use

PROCEDURES

Have enough pictures and containers so that half of the group can have a picture of a pest and the other half of the group can have a pesticide container (or a picture of the pesticide). The pictures should be of pests and pesticides that the farmers will be familiar with.

Distribute the pictures and pesticide containers. Tell the participants to look for their “match” (i.e. participants holding pictures of pesticides should find at least one person holding a picture of a pest that the pesticide works against; participants holding pictures of pests should look for people holding pesticides that are effective against the pest). Once everyone has a partner, ask the pairs to form groups by pesticide type (i.e. all fungal diseases and fungicides should group together; all insects and insecticides should group together).

TOPIC

What's in a pesticide?

Rationale: Many farmers and field technicians do not have a good understanding of what CPAs are made of nor are they familiar with some of the key terminology which is necessary for making informed decisions when it is time to buy or apply a pesticide. As a consequence, they may inadvertently buy the wrong formulation. For example, they may purchase formulations which contain mixtures of recommended active ingredients with active ingredients that are allowed and prohibited.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Generally understand what pesticides are made of
- Understand key terminology such as “active ingredient”
- Be able to define what a formulation is
- Understand why active ingredients are formulated
- Know what the common types of formulations are and know how to interpret the abbreviations used to describe formulations
- Understand the advantages and disadvantages of common types of CPA formulations
- Understand the importance of active ingredients and formulations for informed decision-making when selecting CPAs

ACTIVITY: Interactive discussion on “What's in a pesticide?”



40 minutes



Field technicians and farmers who need to gain a better understanding of pesticide terminology



Classroom

MATERIALS

- Flip chart and markers
- Pesticide containers
- Poster displaying information on what is in a pesticide

PROCEDURES

For each of the points below, lead an interactive discussion, writing terms and definitions on the flip chart paper as you progress.

Active ingredients: Begin by asking the participants if they know what an active ingredient is. Have some pesticide

labels available and have them look at the ingredient statement.

- What is an active ingredient?
 - An active ingredient (a.i.) is the chemical that is active against the target pest (e.g. kills, repels, limits growth, etc.)
 - Explain that there are hundreds of chemicals that are active ingredients.
 - A single a.i. may be sold in many different formulations
- What are inert ingredients?
 - Have no activity against the pest
 - Allow the chemical to be handled, stored and applied more easily and safely.
 - Inert ingredients are not disclosed (i.e. we don't know what they are) and in some cases may be more toxic than the active ingredient. However, in most countries they are not regulated.
- What's in a pesticide?
 - a.i. + inert (or other) ingredients = pesticide formulation

Formulations: Next ask the participants if they know what a formulation is. Explain what formulations are.

- What is a formulation?
 - A pesticide formulation consists of the active ingredient (the chemical that does the work or killing the pest) combined with several other chemicals that are inert ingredients.
- Why formulate?

Explain that combining the active ingredient with inert ingredients helps to:

- **Make the pesticide easier to use.** It makes the a.i. easier to manipulate, mix with water, transport, etc.
- **Make the pesticide safer to use.** There is less chance of farmers touching or coming into contact with the toxic part of the pesticide
- **Make the pesticide more effective,** e.g. some added components help the pesticide to 'stick' to the leaves and not run-off onto the ground
- **Increase the length of time the pesticide can be stored.** Some components slow the breakdown of the active ingredient.
- Adjuvants (or Additives):

Explain that adjuvants are chemicals that are added to pesticide formulations to improve performance of the product but they are not active against the target pest.

- Sometimes the adjuvants are part of the formulation, but sometimes they need to be added separately (depending on label instructions).
- Adjuvants include spreaders, stickers, thickeners, pH buffers, plant penetrants, wetting agents, or foaming/defoaming agents.
- You must follow label instructions for adjuvants. Sometimes they are prohibited for use with a particular pesticide and using one will be risky.

Examples of Adjuvants (or Additives):

Emulsifiers: Help emulsifiable concentrates mix better with water.

Wetting agents: Help wettable powders mix better with water, and help formulations spread on water repellent surfaces.

Stickers: Help the spray mix stick to surfaces.

Spreaders: Help the spray mix spread evenly over treated surfaces.

Penetrants: Enhance the adsorption of systemic pesticides.

Concentration:

Explain that it is also important to understand the concentration of a formulation. Ask the participants if they know what is meant by “concentration”?

- Concentration refers to the amount of the active ingredient in the formulation.
 - ▶ Weight per unit volume: (e.g. 500 g/L)
 - ▶ Percentage by weight (e.g. 40% WP)

Types of Formulations: Explain that pesticides are available in many different forms for example:

- **Liquid** formulations (e.g. emulsifiable concentrates, solutions, liquid flowables)
- **Solid (dry)** formulations
 - Dry sprayable (e.g. Wettable powders)
 - Dry spreadable- (e.g. granules)
- They can also be in the form of living organisms (e.g. bacteria in Bt and other bio-pesticides). Explain that as with chemical insecticides, the active ingredient in bio-pesticides is the living organism (or component that have been extracted from it) which is combined with other chemicals so it can be applied as a pesticide.

Ask the participants for examples of formulation types and record them on a piece of flip chart following the format used in Table 5. As the discussion progresses, show the farmers examples of each of the different types of formulations.

Table 5 List of common formulation types, grouped by physical state, application state and diluent

Physical state	Application state	Diluent	Formulation type	Abbreviations
Solid (Dry)	Solid	Carrier	Dustable powder or dust	DP
			Granule	GR
			Microgranule	MG
	Solid		Seed treatments	S
	Solid	Bran, grain	Bait concentrate	B
	Gas	Air	Smoke, fumigant or gas	F
	Liquid	Water	Wettable powder	WP
Soluble or dispersible powder			SP	
Soluble or dispersible granule			SG/WG	
Liquid	Liquid	Water	Suspension concentrate	SC
			Emulsifiable concentrate	EC
	Liquid	Oil	Low volume	LV
	Liquid	Undiluted	Ultra low volume	ULV
	Liquid		Aerosol	A

TOPIC

Advantages and disadvantages of common CPA formulations

Rationale: The different types of formulations come with both advantages and disadvantages. These factors should be taken into account when selecting and using a CPA. They will have a bearing on the PPE required, the method of application, storage, etc. Farmers should be made aware of these points so that they take them into consideration when selecting and handling CPAs.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn advantages and disadvantages of common pesticide formulations

BACKGROUND INFORMATION

Advantages and disadvantages of CPA formulations are described below.

Liquid Formulations

Emulsifiable Concentrate (EC or E)

EC's usually contain liquid active ingredients (25-75%), one or more petroleum solvents and emulsifiers, which allow the formulation to be mixed with water before spraying. Form milky spray mixtures when mixed with water.

Advantages	Disadvantages
Easy to handle, transport and store	Usually high concentration of active ingredient; therefore need to be carefully measured, mixed and calibrated
Easy to measure and mix with water	Solvents can cause rubber and plastic sprayer parts to deteriorate rapidly
Little agitation required, does not settle out or separate and sink to bottom of tank	Flammable
Little visible residue on plant treated surfaces	Easily absorbed through the skin
Can be used with most types of application equipment	High phytotoxicity

Flowables (L or FL)

A finely ground active ingredient suspended in a liquid. Mixed with water prior to application. Similar to EC's but easier to handle and use.

Advantages	Disadvantages
Easy to handle and apply. Rarely clog nozzles	Require shaking before pouring and mixing May leave visible residues on sprayed surfaces

Soluble Concentrate (SL)

Liquid formulation with active ingredient dissolved in water.

Advantages	Disadvantages
Do not plug strainers and filters	Some that are dissolved salts can be corrosive to skin

Suspension Concentrate (SC)

Non-soluble active ingredient suspended in water to form liquid formulation. Need to be diluted with water before use. Combine benefits of ECs and WPs

Advantages	Disadvantages
Easy to transport, handle and store Easy to mix with water Can be used with most types of application equipment Generally less phytotoxic than ECs Dissolve in water, no constant shaking required.	Container must be shaken before use Spray nozzles and filters can be blocked Inert carriers may leave visible residues on sprayed surfaces Require moderate shaking of the spray tank regularly to prevent active ingredient from sinking to bottom

Ultra Low Volume (ULV or UL)

Pesticides in liquid form, designed to be used as is or diluted with small quantities of carrier. The concentration is usually close to 100% of active ingredient.

Advantages	Disadvantages
Easy to transport, handle and store Don't need to dilute product with oil or water Little agitation required Don't plug screens or filters Little visible residue on sprayed surfaces	Specialised equipment required High drift hazard due to small droplet size. Easily absorbed through skin Solvents can cause rubber and plastic sprayer parts to deteriorate rapidly Need to carefully calibrate and apply due to high concentration of active ingredient.

Dry or Solid Formulations

Dust or Dustable Powders (D)

A powder applied to crops in dry form. Usually low concentration of active ingredient.

Advantages	Disadvantages
<p>Ready to use, usually don't require mixing</p> <p>Can be applied with simple equipment. Water and spray equipment not needed</p> <p>Effective in water scarce situations and hard to reach indoor areas.</p>	<p>Dusty, need to wear mask to avoid inhaling when pouring and mixing</p> <p>Can leave visible residues on treated surfaces</p> <p>Drift</p> <p>Usually need to use large quantities due to low concentration.</p> <p>High transport costs</p> <p>Can be washed away by rains</p>

Wettable Powder (WP)

WP's are dry finely ground powders that need to be mixed with water before use. WP's do not dissolve in water and therefore sink quickly. Usually contain 50% or more of active ingredient.

Advantages	Disadvantages
<p>Easy to transport, handle and store</p> <p>Relatively cheap</p> <p>Easy to measure and mix with water</p> <p>Can be used with most types of application equipment</p> <p>Less phytotoxic than ECs</p>	<p>Dusty, need to wear mask to avoid inhaling when pouring and mixing</p> <p>Need to shake the spray tank regularly to prevent active ingredient from sinking to bottom of sprayer (making the solution less effective)</p> <p>Can block spray nozzles and filters</p> <p>Inert carriers may leave visible residues on sprayed surfaces</p> <p>Can cake in storage</p>

Water Soluble Powder (WSP or SP)

Active ingredient is a powder that needs to be mixed with water before use. Looks similar to WPs, but dissolve easily in water to form solution. Need to be mixed thoroughly initially, but then no additional shaking is required. Active ingredient varies from 15% to 95%.

Advantages	Disadvantages
<p>Easy to transport, handle and store</p> <p>Relatively cheap</p> <p>Easy to measure and mix with water</p> <p>Can be used with most types of application equipment</p> <p>Less phytotoxic than ECs</p> <p>Dissolve in water, no constant shaking required.</p>	<p>Dusty, need to wear mask to avoid inhaling when pouring and mixing</p>

Granules or Grains (G or GR)

Similar to dusts, except larger and heavier. Usually applied to the soil. Usually low concentration of active ingredient, ranging from 1-15% by weight.

Advantages	Disadvantages
<p>Ready to use, usually don't require mixing</p> <p>Applied to soil, doesn't stick to foliage</p> <p>Lower drift risk compared to dusts due to heavier particles</p> <p>Simple application equipment can be used (e.g. spreader or seeder)</p> <p>Slow release of active ingredient provides extended protection</p>	<p>May need to be incorporated into the soil</p> <p>May need moisture to activate</p> <p>Hard to get even coverage</p> <p>Slow release increases persistence</p> <p>Can be hazardous to non-target animals (e.g. domestic animals) which may confuse granules with food</p> <p>Do not stick to foliage</p> <p>More expensive than WPs or ECs</p>

Baits (B)

Active ingredient is mixed with food or other substance meant to attract pest.

Advantages	Disadvantages
Ready to use Little needed as pests move to the bait.	Can be hazardous to non-target animals (e.g. domestic animals or children) who mistake it as food Pests may avoid bait

Other Types of Formulations

Seed Dressings (DS, ES, FS, LS, PS, SS, WS)

Can be liquid or solid formulations. Often contains dye. Dry formulations don't require dilution (except SS). Liquid formulations require dilution with water.

Advantages	Disadvantages
Easier to identify treated seed due to dye Can be applied on-farm using simple equipment. Some types are similar to EC, WP and SC formulations	Protective gloves must be used when applying. Treated seed may be eaten by domestic animals, wildlife or humans. Some types are similar to EC, WP and SC formulations

Fumigants (F)

Pesticides that form a gas when applied. Generally used for soil pests, or in food storage facilities.

Advantages	Disadvantages
Highly effective against a wide range of pests. Usually only one application needed Can easily move through soil or cracks in walls, wood or grains.	Usually extremely toxic to humans and all other organisms. Need special training to use. Special equipment and protective clothing required Site where applied (e.g. soil or building) must be covered to prevent gas from escaping

Attractants

Include pheromones, sugar and protein syrups, yeasts, and rotting meat used in various types of traps. Can be combined with pesticides and sprayed onto foliage or other things in area to be treated.

ACTIVITY: Advantages and disadvantages of different pesticide formulations



40 minutes



Field technicians and farmers who need to gain a better understanding of pesticide terminology



Classroom

MATERIALS

- Flip chart and markers
- Factsheet on the advantages and disadvantages of different pesticide formulations
- Tables for group work

PROCEDURES

In this activity, participants will reflect on the advantages and disadvantages of different types of pesticide formulations.

Begin by explaining that there are many different types of formulations (>60!), but this activity will focus on 8 of the most common formulation types.

Break the farmers into small groups. Assign each group one formulation from the common types of formulations covered in the Factsheet “Advantages and Disadvantages of Formulation Types”. Facilitators should select commonly used formulations for this activity, such as:

- Emulsifiable Concentrate
- Flowables (L or F or FL)
- Wettable Powder
- Suspension Concentrate
- Soluble concentrate
- Dust
- Granule
- Bait
- Fumigant

Explain that each type of formulation given to each group has advantages and disadvantages for storage, mixing, application and safety. Have the participants agree as a group on all these advantages and disadvantages. Allow 15 minutes for the task

After 15 minutes, ask one table to give their answer. Ask the other groups if they agree or have any other advantages or disadvantages to add. Repeat for each table group.

Use the background information on advantages and disadvantages of formulation types to cover any points missed by the participants.

QUESTIONS FOR DISCUSSION

- Q On the basis of what we have covered on formulations, what types of formulations do participants think are most suitable for farmer use? Why?
- Q What types of formulations would be best in an IPM programme?
- Q What types of formulations are most commonly used by local farmers?
- Q Are these the most suitable?
- Q Would a different type of formulation of the same active ingredient be more suitable for farmers? Are such alternatives available?

OTHER POTENTIAL KNOWLEDGE TRANSFER METHODS

If there is no time for the activity on *Advantages and Disadvantages of different pesticide formulations* described above, give a brief explanation of different formulations and the advantages and disadvantages of each. Review the handout/poster/factsheet with participants.

ACTIVITY: Game to group together by active ingredient and formulation type



45 minutes



Field technicians and farmers who need practice applying pesticide terminology



Classroom

MATERIALS

- CPA containers or pictures of labels clearly showing active ingredients and formulations. If relevant in the region, have examples with more than one active ingredients and examples of the same active ingredient in different formulation types
- A sheet for the facilitators listing the groupings for active ingredients and formulations as well as the number of examples of each. This will help facilitators to verify the groupings.

PROCEDURES

In this exercise, different pesticide containers or pictures of containers will be distributed to each of the participants. Have the participants look at the information on the label.

Then tell the participants to look for the other participants who are holding examples of pesticides with the same type of active ingredient. Take note of how participants with pesticides with more than one type of active ingredient have grouped themselves. Have they formed a separate group or are they in groups with one of the constituent a.i.? Ask the participants to explain the reasons for their choice.

Next, the facilitators should confirm the groupings.

Then the facilitators should ask the participants to form new groups based on formulation type.

QUESTIONS FOR DISCUSSION

- Q Do pesticides with the same active ingredient always have the same formulation type?
- Q Why might this matter?

TOPIC

How do CPAs work?

Rationale: Many farmers and field technicians do not have a good understanding of key terminology which is necessary for making informed decisions when it is time to buy or apply a pesticide.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be able to group CPAs based on functionality, i.e. type, mode of action, chemical family
- Be able to explain what mode of action is and why it is important
- Understand what chemical families are and why they are important
- Be able to define CPA specificity and differentiate between broad spectrum and selective CPAs, understand the implications of each
- Understand how insecticides, fungicides and herbicides work
- Be able to make informed decisions based on these groupings to select the right CPA for a given pest

BACKGROUND INFORMATION

Pesticides can be grouped several ways:

- By the types of pests they control
- By the way they work (their mode of action)
- By their chemical family
- By specificity

Type of Pesticide

Pesticides are most commonly grouped by the types of pests they control. Common types of pesticides and their targets are given in Table 6. (Review with participants the flipchart that was made earlier that explains different types of pesticides and target pests).

Table 6 Types of pesticides grouped by the pests they control

Type of Pesticide	Target Pest
Fungicides	Fungi
Insecticides	Insects
Herbicides	Plants (weeds)
Nematicides	Nematodes
Rodenticides	Rodents
Acaricides/Miticides	Spiders, mites
Molluscicides	Snails, slugs
Bactericides	Bacteria
Algicides	Algae
Avicides	Birds
Piscicides	Fish

Bio-pesticides: the type of pest targeted by bio-pesticides varies and is dependent on the active ingredient of the bio-pesticide.

Mode of Action (or site of action)

What is mode of action?

- Mode of action is the way or method in which the pesticide kills or controls the target pest.
- Chemicals and biopesticides with the same mode of action attack pests using the same method. (e.g. Organophosphate insecticides attack the nervous system)
- Mode of action refers to the biochemical effect on the pest (e.g. neurotoxins)

Why is mode of action important?

- Helps you assess which pesticide you should use
- Gives information on which beneficial / non-target organisms might be affected
- Resistance management - don't use pesticides with the same mode of action against the same pest repeatedly in the same season.

Chemical Family

A chemical family is a group of pesticides with a similar chemical structure and properties. Pesticides in the same chemical family often have similar modes of action, poisoning symptoms, and persistence in the environment, as well as similar first aid, clean-up and safety guidelines.

Knowing chemical families will help you:

- Select the proper pesticide
- Decide on the personal protective equipment needed
- Understand the handling precautions for each product

Common pesticide chemical families are listed in Table 7.

Table 7 Examples of common pesticides families (CPAs recommended by PMI are in bold)

Chemical family	Active Ingredient
Insecticides	
Carbamates	aldicarb, carbaryl, carbofuran, methomyl, pirimicarb
Organophosphates	dimethoate, chlorpyrifos, malathion
Neonicotinoids	imidacloprid , acetamiprid, thiamethoxam
Pyrethroids	lambda cyhalothrin, deltamethrin, bifenthrin
Spinosyn	spinetoram, spinosad
Avermectins	abamectin, emamectin benzoate , lepimectin
Indoxacarb	indoxacarb
Herbicides	
Thiocarbamates	triallate, EPTAC, butylate
Glycines	glyphosate, sulfosate
Acetamide	napropamide
Isoxazolidinone	clomazone
Fungicides	
Dithiocarbamates	maneb, mancozeb , metiram, thiram
Carbamates	iodocarb, propamocarb , prothiocarb
Methoxy-acrylates	azoxystrobin , flufenoxystrobin
Acylalanines	metalaxyl, metalaxyl-M , benalaxyl, benalaxyl-M

Specificity

What is specificity? Some pesticides are effective only against a specific pest or diseases and others are toxic to many species and also kill insects, microorganisms, animals and plant species that are not pests.

- **Broad Spectrum:** Many pesticides are less specific or non-specific. Those can kill a variety of insects, microorganisms, animals and plant species
- **Selective:** the selective pesticides are more effective against one type of insect. For example, effective against flea beetles but harmless to bees

Take home message: In an Integrated Pest Management (IPM) programme, it is recommended to use selective pesticides whenever possible.

ACTIVITY: Bioassay for specificity testing



1 hour to start, and follow up at 4, 8 and 24 hours



Field technicians and farmers who benefit from learning more about specificity and the effects of pesticides on the survival of natural enemies



Tobacco field and place to store the “bioassay” (mini-experiment)

MATERIALS

- A tobacco farm, preferably unsprayed
- Plastic bags and small containers to collect insects
- Small soft brush
- Tissue paper
- Tobacco leaves
- 4 buckets (preferably transparent)
- 4 pieces of muslin or mosquito screen cloth with rubber bands, to cover the buckets
- Labels
- Marker
- Notebook and pen
- 4 small hand sprayers (0.5 l), shared between groups
- Water
- Small amounts of different insecticides (including broad spectrum and selective, if possible, a bio-pesticide and botanical e.g. neem)
- Gloves and masks
- Handout with pictures

PROCEDURES

Farmers may not be aware of the disadvantages of using chemical broad spectrum pesticides. They may not know that in addition to the target pest, pesticides kill beneficial organisms such as natural enemies and antagonistic fungi.

Prepare 4 hand sprayers before the session. If a sprayer has been used before, wash it thoroughly with soap. Fill the first hand sprayer with water. This will be a control. Prepare and fill 3 hand sprayers with commonly used pesticides at field rate concentration (note: good to select both broad spectrum and selective pesticide to show difference between the two). Use gloves and masks. Label the hand sprayers to avoid confusion.

Collect several tobacco leaves (3 per spray treatment). Spray each set of leaves with a selected spray solution and let the leaves dry. Use gloves and masks. (note: if tobacco leaves are not available, can use leaves from other crop)

Transfer the dried leaves to the buckets (one leaf per bucket) using gloves. Label the buckets. Divide participants into 4 groups. Each group should have one bucket of each spray treatment (4 buckets in total). Try to get the leaves to lie flat on the inside surface of the bucket.

Have participants collect pests (for example, thrips or leaf eating caterpillars), predators (for example, spiders or syrphid larvae) and unknowns or neutrals from the tobacco farm. Try not to touch the insects by using brushes to collect them in jars or bottles. Carefully transfer them to the treatments so that there is at least one of each species per bucket. For each bucket, take note of the number of individuals inside. If possible, use the same insect species in all treatments and make sure they are of similar size. Cover the bucket with the muslin/mosquito screen cloth and secure with a rubber band.

Check and record the conditions of the insects hourly after 4 hours, after 8 hours and after 24 hours. Count the number of dead insects. It may be necessary to touch the insect with a pen or pencil to determine if it is dead. If it does not walk off in a normal manner, then record it as dead.

QUESTIONS FOR DISCUSSION

- Q What happened to the insects in the different jars? Why?
- Q Did you observe any differences in the behaviour of the insects?
- Q Which of the insects would you prefer on your farm? Why?
- Q What happens in the field when a farmer sprays against a certain pest?
- Q What will happen in a field 1, 2, 3 weeks after spraying?
- Q What other options do you have, besides the spray solutions tested, to manage tobacco pests, while conserving natural enemies?

ACTIVITY: Interactive discussion to delve deeper into insecticides, fungicides and herbicides



40 minutes



Field technicians and farmers who need to gain a better understanding of how pesticides work



Classroom

MATERIALS

- Flip chart and markers
- Pesticide containers
- Examples of local Green and Yellow Lists (optional)

PROCEDURES

For each of the points below, lead an interactive discussion, writing terms and definitions on the flip chart paper as you progress.

Insecticides

Insecticides are classified by:

- Mechanism of action or exposure routes
- How insecticides move or reach target pest

Explain that different insecticides have different mechanisms of action and exposure routes (i.e. how the insecticides are taken up by the insect). Describe the different types of insecticide modes of action.

- **Direct contact:** the pest comes into direct contact with the spray; the insecticide is then absorbed through the 'skin' or cuticle of the insect and kills it
- **Secondary contact:** the pest comes into direct contact with the spray deposit on a leaf; the insecticide is then

absorbed through the 'skin' or cuticle of the insect and kills it

- **Ingested:** the pest feeds on plants that have been sprayed with insecticide; the insecticide travels into the insect's digestive system and kills it.
- **Repellency:** contact with the spray deposit does not kill the insect, but causes it to move away from the treated area
- **Fumigant:** The spray deposit emits a 'gas' which kills the insect or causes it to move away from the treated area

How insecticides move or reach target pest

Ask the farmers if they know the difference between contact and systemic insecticides

- Contact and ingestion insecticides:
 - Kill the pest upon contact or ingestion
 - The spray only acts where it lands (the insect must move to it and, for CPAs with stomach action only, the insect must feed on plants which have been treated)
 - Therefore a thorough and even spray coverage on the foliage is necessary

Ask the farmers if they know of any examples from the local Green and Yellow Lists. Potential examples include:

CPAs which should be ingested include spirotetramat (e.g. Movento) or *Bacillus thuringiensis* (e.g. Dipel)

Contact CPAs such as spinosad (e.g. Tracer or Blackhawk) or indoxacarb (e.g. Steward 150 EC)

- Systemic insecticides:
 - Absorbed into the plant tissues from where they land, they are then moved about in the plant.
 - May be applied to the soil and taken up by roots or applied to leaves (foliage) and transported.
 - Insects will be killed when they feed anywhere on the plant.
 - Bigger droplets, smaller in number, can be dispersed over the crop, which makes treatment easier and less costly.

Ask the farmers if they know of any examples from the local Green and Yellow Lists. Potential examples include:

CPAs containing imidacloprid such as Confidor SL or Admire

CPAs containing emamectin benzoate such as Denim

CPAs containing thiamethoxam such as Actara 25 WG

Fungicides

Fungicides can be grouped based on different characteristics

- Mobility in plant
- Role in protection
- Breadth of activity

Mobility in plant

- Contact fungicides
 - Not absorbed by the plant, remain on surface of plant
 - Prevent fungal spores from germinating on the leaves where they land
 - ▶ Must therefore be applied evenly and thoroughly to the foliage before disease attack in order to be effective.
- Systemic fungicides
 - As with systemic insecticides, these are absorbed and moved about in the plant
 - Protect plant by killing the germinating fungal spores when they start to grow into the leaf.
 - Not as susceptible to weather as surface protectants but more susceptible to resistance

Role in protection

Fungicides are described as *preventive* or *curative*.

Ask the farmers if they know what the difference is between preventive and curative fungicides:

- Preventive
 - Not absorbed by the plant
 - Prevent fungal spores from germinating on the leaves where they land
 - Must therefore be applied evenly and thoroughly to the foliage before disease attack in order to be effective.
 - Generally contacts
 - Repeated applications are needed to protect new growth of the plant and to replace material that has been washed off by rain or irrigation, or degraded by sunlight
 - Sometimes referred to as 'residuals' because residues remain on plant surface

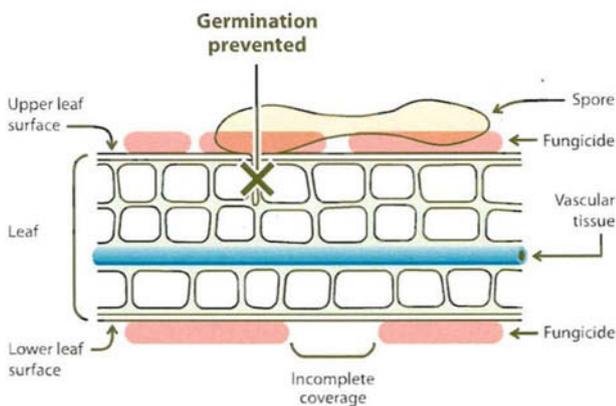


Figure 4 Illustration of how a preventive fungicide works (Source: www.agr.gc.ca, Agriculture and Agri-Food Canada, Publication 10203E. This figure is a reproduction of an official work that is published by the Government of Canada and has not been produced in affiliation with, or with the endorsement of, the Government of Canada.)

Ask the farmers if they know of any examples from the local Green and Yellow Lists. Potential examples include:

CPAs containing Propamocarb such as Previcur

CPAs containing mancozeb such as Dithane 75 DF

CPAs containing dimethomorph such as Acrobat

CPAs containing copper oxychloride such as Cobre Atar BR

- Curative (or Eradicants)
 - Directly attack pathogens after they have invaded plant tissue
 - Protect plant by killing the germinating fungal spores when they start to grow into the leaf.
 - Mainly systemic- these are absorbed and moved about in the plant

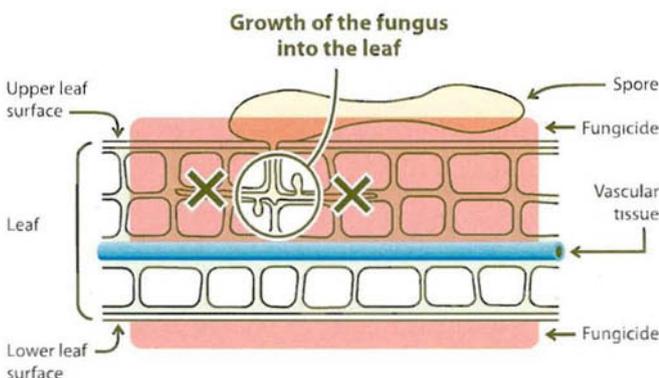


Figure 5 Illustration of how a curative fungicide works (Source: www.agr.gc.ca, Agriculture and Agri-Food Canada, Publication 10203E. This figure is a reproduction of an official work that is published by the Government of Canada and has not been produced in affiliation with, or with the endorsement of, the Government of Canada.)

Ask the farmers if they know of any examples from the local Green and Yellow Lists. Potential examples include:

CPAs containing azoxystrobin such as Quadris

CPAs containing Metalaxyl-M such as Ridomil Gold

Breadth of activity:

- Single-site action
 - Highly specific in their toxicity (only attack one site in a pathogen)
 - More prone to resistance
 - Usually systemic
- Multi-site action
 - Affect many fungi
 - Mostly contact

Take home message: Explain that there are not many fungicides that are able to control an existing infection, so most treatments are preventive. Also, fungicides are often very specific to particular groups of fungi.

Herbicides

Herbicides differ by their:

- Mode of action
- Pest or crop selectiveness (Selectivity)
- Timing of application

Herbicide mode of action

- Contact herbicides:
 - Only kill plant parts that make contact with the product. Have little or no movement (translocation) within the plant.
 - Most effective when applied to small young weeds
 - Usually unsuitable for the control of perennial weeds. The chemical only “burns off” the tops of the plant. Roots can still produce new top growth.

Examples of contact herbicides: *Paraquat*

- Systemic herbicides:
 - Enter the plant via roots or leaves. Move through the plant by translocation. This kills the whole plant.
 - May not show control effects for a week or more after treatment.
 - Do not work as well if too much product is applied to the leaves. Leaf cells can die too quickly and prevent translocation.
 - Can be used to treat annual, perennial, and biennial weeds.

Examples of systemic herbicides: *clomazone, fluazifop-P-butyl, napropamide*

Herbicide Selectivity

All herbicides are also either:

- **Selective** – Kill certain types of plants (e.g. broadleaf or grass weeds). The weed plants are controlled, but the crop plants among which they are growing, are left unharmed
- **Non-selective** – Kill all plants which they land on

Examples of Selective herbicides: *fluazifop-P-butyl* (*non-phytotoxic to broad-leaved crops*)

Examples of non-selective herbicides: *glyphosate*

Herbicide Timing of Application

Herbicides can be grouped by the timing of their application for best effect. Explain that herbicides are usually foliar applied or soil applied.

- Pre-plant
 - Applied and mechanically mixed into the soil before seeding or transplanting the crop
 - Mostly non-selective herbicides

Examples of pre-plant herbicides: *Clomazone*, *sulfentrazone*

- Pre-emergence
 - Applied to the soil or via irrigation after planting but before weeds emerge through soil surface
 - Absorbed by the roots and/or shoots of the weeds as they germinate or begin to grow
 - Mostly all systemic (absorbed by the plant and translocated)

Examples of pre-emergent herbicides: *Clomazone*, *napropamide*

- Post-emergence
 - Sprayed directly onto weeds (foliar applied) after they appear (have broken soil surface)
 - Can be applied soon after emergence, or when a given plant height or leaf number is reached
 - Mostly contact (kill plant tissue upon contact), but can also be systemic

Examples of post-emergent herbicides: *fluazifop-P-butyl*

Some herbicides can be applied as pre-plant, pre-emergence, or post-emergence treatments.

ACTIVITY: Game to group together by insecticides, fungicide, and herbicides



45 minutes



Field technicians and farmers who need practice applying pesticide terminology



MATERIALS

- CPA containers or pictures of labels clearly showing active ingredients. If relevant in the region, have examples with more than one active ingredients and examples of the same active ingredient in different formulation types (Note to trainers: Need to include lots of different types of chemicals, but also chemicals that can be grouped in order for this activity to work)
- Handouts on chemical families and modes of action

PROCEDURES

Working in small groups, ask the participants to group all of the pesticides they have in front of them into groups based on:

- Type (e.g. insecticide, fungicide, herbicides, etc.)
- Mode of Action
- Chemical Family
- Contact vs. Systemic

The team to arrange the CPAs correctly first wins the game.

QUESTIONS FOR DISCUSSION

- Q Do chemicals with the same active ingredient always have the same mode action?
- Q Why is mode of action important?
- Q Why is chemical family important?
- Q Do the grouped CPAs share any other characteristics which would be important considerations when choosing a CPA, e.g. selectivity?

TOPIC

Legislation, key regulations and contractual obligations related to CPA life cycle management

Rationale: Farmers (and sometimes field technicians) are not always aware of the regulations that are in place for CPA management and use. Likewise, they may not be aware of why these regulations are in place and how these relate to practices that are required by the leaf supplier.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Consider the different stages of a CPA life cycle
- Become aware of regulations and contractual obligations that have a bearing on each stage of the CPA life cycle
- Consider how these regulations impact which CPAs farmers may use and how they use them, store them, etc.
- Be aware of the consequences of failing to meet these requirements.

BACKGROUND INFORMATION

A CPA's "life cycle" refers to all of the stages a CPA might pass through from production to its degradation in the environment after use, or its destruction as an unused product (FAO 2014). The life cycle of a CPA includes manufacture, formulation, packaging, distribution, storage, transport, use and final disposal of the CPA and its container (FAO 2014). Regulations and/or company policies tend to regulate each step in the life cycle of a CPA in order to reduce risks to human health and the environment posed by CPAs. Facilitators who lead this exercise should be familiar with national regulations which are in place for CPA management as well as related company policies. They should also be familiar with consequences of non-compliance. What happens if someone violates the laws or company policies? What penalties could be levied?

ACTIVITY: Exercise on understanding regulations for CPA life cycle management



1 hour



Farmers; field technicians



Classroom

MATERIALS

- Flip charts and markers
- Slips of paper with key regulations/policies for each of the steps in the CPA life cycle (Optional)

PROCEDURES

If the participants are not likely to be at all familiar with the regulations for CPA use and management, facilitators may want to prepare slips of paper which briefly list/explain the main regulations which are in effect for each step in the CPA life cycle. For example, a card which says “Pesticides must be registered” could be relevant to the CPA manufacture or CPA import steps. “Pesticides must be stored in locked cabinets out of the reach of children” could be relevant to CPA storage. One regulation should be listed per card and there should be enough cards for each group to have one card for each regulation.

Divide participants into group of 4-5 people. Each should have a flipchart or a large piece of paper to draw.

Introduce the concept pesticide “life cycles”. Ask the groups to draw/describe the different stages of a CPA life cycle. Monitor their progress to make sure that they have not omitted any key steps.

Once they have developed their life cycles, ask them to write down regulations which are relevant to each step in the life cycle. Alternatively, they could tape the slips of paper with the relevant regulations beside each step that they are associated with. Ask the participants to add any company policies that they are aware of that relate to each of the steps in the CPA life cycle.

Once their analyses have been completed, ask the groups to present their illustrations. Depending on how many groups there are, facilitators can potentially ask each group to present one step and one regulation/policy.

QUESTIONS FOR DISCUSSION

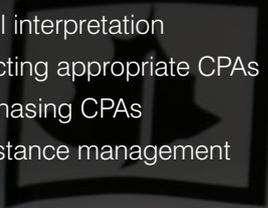
- Q** For each step, ask the presenters what purpose the regulation is intended to serve. Why is it needed?
- Q** Ask whether any key regulation has been omitted by the presenting groups
- Q** Once the full CPA life cycle and related regulations have been presented, ask whether the participants feel that the regulatory framework addresses the major risks. Are there any gaps?
- Q** Whose responsibility is it to address the risks in the CPA life cycle?
- Q** What happens if they do not follow through on this responsibility?
- Q** What consequences might farmers face if they fail to follow the law and/or company policy?

3.3 Selecting CPAs

Many farmers buy their own CPAs directly from retailers who also sell products which are not allowed / recommended for use on tobacco. Even those farmers who receive CPAs in input packs are faced with a decision of what product to use when. This section covers topics to support the selection of appropriate CPAs and for discriminating between products which are recommended versus products which are not. It aims to empower farmers to make appropriate selection of CPAs.

Topics covered in this section include:

- Label interpretation
- Selecting appropriate CPAs
- Purchasing CPAs
- Resistance management



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COPROX SUPER
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TOPIC

Label interpretation

Rationale: Baseline data indicates that many farmers are not always referring to and following labels when selecting and applying CPAs. The label is meant to provide the user with all the essential information about the product and how to use it safely and effectively. This training topic looks further into the information on the label with the aim of empowering farmers to actively make use of the information.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand what is on a pesticide label and what the terms mean, as well as why it is important to understand this.
- Be able to find pertinent information on the primary and secondary display panels.
- Be able to use this information for informed decision-making

ACTIVITY: Interactive discussion on CPA label interpretation



45 minutes



Farmers and field technicians who are not fully able to interpret CPA labels



Classroom

MATERIALS

- Poster displaying the key elements of a CPA label
- Examples of primary and secondary display panels

PROCEDURES

Discuss the following points with the participants, making sure to solicit answers from the group and to encourage them to look at the example materials to see the information themselves.

A pesticide label has two parts:

- The *primary display panel* must be fixed to the container (Figure 6).
- The *secondary display panel* is often a booklet attached to the container



Figure 6 Illustration of information on CPA's primary display panel

Primary Display Panel

- **Trade name** (or Brand name): the name under which the product is sold.
- **Formulation:** the name for the form in which the pesticide is sold. May be printed in full, stated as an abbreviation, or both (e.g. WP or Wettable Powder).
- **Type of pesticide:** Explains the type of pest the product controls (e.g. herbicide, insecticide, fungicide, etc.).
- **Ingredient statement:** Provides the common and/or chemical name and amount of each active ingredient and the total amount of inert ingredients in the container.
- **Active ingredient:** the chemical that is active against the target pest. Listed on the label by common name and/or chemical name and percentage in the product.
 - *Common name:* A simpler name given to a chemical name.
 - *Chemical name:* The complex name identifying the chemical components and structure of a chemical.

An example of pesticide names is:

- ▶ *Chemical name:* N-[1-[(6-chloropyridin-3-yl) methyl]-4,5-dihydroimidazol-2-yl] nitramide
 - ▶ *Common name:* Imidacloprid
 - ▶ *Product names:* Admire, Confidor, Gaucho, Premier, Provado, etc.
- **Concentration:** The concentration of the active ingredient in the formulation (e.g. 17.8 SL = 17.8 g/litre). The concentration may be given in two ways:
 - Weight per unit volume: In this example, 17.8 grams of the active ingredient (*imidacloprid*) is present per litre of product (17.8 g/L).
 - Percentage by weight: For example, imidacloprid is also available in water-dispersible granules (WG) formulation could be stated as “70% by weight”. This means that 700 grams of imidacloprid are present per kilogram of product (or for each 100 parts of pesticide, 70 parts are the active ingredient).
- **Net contents:** the amount the container holds (e.g. 1L or 1 kg)
 - Registration number
 - Colour codes
- **Precautionary symbols and words:** state the hazards of using a pesticide.

Symbols relating to the toxicity and safety precautions for CPA use are also provided on CPA labels. Facilitators should ask the participants if they know what these signs mean. The answers should be revealed one by one as the participants begin to give their answers.

The *Global Harmonised System (GHS) of Classification and Labelling of Chemicals* (2015) has created and designed one universal standard to replace all the diverse classification systems. The GHS provides the infrastructure for participating countries to implement a hazard classification and communication system. The acute toxicity of a chemical has been divided into five classes and shown according to the following symbols and text on the label (Table 8 and Table 9). However, the adoption of the GHS in pesticides is still under consideration by most countries. Presently, different symbols may be found in different countries. In this exercise, training teams should refer the existing symbols used in the country.

Table 8 Classification and labelling of acute toxic chemicals by GHS (Source: *Globally Harmonized System of Classification and Labelling of Chemicals*. 2015. Sixth Revised Edition. United Nations)

Classification			Labelling			Hazard statement codes	
Hazard Class	Hazard category		Pictogram		Signal word		Hazard statement
			GHS	UN Model Regulations ^a			
Acute toxicity	1	Oral			Danger	Fatal if swallowed	H300
		Dermal				Fatal in contact with skin	H310
		Inhalation				Fatal if inhaled	H330
	2	Oral			Danger	Fatal if swallowed	H300
		Dermal				Fatal in contact with skin	H310
		Inhalation				Fatal if inhaled	H330
	3	Oral			Danger	Toxic if swallowed	H301
		Dermal				Toxic in contact with skin	H311
		Inhalation				Toxic if inhaled	H331
	4	Oral		Not required	Warning	Harmful if swallowed	H302
		Dermal				Harmful in contact with skin	H312
		Inhalation				Harmful if inhaled	H332
	5	Oral	No pictogram	Not required	Warning	Maybe harmful if swallowed	H303
		Dermal				Maybe harmful in contact with skin	H313
		Inhalation				Maybe harmful if inhaled	H333

Table 9 Other GHS hazard symbols (Source: *Globally Harmonized System of Classification and Labelling of Chemicals*. 2015. Sixth Revised Edition. United Nations).

Hazard Symbols (to be used in pictograms for substances of the particular class)		
		
Flame over circle – used for these classes: <ul style="list-style-type: none"> • Oxidizers 	Flame – used for these classes: <ul style="list-style-type: none"> • Flammables • Self Reactives • Pyrophorics • Self-Heating • Emits Flammable Gas • Organic Peroxides 	Exploding bomb – used for these classes: <ul style="list-style-type: none"> • Explosives • Self Reactives • Organic Peroxides
		
Skull & Crossbones – used for these classes: <ul style="list-style-type: none"> • Acute toxicity (severe) 	Corrosion – used for these classes: <ul style="list-style-type: none"> • Corrosives 	Gas Cylinder – used for these classes: <ul style="list-style-type: none"> • Gas under pressure
		
Health hazard – used for these classes: <ul style="list-style-type: none"> • Carcinogen • Respiratory Sensitizer • Reproductive Toxicity • Mutagenicity • Aspiration Toxicity 	Environmental hazard – used for these classes: <ul style="list-style-type: none"> • Environmental Toxicity 	Exclamation mark – used for these classes: <ul style="list-style-type: none"> • Irritant • Dermal Sensitizer • Acute toxicity (harmful) • Narcotic Effects) • Respiratory Tract Irritation

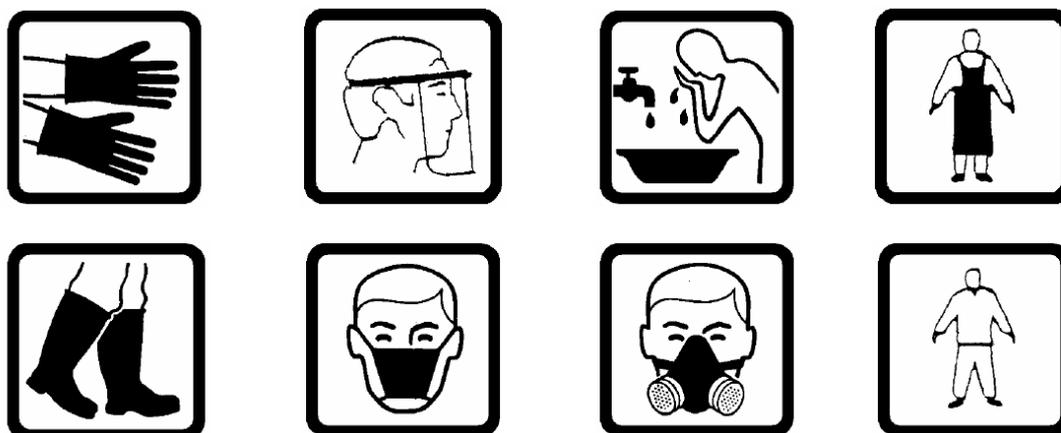


Figure 7 Pictograms appearing on CPA labels which convey key safety information, (Source: *Guidelines on good labelling practice for pesticide*. 1995. FAO, United Nations).

Secondary Display Panel (or booklet)

- Directions for use
 - Pests that can be controlled
 - Crops on which the product can be used
 - Dosage rates
 - Directions for mixing and applying
 - Application equipment needed
 - How to ensure crop safety, and when the product should not be used (e.g. not to be applied when temperatures exceed 25°C)
 - Maximum number of applications
 - ▶ Total number of applications per season can be limited for some products due to the risks of:
 - Food, feed, or soil residues
 - Crop damage
 - Development of pest resistance
 - ▶ The label will sometimes state a maximum number of applications for one field season. The label statement will vary with the product.
 - ▶ Example: “Do not make more than two (2) applications at 0.75 L or one application at 1.5 L per growing season.”
 - When to harvest (pre-harvest interval, days to harvest)
 - ▶ PHI (or pre-harvest interval) - is the time that must pass between the last pesticide application and any use of the crop. This might involve either harvesting or cutting for livestock food.
 - Failure to wait for this period of time can result in pesticide residue levels above the maximum residue limit (MRL) for that crop.
- Safety information
 - Health hazards/Environmental toxicity information
 - First aid instructions
 - Required personal protection equipment (PPE)
 - REI (or re-entry interval) is the minimum time between a pesticide application and the return of workers to a crop area.
 - ▶ This prevents the risk of contamination by working in or walking through a treated area
 - ▶ Many product labels will state the minimum periods which MUST elapse before re-entry.
- **Storage and disposal instructions:** gives directions on how to safely store and dispose of the product and product containers.
- **Notice to buyer (limitation of warranty statement):** states that the buyer accepts all risks of product use. It can also appear as a Seller’s Guarantee that states the seller’s liability as limited to label instructions.

QUESTION FOR DISCUSSION

- Q When should farmers refer to the label and why?

ACTIVITY: The pesticide label says... (Game for label interpretation)



45 minutes



Farmers and field technicians who are not fully able to interpret CPA labels



Classroom

MATERIALS

- Examples of primary and secondary display panels
- Notepads
- Writing utensils

PROCEDURES

To warm up, ask the field technicians / farmers how many of them read the label on a CPA bottle before they use it. If some of them or all of them read the label, follow-up by asking them what information they find on a CPA label. If none of them read the label, ask them why they do not read it.

Ask the participants to form pairs or small groups. Pass out the notepads, writing utensils and CPA labels to each pair or group. Ask the groups to take a minute or two to study them.

Once the participants have had time to read the labels, ask them to answer the following questions:

- What is the trade or brand name?
- What is the active ingredient?
- What is the CPA intended to kill?
- How should the CPA be used or what are the product directions? How much should be applied? How often should it be applied?
- Are there any warning or caution symbols? What do they mean?
- What type of PPE should be used?
- How soon can the crop be harvested after an application?
- When can people and animals re-enter the field following an application?
- How should the CPA be disposed of after use?
- What are the first aid indications?
- What should the farmer do if there is an accident?

Once they have jotted down their answers, ask them to share out loud to the group what they came up with. What additional information did they find on the label?

Conclude the activity by reminding the participants that they should read CPA labels before they buy and apply them.

Remind them that protection of human health and the environment against the harmful effects of CPA is based on: 1) registration of CPAs bought and sold, 2) CPA labels providing the user with safe handling information, and 3) CPAs being used according to the indications on the label in order to achieve effective pest control.

ACTIVITY: Demonstration of the importance of reading the label



20 minutes



Farmers



Classroom

MATERIALS

- CPA bottles or labels (two of the same type)
- Notepads
- Writing utensils

PROCEDURES

Facilitators should begin with a discussion on why it is important that farmers ALWAYS read and follow label recommendations. Points to cover:

- Always read the label, or have the label read to you, to be sure the CPA is safe for your intended use
- Do not buy CPAs if the container is missing a label or the information is illegible/unreadable
- Check manufacturing date and expiration date.
- Check to be sure the CPA can be used on tobacco.
- Look for the PHI, REI, and the maximum number of applications permitted for that crop.
- Read the directions to understand how much of the CPA to use, when and how to apply.
- Always follow the label recommended dosage rate
 - A dose that is too low will not be effective and increases the risk of resistance.
 - A dose that is too high leads to waste and an increase in cost.
 - Further drawbacks include an increased risk of resistance and increased phytotoxicity to plants. There will also be increased risks to human health.

Next, select two volunteers. Give one label/bottle to one participant to read through carefully. This participant can use a notepad to take note of key instructions. This participant should step out of the room.

Show the other CPA bottle to the other volunteer, without allowing him/her to read the label. Ask the participant to explain how to use the CPA.

In plenary, ask the group what were differences between the two sets of instructions. Discuss the differences between how the farmer who did not read the label and how the farmer who did read the label would apply the CPA.

QUESTION FOR DISCUSSION

- Q Why is it important to read CPA labels?
- Q What should a farmer do if he/she cannot read a CPA label?

TOPIC

Selecting appropriate CPAs

Rationale: Many farmers do not know the underlying reasons why one CPA is included in the recommended CPA list and another is not. If farmers view CPAs as being more or less interchangeable, season to season changes in the list of recommended CPA can seem arbitrary. Raising awareness about the favourable characteristics that would merit a CPAs inclusion in the CPA list (e.g. efficacy against target pests, low toxicity, residue, selectivity, registration, PHI, price) and the negative characteristics that would lead to its use being prohibited can help farmers to appreciate the differences between CPAs. This would then enable them to make appropriate selections on their own. Correct pest identification and thresholds are not being considered here as they are covered in other sections.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn which CPAs are recommended for use and why
- Learn which CPAs are not allowed
- Assess the characteristics of each
- Be able to select appropriate CPAs on their own

BACKGROUND INFORMATION

PMI has a list of recommended CPAs for use against insects, diseases and weeds for tobacco crops which it updates on an annual basis by considering factors such as residue issues, toxicity level, chemical group/class, human health hazards, environmental protection, national and international laws, and resistance level etc.

ACTIVITY: Interactive discussion and group work on ‘What can be used and why’



1 hour



Farmers



Classroom

MATERIALS

- Harmonized list of CPAs that are recommended / allowed / distributed (whichever list is most appropriate)
- “Red list” of CPAs that sometimes cause problems (e.g. WHO Class 1 CPAs or non-tobacco CPAs, which are sometimes detected through residue testing)
- CPA containers and / or references such as CPA lists, which describe some of the attributes of the CPAs (have examples or reference material available for both)
- Other relevant reference material which gives an indication of why a CPA might or might not be acceptable, e.g. the list of CPAs which are registered for tobacco in the country and the list of CPAs which are not acceptable to export markets

PROCEDURES

Begin by reminding the participants of some of the reasons that CPAs may not be acceptable e.g. toxicity to humans, impacts on the environment, efficacy, cost, etc.

Next divide the participants into small groups and assign each group a CPA (either one that is allowed or one that is not permitted). The groups should then examine the information available (the label and any other references), and prepare a mini-report on what they discover. In particular, the reports should take note of the following:

- Target pest(s)
- Toxicity of the CPA (e.g. WHO Class or colour code) and other health and environmental information
- PHI, REI
- IRAC, FRAC or HRAC
- Whether or not the CPA is registered for use on tobacco or is acceptable to export markets
- Price

Once the participants have compiled their reports, ask them to present their findings in plenary. After each presentation, ask the group whether or not they think that the CPA should be recommended for use in tobacco and why.

End the session with a clear statement of which of the CPAs are recommended / allowed and which are not. Remind participants of the potential consequences of using non-tobacco CPAs. Emphasise that the appropriate national list of CPAs is the definitive tool for knowing what is allowed for use in tobacco.

Activity: Group work to analyse and select the appropriate CPA



45 minutes



Farmers



Classroom

MATERIALS

- Written case study
- Flip chart
- Writing utensils

PROCEDURES

This activity can be used as a follow-up to the activity on “What to use and why” as a means to put into practice the criteria for selecting CPAs. The facilitator should create two to three case studies, which should describe a certain pest problem in a particular stage of crop that needs to be controlled.

Divide the participants into small groups and assign each group one of the case studies. The groups should then decide which of the CPAs should be selected in each case. A table may be created to tick off certain criteria such as toxicity and target pests (see above list for more examples) and the groups can then prioritise certain CPAs based on these criteria (see below for the table template).

Table 10 Criteria for CPA selection

Pest	CPA Name	Toxicity class	Register	PHI / REI appropriate	Availability	Others	Priority Rank
Pest Name (e.g. aphid)	1.						
	2.						
	3.						

Once the participants have completed the task, ask them to present their findings in plenary and discuss their reasons for prioritising the CPAs they have chosen. The facilitator and the rest of the groups should provide feedback on each group’s choices.

ACTIVITY: Debate on the pros and cons of biopesticides



40 minutes



Farmers and potentially field technicians



Classroom

MATERIALS

- Paper and writing utensils

PROCEDURES

Divide the participants into two groups. One group will present the “pro” case in favour of biopesticides. The second group will present the “con” case against biopesticides. Give each group 10 minutes to prepare their arguments. In formulating their arguments, they should take into consideration all of the selection criteria which have been presented thus far. Each group should select one person to be the group spokesman. Each spokesman will have 10 minutes to present their arguments.

Following the presentation of the main arguments, each group will have 5 minutes to make their rebuttal.

TOPIC

Purchasing CPAs

Rationale: Generally, national and regional governments are responsible for fighting problems such as counterfeit and poor quality CPAs, but government enforcement is sometimes weak and inadequate. In countries where farmers purchase CPAs from largely unregulated retailers, this has been highlighted as an urgent issue. Where regulatory oversight is not strong, farmers need to be aware of potential issues and should be given guidance for recognising counterfeit, adulterated or low quality CPAs so that their choices when making purchases are informed ones that are not based solely on price.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be made aware of the risks associated with the purchase of CPAs of questionable quality
- Learn tips for recognizing counterfeits, illegally imported CPAs and low quality CPAs

ACTIVITY: Buyer beware – interactive discussion and demonstration on the hazards of CPAs of questionable quality



1 hour



Farmers and potentially field technicians



Classroom

MATERIALS

- CPA containers or pictures of containers which are counterfeit, illegally imported or otherwise of low quality
- References regarding local regulations for the packaging and sale of CPAs; local information and data on issues associated with fake and low quality CPAs in the market place
- Flipchart and markers

PROCEDURES

Begin the session by explaining that CPAs should be manufactured according to certain standardised specifications. Poorly produced CPAs or counterfeit CPAs will not conform to the required specifications.

Next, in plenary, brainstorm with the participants a list of issues that can be associated with illegal, fake or low quality CPAs which may be available in market places or some agro-dealer shops. Examples could include:

- CPAs that have been re-packaged may be missing a label, so the instructions for use are missing
- CPAs that have been re-packaged may be adulterated or may not be genuine, so they may not work against the target pest.
- Adulterated products may contain substances which are harmful to the crop, human health or the environment

- Adulterated or mislabelled products may contain CPAs which are not allowed, potentially leading to residue problems
- Products may contain the correct active ingredients but at lower concentrations, leading to low effectiveness and problems with pest resistance.

Ask the group whether any of them have ever encountered any of these problems.

Next, ask the participants to suggest their ideas about which clues they would look for in order to identify CPAs that are counterfeit, illegally imported or potentially of poor quality. Fill in any gaps. Often there will be regulatory measures for assuring CPA quality. If participants are not familiar with the regulations, then make sure that they are informed. Some examples of clues for spotting issues such as counterfeits are as follows:

- The label is in the wrong language (e.g. where laws stipulate that CPA labels be in a local language)
- Container is missing a label or the information is illegible/unreadable
- Container is open, the seal is broken or the product is leaking
- Manufacturing date and expiration date are missing or the product is expired
- Product is not in its original container
- Container is missing legally required national marks such as a registration number on the label

Once you have brainstormed these lists, show the participants pictures (e.g. slides) or examples of containers of fake CPAs, illegally imported CPAs or CPAs of low quality. For each example, ask them *“What is wrong with this picture?”* Review the answers together.

Wrap-up by urging the participants to avoid buying illegal or counterfeit CPAs by following these tips:

- Buy products from a preferred source (e.g. leaf supplier or cooperative) or from reputable stores or dealers.
- Avoid deals that seem to be “too good to be true”.
- Never buy CPAs that do not have instructions written in the language required by law.
- Ensure the product has a proper label that includes a registration number (in countries where applicable) or any other legally required identifiers.
- Make sure the label clearly identifies the names of the active ingredients.
- Never buy CPAs that are not in their original container.
- Check that the container is in good shape with the seal intact.
- Check that the product has not expired.

COMPLEMENTARY METHODS FOR KNOWLEDGE TRANSFER

- Carry-out a mini-experiment to test the comparative efficacy of counterfeit / low quality products and provided / recommended products. Refer to the activity for specificity testing for more information on how to set up the experiment.

ACTIVITY: Shopping challenge (Game for considering all criteria for CPA selection)



45 minutes



Farmers



Classroom

MATERIALS

- Cards that list a target pest and crop stage (e.g. “aphids in the seedbed” or “hornworm in the field”)
- CPA containers; there should be only one recommended CPA available for each pest/crop stage scenario and there should also be examples of CPAs which would not be allowed for use
- As an option, references such as the harmonised list of CPAs could also be made available

PROCEDURES

Before the session, arrange the CPA containers on a table or shelf.

To begin with, remind the participants of all the topics covered so far about the correct selection of CPAs, i.e. label interpretation, choosing the appropriate CPA and purchasing CPAs. Divide the participants into small groups. Give each group one card listing a pest and a crop stage. Tell the groups to go to the “store” (the table or shelf with the CPAs) and to select a CPA for their problem. It is up to the facilitators to decide whether or not to tell the groups that only one CPA is available that can be used for their target pest at the stage in question. Facilitators should step in and provide support as needed.

Once the groups have made their selections, ask them to present to the rest of the group what they have chosen and why. Make sure that they have taken all of the key points into consideration, e.g. is the CPA effective against the target pest? Is the PHI of the CPA appropriate for the crop stage? Ask each group to give a reason for why they rejected one of the CPAs.

QUESTION FOR DISCUSSION

- Q** What principles did they apply when selecting their CPAs?
- Q** Would they be able to apply these principles to a real life situation?
- Q** In a real life situation, what should they do if an agro-input dealer tries to steer them to a different CPA than the one they intended to buy?

CPA Resistance Management

Rationale: In several countries where tobacco is grown, resistance to certain CPAs is observed to be a problem (e.g. pigweed resistance to glyphosate or insect resistance to indoxacarb). In some countries, interviewed farmers tend not to apply resistance management strategies. In many instances, farmers are not even aware that pests can become resistant to CPAs.

Training on this topic will inform farmers about the issue of CPA resistance and enable them to apply a resistance management strategy in order to avoid the build-up of pest resistance.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand the factors leading to resistance
- Recognise the importance of maintaining CPA effectiveness over time, e.g. with regard to cost, health, residue issues due to increasing dosage, etc.
- Understand the main resistance management strategies sufficiently for participants to be able to apply them

BACKGROUND INFORMATION

Resistance may be defined as “a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a CPA to achieve the expected level of control when used according to the label recommendation for that pest species” (IRAC).

In the field there will be some initially very rare, naturally occurring, pre-adapted insects with resistance genes. Natural selection by a CPA allows these individuals to survive and pass the resistance trait on to their offspring. Through the continued application of CPAs with the same mode of action, selection for the resistant individuals continues so that the proportion of resistant insects in the population increases, while susceptible individuals are eliminated by the CPA. Under permanent selection pressure, resistant insects will begin to outnumber susceptible ones and the CPA will no longer be effective. The speed with which resistance develops depends on several factors, including how fast the insects reproduce, the migration and host range of the pest, the availability of nearby susceptible populations, the persistence and specificity of the crop protection product, and the rate, timing and number of applications made.

Cross-resistance occurs when resistance to one CPA confers resistance to another CPA, even where the pest has not been exposed to the latter product. Cross resistance can often occur between CPAs with the same MoA. Misuse and overuse of CPAs will select for resistant pests, increasing the risk that CPA resistance may evolve.

Elements of a resistance management strategy include the following:

- avoid repetitive and sole use of CPAs with the same modes of action;
- mix or alternate CPAs with an appropriate partner CPA (refer to IRAC, HRAC, and FRAC codes);
- limit number and timing of treatments;
- avoid eradicant use, e.g. fungicides that kill fungi which have already invaded;
- maintain recommended dose rate; and
- use of (and giving preference to) non-chemical methods for pest management.

Wherever feasible, several of these elements should be used together.

To find out the mode of action of a particular CPA, visit the websites of the Insecticide Resistance Action Committee, the Fungicide Resistance Action Committee and the Herbicide Resistance Action Committee.

- IRAC: <http://www.irac-online.org/modes-of-action/>
- FRAC: <http://www.frac.info/>
- HRAC: <http://hracglobal.com/pages/classificationofherbicidesiteofaction.aspx>

ACTIVITY: Pesticide resistance role-play



30 minutes



Farmers who have access to a range of CPAs in different classes



Classroom

MATERIALS

- Tissues to cover noses of “super insects”
- 1 hand sprayer filled with water
- 6 chairs or stools to represent tobacco plants
- Prepared script of the story

PROCEDURES

Organize participants for the mime role-play. You will need the following volunteers:

- 1 participant to be the Story Teller
- 1 participant to be the Farmer (who will keep the “poison sprayer” with him/her)
- 7 participants to be “Ordinary Insects”
- 14 participants to be “Super Insects” who cover their noses with tissues

A group of “observers” (all remaining participants) will take notes. Ask the “Ordinary Insects” to stay on one side and the “Super Insects” on the opposite side. The middle area is the tobacco farm. A boundary may be drawn on the ground for the two sides of the “farm” using chalk. Put 6 chairs or stools as tobacco plants in the area representing the farm. The storyteller starts reading the script, while the acting participants mime the role-play. The facilitator should provide the instructions in *italics* to the participants involved in the role play.

Script

Storyteller: *“In the first week of the tobacco season, a farmer went to his farm and found five insects. He complained bitterly about the presence of these insects because he regularly sprayed the farm in the last season. He did not know it, but one of these, a Super Insect, was resistant to the CPA that he usually used. All the others were Ordinary Insects”.*

(1 Super Insect and 4 Ordinary Insects go into the farm and settle, feeding on the tobacco plants. After that, the farmer comes in and acts as though he is observing the crop and complaining about the insect population)

Storyteller: *“The farmer became very worried that his tobacco plants would be eaten by the insects, and he decided to spray a CPA immediately. He went home to get his CPA sprayer and sprayed the farm. One lucky Ordinary Insect managed to escape the CPA by hiding behind a tobacco leaf.”*

(The farmer brings the CPA sprayer into the farm and sprays all except one Ordinary Insect. All Ordinary Insects die while the Super Insect covers his/her nose with a tissue. He/she shows to the public how his nose cover protects him/her and smiles)

Storyteller: *“All but one of the Ordinary Insects was killed by the CPA but the Super Insect happily survives because of the resistance he/she has against the CPA. Now the Farmer was happy, so he went away for a week. In that week, the surviving insects gave birth to babies. Each adult insect makes 3 babies so that in the next generation, there were 3 Ordinary Insects and 3 Super Insects. After mating and making babies, the adult insects died.”*

(Surviving insects get babies by inviting 3 more Ordinary Insects and 3 more Super Insects into the field, then fly away and die)

Storyteller: *“The next week the farmer came to the field and found 6 insects. Of course, he did not know that among the 6, there were 3 Super Insects that were resistant to the CPA. Again he was worried and he decided to spray. This time he mixed a stronger solution of CPA and took care to cover all areas of the trees where the insects could be hiding.”*

(Farmer looks around carefully and sprays all insects, not excluding anyone)

Storyteller: *“All Ordinary Insects were killed by the CPA spray, but the Super Insects survived.”*

(Ordinary Insects die, while the Super Insects again show their nose covers to the public and smile)

Storyteller: *“Again the remaining insects (3 Super Insects) make babies. As before, each adult made 3 babies, flew away and died. Because the parents were Super Insects, the 9 new babies were all Super Insects”.*

(Surviving Super Insects get babies by inviting 9 more Super Insects into the field, then fly away and die. Farmer takes the CPA sprayer, looks around carefully and sprays all the insects, not excluding anyone. The Super Insects again show their nose covers to the public and smile. The farmer looks puzzled.)

Storyteller: *“WHAT SHOULD THE FARMER DO NOW?”*

(End of the role-play. All players stand up and all observers clap)

QUESTIONS FOR DISCUSSION

- Q** What did you observe in the role-play?
- Q** Why did some of the insects die during the spraying? Why did some not die?
- Q** How many insects died out of how many in each generation?
- Q** How and why did the numbers change between the generations?
- Q** What do you think would have happened if the farmer had continued spraying CPAs?
- Q** What else could the farmer try to do?

Through this discussion, facilitators should draw out ideas for steps that can be taken to manage pest resistance. The key points in a resistance management plan should be noted on the flip chart, and the actions that farmers should take in this regard should be emphasised. Examples can be found in the topic’s background information.

ACTIVITY: Group work on pesticide resistance management – what can you do?



30 minutes



Farmers who have access to a range of CPAs in different classes; field technicians who support them



Classroom

MATERIALS

- Flip charts and markers
- CPA containers and/or labels
- Case study

PROCEDURES

Begin by asking whether they are applying any resistance plan or strategy. Then describe a specific case study using a pest problem which will be familiar to the participants. It is advisable to select real world examples such as herbicide resistant weeds.

Divide the participants into small groups, and ask the groups to outline a plan for managing resistance to the CPAs that they would use in the case study scenario. Encourage the participants to incorporate different elements in their resistance management strategy (e.g. avoid repetitive and sole use of CPAs with the same modes of action; mix or alternate CPAs with an appropriate partner fungicide; limit number and timing of treatments; avoid eradicant use; maintain recommended dose rate; use of, or giving preference to, non-chemical methods for pest management). They must prepare the detailed step by step strategy by mentioning the names of CPAs, non-chemical methods or biologicals etc. during the course of the crop period.

Once they have outlined their strategies, ask the groups to present their resistance management plans and discuss.

3.4 Personal safety and contamination

A major objective of the overall IPM programme is to reduce impacts of CPAs on human health and the environment. Likewise, measurable standards under the People and Environment pillars of PMI's GAP programme address CPA impacts on people and the environment as well as. In order to achieve these aims for harm reduction, farmers and farmer workers must take proper precautions to safeguard themselves and their surroundings. In order to motivate them to apply these precautionary measures and to respond appropriately when issues arise, they should be made aware of the hazards associated with CPAs and steps which can be taken to reduce risks. This section covers potential problems associated with CPA use as well as steps which can be taken in order to address these issues.

Topics covered in this section include:

- Problems associated with CPAs
- Routes of CPA exposure
- Symptoms of CPA poisoning
- Treatment of CPA poisoning
- Personal hygiene and general precautions
- Personal Protection Equipment (PPE)
- PPE maintenance



Problems associated with CPAs

Rationale: CPAs are toxic substances which can potentially have an adverse impact on farmers', farm workers' and consumer health as well as on the environment. Awareness of, and knowledge about, these risks is the basis for adapting behaviour in such a way that these risks can be minimised. The WHO classification system is an important tool in this context for use in assessing the potential effects of a CPA that is chosen for application. Awareness of the possible negative effects of pesticides, especially when connected with personal experience, often proves to be an important driving force for adopting recommended practices in RPU as well as encouraging farmers' efforts to implement IPM going forward.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Understand that pesticides can be harmful
- Be made aware of hazards such as acute and chronic health effects
- Be made aware of the risks CPAs pose to vulnerable groups such as children and pregnant or nursing women
- Be made aware of environmental hazards

BACKGROUND INFORMATION

Problems with pesticides

There are several problems associated with the use of pesticides:

- Pesticides are potentially dangerous/harmful to farmers (spray applicators)
 - They may have acute and long-term (chronic) effects
 - Farmers often do not wear protective gear because of a lack of awareness of pesticide toxicity
- Pesticides are harmful to the environment and to non-target organisms.
 - They pollute drinking water, rivers and lakes.
 - They are harmful to fish, birds, pollinators, natural enemies, and animals in the soil such as earthworms.
- Pesticide residues can be harmful to consumers, particularly when the pre-harvest interval is not obeyed.
- Improper disposal of excess CPAs, empty CPA containers and contaminated material poses a risk to children, the environment, farm animals etc.

Pesticide toxicity

Pesticides are designed to be toxic to living organisms so that control of unwanted pests (plants, insects, rodents, fungi, bacteria, etc.) can be achieved. Living organisms share many similarities and so something that is toxic to one species (animal or plant) may also be toxic to other organisms. This is especially true if the organisms are related. For example, insects, rodents and humans, all being animals, have similarities in their nervous, circulatory and respiratory systems. These similarities are the reasons that pesticides designed to target insects can also affect people. However, although pesticides may also be toxic to humans, they vary significantly in the hazard they present. While all pesticides can be dangerous, some may be more so than others;

The level of danger can be represented as a hazard classification developed by World Health Organisation system (Table 11).

Table 11 Toxicity classes used in the WHO Recommended Classification of Pesticides by Hazard (2009)

Toxicity Class	Hazard statement	Colour code
Ia	Extremely hazardous	Red
Ib	Highly hazardous	Red
II	Moderately hazardous	Yellow
III	Slightly hazardous	Blue
U	Unlikely to present acute hazard under normal use	Green

The WHO classification scheme is based on the LD₅₀ of a rat population i.e. the dose of a pesticide required to kill 50 percent of the population of test rats under a standard set of conditions. Class Ia and Ib pesticides should be avoided wherever possible since exposure to even a very small quantity can poison a person.

Many countries and regions have their own classification systems. For example, the US EPA (United States Environmental Protection Agency) and European Union systems use four and eight toxicity classes respectively. Some countries indicate CPA hazard classes using colour coded labels.

Some biological pesticides, e.g. nicotine, can be very toxic and their use is as hazardous as many inorganic or synthetic pesticides. Some examples of biopesticides that are less toxic include extracts of the flowers of *Pyrethrum*, root extract of *Derris elliptica* (Rotenone) and leaves and flowers of the Neem tree (*Azadirachta spp.*). In general, exactly the same precautions must be taken whether using chemical or biological pesticides.

Acute and chronic health effects

Acute poisoning is the severe poisoning which occurs after exposure to a single dose of pesticide. The appearance of symptoms may be sudden and dramatic or they may be delayed but will generally occur within 24 hours of exposure.

Chronic poisoning is the poisoning which occurs as a result of repeated, small, non-lethal doses over a long period of time. There are many symptoms that may appear, and these can include nervousness, slowed reflexes, irritability, or a general decline in health.

Vulnerable groups

Pregnant and nursing women, the unborn, infants and children, the elderly, and HIV/AIDS affected people are particularly vulnerable to CPA exposure. Special precautions should be put in place to avoid exposure of these individuals to CPAs.

Environmental contamination

Sometimes releasing pesticides into the environment can be harmful, as not all of the pesticide applied reaches the target site. For example, the pesticide might run off the leaves and land on the soil around the plants, where it may kill any beneficial insects that are living in the soil. Also, some of the pesticide may drift downwind and outside of the field being treated. In both cases, the pesticide is wasted, pest control is reduced and there is more chance of polluting the environment.

Anyone who uses a pesticide must consider how that pesticide may affect the environment. Two important questions to consider when using pesticides are:

- Where the pesticide is going to go in the environment after it leaves the sprayer, and
- What effects this pesticide can have on those non-target sites that it may reach in the environment.

It is important to remember that the environment includes more than just the crop plants and soil. It includes the air, soil, water, plants, animals, houses, etc., and therefore pesticides that move away from the targeted application site may cause contamination to any of these other parts of the environment. Pesticides can move in several ways:

- In air
- In water
- On or in objects, plants or animals

Movement in air

Pesticide movement away from the application site by wind or air currents is called drift. Drift can occur during mixing and application of pesticides. Pesticides may be carried off-site in the air as spray droplets, vapour, or solid particles. Pesticides can even be carried away on soil particles that are blown by the wind (e.g. dust).

Movement in water

Most pesticide movement in water is either by surface movement out of the treated field (runoff) or by downward movement through the soil (leaching). Runoff and leaching may occur when:

- Too much pesticide is applied or spilled onto a surface
- Too much rainwater or irrigation water moves the pesticide through the soil out of the sprayed field or into groundwater

Runoff water may move into drainage systems, streams, ponds, or other surface water, potentially resulting in long distance dispersal. Pesticides that leach downward through the soil may reach the groundwater, which may then be used as drinking water by humans. Besides runoff and leaching, pesticides also can enter water through drift.

Movement on or in objects, plants or animals

Pesticides can move away from the treated field when they are on or in objects or organisms that move (or are moved) off-site. When sprayer operators bring home or wear contaminated PPE, work clothing or other items, residues can rub off onto furniture, other clothing, pets and other people.

ACTIVITY: Group work ranking CPAs according to hazard as perceived by participants



45 minutes



Farmers; to introduce the topic “problems associated with pesticides



Classroom

MATERIALS

- Set of pictures of CPA packages, if possible of various hazard classes (facilitators should choose products that are used or at least known to most of the farmers)
- Flip chart
- Paper for group work

PROCEDURES

Pictures of the CPA packages should be placed in front of the trainees. An initial discussion and exchange about the products displayed should cover the following questions:

- Do the farmers know and/or use the product?
- What is it used for?
- How is it used?
- What are its advantages and disadvantages?

Additional information should then be given by the facilitator explaining that the session will focus on the problems associated with the use of CPAs. A continuation of the discussion and exchange within the group should include the following:

- What are the negative effects of CPAs that are known to the participants?
- What difficulties associated with the use of CPAs have the participants experienced personally, within their families, or in the wider community?

Group work

Participants should be split up into groups of 3-4 and each group is given the set of pictures (CPA products used in the introduction). In their groups, participants will be given the following tasks:

- Rank the products according to their level of danger (based on the participants' own knowledge, experiences and assumptions)
- Summarise the discussion previously held in the group and explain briefly for what reasons the group came up with their proposed classification
- For each of the products, discuss and summarise within the group what could be done in order to minimise the risk associated with the CPAs.

To end the activity, hold a plenary session to include short presentations from the group work; each group will display their classification and present the results of their discussions as described above. Either during these group presentations or during a final plenary discussion the facilitator can provide further information about hazard classification. For example, the WHO classes can be introduced, and these can be compared to the groups' proposed classification. The facilitator can then give the actual WHO classes for the products shown in the pictures. If needed, further clarification about the toxicity of pesticides (as outlined in the background information) may also be provided.

ACTIVITY: Group work to identify where CPAs can contaminate the environment



45 minutes



Farmers; to raise awareness about environmental contamination



Classroom

MATERIALS

- Paper and markers for group work
- Flip chart
- Poster or handouts summarising the background information (optional)

PROCEDURES

Using a poster or flip chart, the facilitator provides introductory information about problems associated with pesticides and environmental contamination (see background information).

With the support of the facilitator, the group will develop a list of activities ranging from the purchase of the product to its application and the disposal of containers, similar to the list in Table 12.

Table 12 Summary table of CPA-related activities, potential for environmental contamination, relative risk and means of mitigation

Activity	Describe, in detail, how the CPAs can get into the environment	Risk e.g. on a scale from 1 to 5	How can this risk be minimised?
Transport of CPAs from the retailer to the farm			
Storage of CPA			
Mixing of CPA			
Calibration of equipment			
CPA application			
Disposal of CPA containers			
...			

Group work

The participants will be split into small groups and for each of the activities described above, they will discuss within their groups how it is possible for the CPAs to get into the environment (for example, during transport a container may be opened as it is being loaded onto a truck, resulting in leakage of the liquid product into the waterway along the road). Once these possible means of contamination have been described, participants will firstly rate the risk that each described scenario may happen (e.g. on a scale from 1 to 5) and secondly describe possible measures for ensuring that this risk is minimised.

In a plenary session, the groups will present reports about their findings and a final discussion will summarise what the participants have learnt.

Routes of CPA exposure

Rationale: CPAs are toxic substances that can have a potential impact on human health. This can be a direct effect on the CPA spray operators or an indirect effect on other people who may come into contact with the CPA before, during or after the application. The effects of CPA contamination may be acute or chronic, as discussed under the topic of the problems associated with CPAs. It is therefore important to recognise the potential routes by which contamination with CPAs may occur, so that appropriate preventative measures can be employed in order to reduce the health risks to farmers, farm workers and the wider community.

LEARNING OBJECTIVES

Through discussions held on this topic trainees will:

- Understand how CPAs may enter the human body
- Understand what the risks of contamination are from either direct or indirect involvement with the use of CPAs

BACKGROUND INFORMATION

The use of CPAs poses a number of acute and chronic risks to humans. The ways by which the CPAs may contaminate people are referred to as routes of contamination. These routes of contamination are primarily grouped into three types, dermal (through the skin, may also include the eyes), oral (through the mouth), or inhalation (through the nose).

The table below lists a number of ways in which CPAs can enter a human via these routes of contamination (Table 13)

Table 13 Common sources of CPA exposure

Dermal exposure	Oral exposure	Inhalation exposure	Eye exposure
Not washing hands after handling CPAs or containers	Not washing hands before eating, smoking or chewing	Spraying in confined or poorly ventilated areas	Rubbing eyes or forehead with contaminated gloves or hands
Splashing or spilling CPA on skin	Splashing CPA into mouth	Being exposed to drift	Splashing CPAs in eyes
Wearing CPA contaminated clothing	Accidentally applying CPA to food	Mixing/loading dusts, powders or other dry formulations	Applying CPAs in windy weather, drift exposure
Applying CPAs in windy weather, drift exposure	Storing CPAs in drink containers	Using an inadequate or poorly fitting respirator	Mixing/loading dry formulations without wearing goggles
Touching treated plants or soil	Getting drift on lips or mouth		

Everyone who works with CPAs should be aware of the potential mechanisms and routes of exposure and/or contamination, so that any immediate or long-term effects of CPA contamination can be reduced through application of precautionary measures like using PPE.

Activity: Group work for recognising risks of contamination and routes of entry with CPAs



20 minutes



Farmers



Classroom

MATERIALS

- Flip charts and markers

PROCEDURES

Working in small groups, farmers should list the type of CPAs they use, and then identify potential routes of contamination for each type of CPA (both dry and liquid formulations) for themselves and other people. For further information refer to Table 13 above.

One group should present their findings and a discussion should be held with the whole group taking part.

The facilitator should clearly identify the different risks associated with mixing, application, cleaning of equipment etc. of a range of CPAs. In particular issues associated with both direct operators as well as non-operators should be highlighted.

Symptoms of CPA poisoning

Rationale: Sometimes farmers who have experienced acute CPA poisoning do not recognise the symptoms as such and they may erroneously attribute the problem to other causes. This can be hazardous as it may result in cases of CPA poisoning going untreated and, if symptoms of pesticide poisoning are not recognised, risky behaviours may go uncorrected, increasing the likelihood of further exposure. Training under this topic is intended to raise awareness about the symptoms of CPA poisoning both in the short- and long-term.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn about, and be able to recognise, the symptoms of acute CPA poisoning
- Know how to react if symptoms appear after contact with a CPA
- Be aware of some of the symptoms of chronic CPA poisoning

BACKGROUND INFORMATION

As mentioned in the topic on problems with CPAs, the “toxicity” of a CPA is a measure of the harm which it can cause. CPAs vary in terms of toxicity; for some extremely toxic CPAs, only a small dose is enough to be fatal whereas with other less toxic CPAs greater exposure is required to do harm.

CPAs also vary in terms of when the effect of exposure can be observed:

- An **acute effect** is any illness caused by a CPA that occurs within 24 hours after exposure. Acute effects are often reversible if medical care is received.
- A **chronic effect** is any illness that develops slowly, due to a long and continuous exposure to low concentrations of a CPA.

Symptoms due to acute CPA poisoning will become apparent relatively rapidly after exposure. While the specific effects may vary, there are some general symptoms which anyone who uses CPAs should be familiar with. These are listed in the table below (Table 14). As can be seen by referring to the table, some of the symptoms of CPA poisoning are similar to symptoms which can be attributed to other causes such as flu, heat stress, asthma, food poisoning, GTS and even a hangover. This is particularly true for the general symptoms of mild cases of acute CPA poisoning. If these symptoms appear after exposure to a CPA, then it should be assumed that they have been caused by contact with the CPA and the appropriate first aid response should be applied. (Refer to the section on treatment of CPA poisoning for more information.)

Table 14 Examples of symptoms of acute CPA poisoning

Route of exposure	General symptoms of acute CPA poisoning
Contact with skin	Skin irritation (drying or cracking), skin discolouration (redness or yellowing), itchy skin
Ingestion	Mouth and throat irritation, chest pain, nausea, stomach ache, diarrhoea, muscle twitching, excessive sweating, headache, weakness / tiredness
Inhalation	Burning sinuses (nose), throat and lungs, coughing, hoarseness, upper respiratory congestion
Contact with eyes	Eye irritation, temporary or permanent loss of vision. Contact with eyes can also lead to the CPA entering the body and causing the other symptoms listed above

Note: Some information is provided below on the symptoms of CPA contamination for groups of CPAs that are not recommended by PMI, and may even be banned for use in farmers' contracts. Even so, some farmers may be using some of these chemicals in other crops (or against the recommendations on their tobacco crops) so raising awareness on these symptoms may also be important.

- Organophosphorous CPAs, carbamate CPAs and chlorinated nicotinoid CPAs can act as cholinesterase inhibitors. Many cholinesterase inhibitors are no longer in widespread use (e.g. aldicarb), but there are some which remain on the market and are among the more popular CPAs (e.g. chlorpyrifos, carbaryl). Typical symptoms of poisoning with cholinesterase inhibitors include: salivation, lacrimation, urination, defecation, gastric cramps, emesis (together these symptoms are known by the acronym 'SLUDGE'). Other symptoms of more severe / advanced cases of poisoning with cholinesterase inhibitors include constricted pupils, blurred vision, twitching, trembling, paralyzed breathing, convulsions, and in extreme cases coma and death. Depending on the chemical, symptoms may only become apparent after a delay of several hours.
- *Pyrethroids* are one of the least acutely toxic insecticides to mammals because they are quickly deactivated by metabolic processes. Systemic intoxication is rare; problems encountered more frequently include irritant effects to the eyes, the throat and the respiratory system.

Chronic effects of CPA exposure include cancer; endocrine disruption; reproductive effects; neurotoxicity; kidney damage; liver damage; skin sensitizers; birth or developmental effects; and degenerative diseases (gradual weakening of the body). Often, CPA labels will list chronic effects that a CPA might cause. Since chronic effects are the result of repeated exposure to a CPA over long periods of time, their symptoms only emerge slowly, making it difficult to determine the specific cause of the health effect. Signs of chronic health effects will vary, but some of the general symptoms of chronic poisoning are the similar to those which are observed following mild acute CPA poisoning, and may include headache, tiredness, diarrhoea, irritation of the skin, eyes, nose and throat, dizziness, loss of appetite, and excessive sweating. Other symptoms include nervousness, slowed reflexes, irritability, or generally declining health. Another important symptom of chronic health effects is an increased sensitivity to CPAs.

ACTIVITY: Interactive discussion on symptoms of CPA poisoning



30 minutes



Farmers (and potentially field technicians) who are unfamiliar with the symptoms of CPA poisoning



Classroom

MATERIALS

- Poster showing a human body to facilitate discussion
- Flip chart and markers

PROCEDURES

Remind the group of the routes of CPA exposure, i.e. through contact, ingestion, inhalation and the eyes). Ask the group whether they have ever experienced any health effects themselves during or following CPA use. What were these health effects? Through discussion with the group, compile a list of symptoms of CPA poisoning. These could be written on a poster showing the human body or in a table like the one given in the background information.

Next, explain that some CPA poisoning symptoms become apparent rapidly after exposure – these are symptoms of acute CPA poisoning. Other chronic effects develop slowly, following long and continuous exposure to low concentrations of a CPA.

On a separate sheet of paper, list some examples of symptoms of chronic effects – these can be hidden conditions that would require medical testing to identify such as cancer, blood disorders or organ damage. Note that some chronic effects have symptoms which are similar to symptoms of mild acute CPA poisoning.

The discussion on symptoms of CPA poisoning can be followed immediately with the topic on treatment of CPA poisoning.

COMPLEMENTARY METHODS FOR KNOWLEDGE TRANSFER

- Video or role play to demonstrate the symptoms of CPA poisoning

TOPIC

Treatment of CPA contamination

Rationale: Once symptoms of CPA poisoning emerge, it is important to know how to react. This section covers first aid for CPA poisoning.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn what to do in cases of CPA poisoning
- Be able to apply first aid

BACKGROUND INFORMATION

When working with CPAs if the symptoms of acute CPA poisoning are detected, then it is important to take immediate action. The first step should be to stop the CPA exposure immediately. Work with the CPA should be stopped and the person who is experiencing CPA poisoning should be removed from the treated area. The people who are providing first aid also must also avoid becoming exposed to the CPA themselves.

General first aid for the different routes of CPA exposure is described in Table 15. If the CPA label is available, refer to it for specific information on what to do in case of an emergency. Once first aid has been applied, medical attention should be sought.

Table 15 First aid for acute CPA poisoning

Route of exposure	General symptoms of acute CPA poisoning
Contact with skin	<p>Washing off as soon as possible will reduce injury. Drench skin with water (any water source will do as long as it is not contaminated with CPAs).</p> <p>Wash skin and hair with soap.</p> <p>Remove contaminated clothing.</p> <p>Dry and wrap in a blanket or other clean cloth. Make sure the person does not become chilled.</p> <p>Loosely cover the affected skin with a clean bandage or cloth.</p> <p>If the skin has chemical burns, do not apply ointments, greases, powders or other drugs to the skin.</p>
Ingestion	<p>Rinse the affected person's mouth with plenty of water.</p> <p>The person should drink large amounts of milk or water (more than a litre).</p> <p>Check the CPA label to see whether it instructs that vomiting should be induced. Even if it does recommend inducing vomiting, only induce vomiting if the person is conscious and not convulsing.</p> <p>To induce vomiting:</p> <p>The affected person should lay face down or sit kneeling forward. (If the person is lying on their back, the vomit could enter their lungs and cause choking or other damage.)</p> <p>Put a finger or the blunt end of spoon at the back of the person's throat or give the person syrup of ipecac.</p> <p>Never induce vomiting under the following circumstances:</p> <p>The affected person is unconscious or is having convulsions. Vomiting could cause the person to choke to death.</p> <p>The person has swallowed a corrosive chemical. A corrosive poison is strong acid or alkali which will cause the throat and mouth to burn as severely coming up as it did going down. Dilute the poison as quickly as possible by ingesting milk or water. For patients one to five years old, use one to two cups; for patients five years and older, use up to approximately one litre. For acids, milk of magnesia may also be used (two tablespoons in one cup of water).</p> <p>The person has swallowed petroleum products. Most CPAs which come in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the CPA label are signals NOT to induce vomiting in the poison victim if he has swallowed the concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. If the affected person has swallowed a dilute form of these formulations, then the person should be forced to vomit immediately.</p>
Inhalation	<p>Wear an air-supplied respirator to retrieve someone from a closed space with CPA fumes (e.g. fumigants).</p> <p>Carry the affected person (do not let them walk) to fresh air immediately.</p> <p>Open all doors and windows.</p> <p>Loosen all tight clothing so that the affected person can breathe freely.</p> <p>Apply artificial respiration if breathing has stopped or is irregular. If CPA or vomit is on the person's mouth or skin, avoid direct contact.</p> <p>Keep the affected person as quiet as possible.</p> <p>In case of convulsions, watch the affected person's breathing and protect the person from falling or injury.</p> <p>Keep the person's chin up so the air passage will remain free for breathing.</p> <p>Make sure the person does not become chilled.</p> <p>The affected person should not take alcohol in any form.</p>
Contact with eyes	<p>It is most important to wash the eye out as quickly but as gently as possible.</p> <p>Hold eyelids open and wash eye with a gentle stream of clean running water. Drip water into the eye so that it flows across the eye rather than directly into it.</p> <p>Wash the affected eye for fifteen minutes or more. It is important to use a large volume of water. If possible, at least 19 litres should be used to flush the eye properly.</p> <p>Do not use chemicals or drugs in wash water. They may increase the extent of the injury.</p> <p>Cover the affected eye with a clean piece of cloth and seek medical attention immediately.</p>

ACTIVITY: Role play to demonstrate first aid for CPA poisoning



45 minutes



Farmers and field technicians



Classroom

MATERIALS

- Slips of paper with CPA poisoning scenarios written on them
- CPA bottle/ label
- Other material required to perform role play for first aid (e.g. blanket, bandages, water, milk)
- Handouts describing appropriate first aid for different types of CPA exposure

PROCEDURES

In advance of the activity, prepare slips of paper with CPA poisoning scenarios written on them. There should be at least one scenario for each of the main routes of exposure (e.g. CPA in eyes, CPA swallowed, CPA inhaled, etc.). Symptoms of the type of CPA poisoning can be written on the paper as well as a hint to the “victim”. To make the scenario more specific, the CPA which caused the problem can also be identified on the piece of paper. The examples used should be CPAs that the participants are familiar with. Cues can be given as to the severity of the case of CPA poisoning if required.

Select volunteers in pairs to do a role play in front of the group. One person in each pair should be the “victim” and the other will be the first responder who provides first aid.

Ask the victim to choose a slip of paper with the scenario written on it. The first responder should then ask the victim questions to diagnose the problem. Once the first responder has identified the problem, they should act out the provision of appropriate first aid to the victim. Once the first responder has finished giving treatment, the rest of the group should be allowed to give feedback. What could the first responder have done differently?

Pairs should continue with this role playing until each of the scenarios has been demonstrated.

The facilitator should ensure that for each scenario the appropriate first aid has been noted. Handouts can be distributed to re-enforce the message.

Wrap-up the activity by reminding the group of the following good practices, which can be followed in order to reduce the risk of CPA poisoning:

- Store CPAs safely
- Use recommended PPE and well-maintained, appropriate equipment
- Store CPAs in their original containers
- Avoiding spilling or splashing CPAs – clean up spills immediately
- Dispose of empty CPA containers appropriately

COMPLEMENTARY METHODS FOR KNOWLEDGE TRANSFER

- Video to demonstrate first aid for CPA poisoning

TOPIC

Personal hygiene and general precautions

Rationale: Pesticides are toxic substances which can potentially impact the health of operators and other people that come into contact with them. Precautions should be taken to reduce health risks to farmers and farm workers.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Learn how to minimise the risk of contamination

ACTIVITY: Interactive discussion on personal hygiene



30 minutes



Farmers



MATERIALS

- Poster on personal hygiene and general precautions
- Note cards
- Markers
- Tape

PROCEDURES

Personal hygiene and general precautions

Explain that pesticides can cause both short-term and long-term effects in humans. It is therefore necessary to take care whenever handling or applying pesticides to prevent immediate contamination as well as the build-up of toxic effects over time. Emphasise that it is easier to prevent pesticide poisoning than treat it!

Personal hygiene is of utmost importance to everyone involved in the application of pesticides. Ask the participants to write down on cards the personal hygiene practices or general precautions they use when mixing, spraying and after pesticide application.

Compare the farmer's comments on the cards to the poster of the general precautions that pesticide users must take. Tape the cards next to the related practices. Review any general practices the farmers may have missed.

Do not eat, drink or smoke while mixing or applying pesticides (this is to avoid contamination of food and drinks and to limit contact with mouth, eyes and other sensitive areas)

Always wash hands and face thoroughly after handling or using pesticides, especially before eating, drinking or smoking

Ensure that all the safety precautions on the pesticide label are observed

Do not touch face or other bare skin with contaminated gloves or hands. (Even if they look clean, hands and gloves can be contaminated.)

Do not store pesticides in drinks bottles or food containers – they MUST be kept in their original containers

Wash thoroughly immediately after work. Waiting until the end of the day to clean up can allow additional absorption of the pesticide through the skin.

Never wear contaminated clothing under any circumstances.

Clean work clothes separately from family washing. Keep contaminated clothing separate from other laundry and tell the person who washes the clothes of the possible hazards. Encourage him/her to wear protective gloves while doing the laundry.

Dispose of contaminated clothing if it cannot be cleaned properly.

TOPIC

Personal Protection Equipment (PPE)

Rationale: Pesticides are toxic substances which can potentially impact the health of operators and other people who come into contact with them. To reduce health risks, farmers and farm workers need to protect themselves and wear personal protection equipment. Conditions related to the use of PPE may vary but a minimal level of PPE is required.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Know how to protect themselves correctly
- Know and understand which type of PPE is required for different product types

ACTIVITY: Demonstration and interactive discussion on PPE



30 minutes



Farmers



Classroom

MATERIALS

- Ideal/Required PPE
- Minimal PPE
- Pesticide label

PROCEDURES

 Note to facilitator: required PPE may vary by country and it is important to adapt this training so that it is relevant to the country.

This is an interactive discussion as well as a demonstration of proper PPE. Ask for a volunteer from the GROUP. As you go through all of the PPE requirements listed below (e.g. gloves, mask, etc.) ask the farmer put on the PPE step-by-step so that by the end of the discussion the volunteer is fully suited in the required PPE.

IMPORTANT: Demonstrate all PPE during the session. Try to bring along clothing that is NOT suitable as PPE as well (e.g. leather boots, short gloves, cotton gloves, ripped shirt, etc.) and show this to the farmers to emphasize what not to use.

Personal Protection Equipment

- PPE must ALWAYS be worn whenever handling and applying pesticides – as well as when cleaning and maintaining sprayers.

- The most dangerous operations are *mixing* pesticides and *filling the sprayer* since the operator is handling concentrated product.
- PPE is displayed on the pesticide label.



Explain to the farmers that the use of PPE when mixing and applying pesticides is essential to help prevent pesticide contamination.

It is important to always read the pesticide product label before use to determine which items of PPE are essential to wear.



It is also important to look for the warning symbols

Allow farmers to observe these symbols on real pesticide containers.

Ideal features of PPE

 Note: PPE requirements should follow the laws and regulations of the country in question.

Coverall

Overalls (i.e. one-piece suit) or two-piece garments can be used. Explain that a two-piece garment offer greater flexibility and comfort. Use suits which allow easy movement and good air circulation.

For two-piece garments, the top should not be tucked into the pants, but should hang well below the waist line.

Seams should be tightly woven; zippers and pockets should be covered with a protective flap.

Explain the following important features of coveralls:

- Coveralls should be made of sturdy material such as cotton, polyester, a cotton-synthetic blend, denim, or a non-woven fabric.
- The level of protection depends on the weight, weave and thickness of the fabric. Choose fabrics that are as heavy as can be comfortably worn in the local climate. Twills are preferable to plain weave for woven fabrics.
- Non-woven polypropylene coveralls can be used in hot and humid climates. They offer a similar level of protection to cotton, but need to be replaced more often.
- Cotton or polyester/cotton blends are appropriate for most conditions of use.
- Light cotton provides minimal protection.
- Heavier cotton provides better protection.
- If cotton becomes wet, it can increase contamination. Farmers should avoid walking through wet fields or protect the coverall from becoming wet.
- Aprons and rain suits provide extra protection in wet conditions.

Show an example of standard PPE to the farmers.

Gloves

Explain all the following important features of gloves:

- Gloves made of nitrile, rubber or Neoprene are suitable for most pesticides.
- Natural rubber gloves do not provide sufficient protection. When used with solvents such as those in emulsifiable concentrates (ECs) they become damaged.
- Leather, or any other absorbent gloves are not suitable
- Gloves should fit comfortably and be flexible enough to grip containers and other equipment firmly
- Gloves should be long enough to reach the elbows
- They should be worn outside the sleeves of the shirt/overall

Short gloves should at least cover the wrists and be worn outside the sleeves

Show examples of suitable gloves to the farmers and allow them to try them on.

Boots

Explain the following important features of boots:

- They should be waterproof
- Rubber boots offer good protection
- Leather boots are unsuitable because they absorb some pesticides and cannot be decontaminated
- Trousers should be worn outside the boots (i.e. not tucked inside boots) so that splashes and spills do not fall inside the boots.

Eye and face protection

Explain that the eyes are particularly sensitive to pesticide contamination and require special attention. Therefore, eye protection (glasses) or a face shield should always be worn.

A face shield should be worn especially when mixing and loading pesticides into the spray machinery to protect against splashes. Face shields are less likely to mist over than goggles, but do not give protection against toxic fumes.

Face mask

A lightweight face mask covering the mouth and nose **MUST** be worn when handling dusts and powders. It also offers extra protection when mixing or loading pesticides into the sprayer. Ideally face masks with respirators should be used. Check the label of the face mask to see what it can be used for. Respirators fitted with replaceable filter canisters should be changed regularly. Disposable respirators should be changed regularly.

Hat

Explain that the head is a sensitive area due to a higher rate of absorption of pesticide via the hair follicles. A hat is therefore essential.

Apron

Explain that an apron is recommended when mixing and loading pesticides and cleaning out containers before disposal. It should be made of PVC or rubber.

Discussion Questions:

- Ask the farmers if they use the standard PPE that are either noted above or required by law.
- If they do not use the required PPE, ask them why not. Ask the farmers what type of protection they do use.

Minimum PPE

Explain that if farmers do not have full protection, then they must follow the minimum requirements in order to protect themselves.

The minimum requirement for all types of pesticide operations is clothing covering most of the body i.e.

- Long sleeved shirt
- Trousers covering the legs pulled over the outside of boots
- Rubber gloves
- Waterproof boots
- A hat
- Eye protection (glasses) or face shield
- Face mask (mouth and nose protection such as handkerchief/bandana)
- Apron: If nothing else is available, clean plastic sheets or sacks cut to form an apron can be worn as a temporary measure and destroyed after use.

ACTIVITY: Spot the problem with the CPA use (Game)



20 minutes



Farmers



Classroom

MATERIALS

- Presentation (see Plantwise P2-10: Safe Use of Pesticides)
- Projector
- Screen or white wall

PROCEDURES

Show the participants the slide show presentation of the incorrect PPE practices. Ask the participants to count the number of problems they see in each slide. The group can then review the presentation, pointing out and discussing the problems in each slide.

ACTIVITY: Personal Protection Equipment (PPE) and its use (Dye exercise)



1 hour



Farmers



Tobacco field or other crop

MATERIALS

- 4 or 5 sets of white coveralls, gloves, masks and slippers
- 4 or 5 clean sprayers
- Red dye
- Spoons for transferring red dye
- 4 or 5 containers (for pre-mixing the red dye and water before pouring it into spray tank)
- 4 or 5 stirring sticks or small branches from a tree
- Water supply and large plastic buckets to hold water

PROCEDURES

- Put on a white coverall, white gloves, slippers and mask if available
- Use a red dye as a substitute pesticide and transfer one spoonful into a container
- Pour a small quantity of water into the container and stir it to dissolve the dye
- Fill a spray tank 1/3 full with water
- Pour the red dye and water into the spray tank and stir again
- Spray the mix onto a crop – try to encourage the volunteers to spray carelessly so that some of the spray drifts onto themselves
- Observe the red spots on the white clothing that represent pesticide contamination (from spillages, spray drift and leaking spray tanks)
- Show the 'proper' PPE to the group (coverall, apron, boots, gloves, goggles, hat)

During implementation, a small number of volunteers from the group should conduct the exercise while the rest of the group observe.

A group discussion should be held at the end of the exercise to discuss the results and the key messages of the exercise.

Close the session by emphasizing the following key messages:

- All spray operators must wear PPE
- The process of mixing pesticides can result in personal contamination
- Applying pesticides can lead to personal contamination
- Contamination can be minimised through careful pesticide application

ACTIVITY: Practical exercise to make PPE



1 hour



Farmers



Classroom

MATERIALS

- Plastic gloves
- Plastic bottles (preferably 1 litre)

PROCEDURES

If gloves, visors or aprons are not available, it is then recommended to take at least the following actions:

- Employ plastic bags to act as gloves. They should be used only once and then disposed following best practice.
- Make an apron using a resistant plastic sack.
- Make a visor using an empty clear plastic drinks bottle.
- Make mouth and nose masks using the top of the same plastic bottle. Add a tissue in the top to act as a filter (see Figure 8).

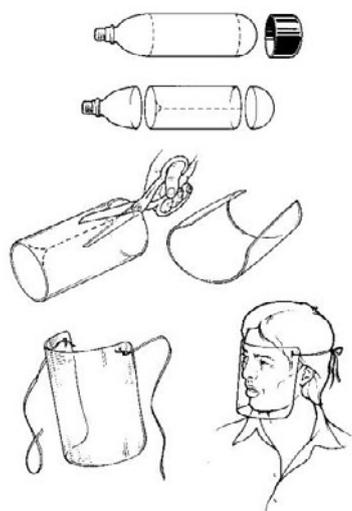


Figure 8 How to make a home-made face shield (Source: stewardshipcommunity.com)

TOPIC

PPE maintenance

Rationale: To be effective and ensure the protection of farmers and farm workers PPE needs to be regularly maintained and renewed.

LEARNING OBJECTIVES

- To understand how to clean and maintain PPE.

ACTIVITY: Interactive discussion on PPE maintenance



20 minutes



Farmers



Classroom

MATERIALS

- Poster on PPE maintenance best practices

PROCEDURES

Begin by asking the participants what they do to maintain their PPE. Note that it is important to maintain PPE properly to ensure it remains clean and safe to use for as long as possible:

- Inspect and wash all PPE after every use
- Repair damaged PPE

PPE must be kept in a good state of repair so that there are no tears or worn areas through which pesticides can cause skin contamination – repair any damaged clothing

Boots must be inspected regularly for signs of damage and be repaired or replaced accordingly.

PPE, including boots and gloves, should be washed after every day's use with detergent (even if they do not appear to be dirty). Gloves should be replaced regularly.

PPE should be washed separately from other clothing

Gloves should be washed on the outside and inside after every pesticide application

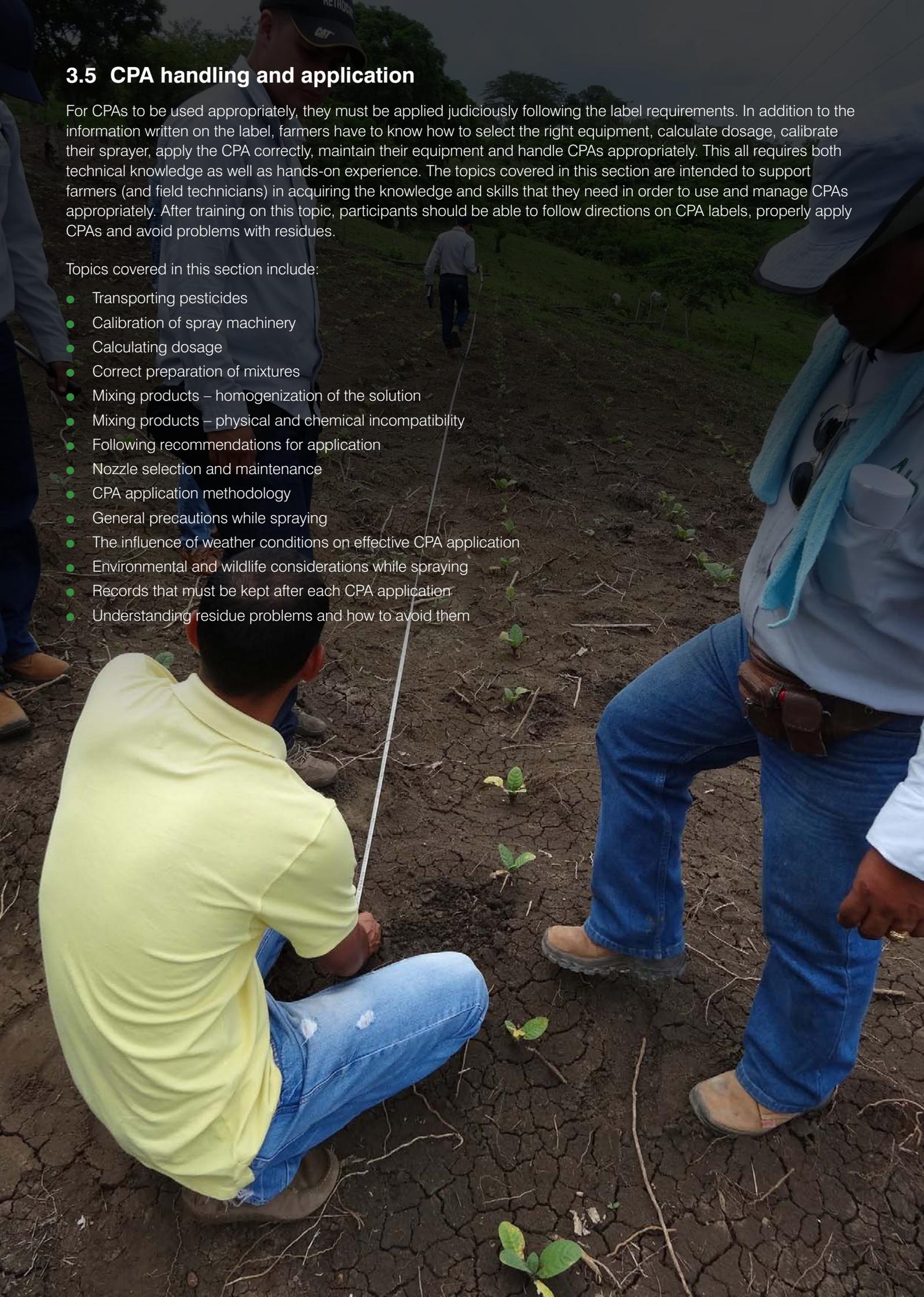
Explain that PPE must be stored in a separate compartment in the pesticide storage facility or in another locked facility that meets the same requirements as the pesticide storage facility – more details on this are provided in the CPA storage section (section 3.7).

3.5 CPA handling and application

For CPAs to be used appropriately, they must be applied judiciously following the label requirements. In addition to the information written on the label, farmers have to know how to select the right equipment, calculate dosage, calibrate their sprayer, apply the CPA correctly, maintain their equipment and handle CPAs appropriately. This all requires both technical knowledge as well as hands-on experience. The topics covered in this section are intended to support farmers (and field technicians) in acquiring the knowledge and skills that they need in order to use and manage CPAs appropriately. After training on this topic, participants should be able to follow directions on CPA labels, properly apply CPAs and avoid problems with residues.

Topics covered in this section include:

- Transporting pesticides
- Calibration of spray machinery
- Calculating dosage
- Correct preparation of mixtures
- Mixing products – homogenization of the solution
- Mixing products – physical and chemical incompatibility
- Following recommendations for application
- Nozzle selection and maintenance
- CPA application methodology
- General precautions while spraying
- The influence of weather conditions on effective CPA application
- Environmental and wildlife considerations while spraying
- Records that must be kept after each CPA application
- Understanding residue problems and how to avoid them



TOPIC

Transporting pesticides

Rationale: If procedures for minimising risks are not observed during pesticide transport, then accidents can happen. If these accidents happen on a public road then the wider community is placed in jeopardy. It is important that anyone transporting pesticides is aware of the hazards and knows how to minimise them.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be made aware of risks associated with pesticide transport
- Learn the relevant regulations relating to pesticide transport
- Know how to implement measures to reduce risks in order to transport pesticides safely and according to regulations

ACTIVITY: Interactive discussion on how to safely transport pesticides



1 hour



Farmers who transport pesticides



Classroom; outside where vehicles are parked (optional)

MATERIALS

- Flip chart and markers
- Pens and paper
- Vehicles used by farmers (1 per group), CPA containers, material for packing such as tarps and ropes, secure store boxes (optional)

PROCEDURES

Begin by brainstorming a list of potential hazards associated with pesticide transport – ask the participants “*What could go wrong during transport of CPAs?*”

Some issues to highlight are:

- Pesticides can catch fire
- Pesticides can give off fumes, so keeping them in enclosed spaces is both a health risk and could cause accidents
- If there is an accident, the pesticide could spill on the road
- If the pesticide is being transported in the back of a truck and is not secured, it could bounce out and spill
- Spills can be difficult to clean up inside a vehicle

Next, facilitators should ask the group for their suggestions for what can be done to ensure that pesticides are transported safely. Fill in any gaps. In particular, make sure that participants are aware of any relevant regulations or policies related to pesticide transport.

Some measures to reduce risks include:

- Making sure the vehicle is well-maintained and road-worthy.
- Check to see that containers being transported are closed and intact. Do not transport leaking containers.
- Keep pesticides separate from the driver, passengers and animals. Avoid carrying pesticides in the passenger compartment of a vehicle because of the potential for spills and fumes. If it is not possible to avoid this, make sure vehicle is ventilated (e.g. windows are open) during transport.
- Do not transport pesticides with food, animals or animal feed.
- Make sure the load is safe and secure. The cargo area must be able to securely hold containers so that they do not bounce out of the vehicle and are protected from tears, punctures or impacts. Enclosed cargo boxes offer the best protection.
- Organise the load to maximise stability.
- In pick-up trucks, never stack pesticide containers higher than the side of the vehicle.
- For flat-bed trucks, secure the load using tarpaulins, which are tied down using cleats.
- Steel beds are preferable to wooden beds as they are more easily cleaned; pesticides can soak into wood.
- Protect the pesticides from temperature extremes.
- Keep herbicides separate from other pesticides and fertilisers to reduce the risk of cross contamination.
- Never leave pesticides unattended or unsupervised.
- When transporting pesticides, make sure to carry the Master Safety Data Sheets for the pesticides being transported, a spill kit and PPE.

Divide the participants into small groups and ask them to devise their own transportation security plans. What steps will they take to ensure that they transport pesticides safely?

End the session by asking the participants to present their pesticide transportation security plans and discussing the plans as a group.

Alternatively, facilitators can opt for a practical, hands-on approach. Farmer vehicles of the type typically used for transporting CPAs could be used to demonstrate appropriate packing of CPAs and empty CPA containers for transport. Work in small groups. Each group should have one vehicle and sufficient packing material and examples of CPAs and empty CPA containers. Facilitators and the rest of the group should check to see that the materials in each vehicle are packed securely, highlighting good practices as well as any potential issues.

Calibration of spray equipment

Rationale: While farmers who use tractor mounted sprayers usually calibrate their equipment, in many locations very few farmers who use backpack sprayers calibrate them. Many do not know how to calibrate their sprayers, and some have never even heard of the practice. As a consequence, farmers may inadvertently be applying the wrong dosage – this can result in both wasted product and water, together with poor pest control, resistance, high levels of pesticide residues and potentially even dead plants.

There is therefore a need to demonstrate what sprayer calibration is, convince farmers that it should be done and empower them to be able to calibrate sprayers on their own.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Recognize why it is important to calibrate sprayers
- Learn the steps involved in sprayer calibration and be able to carry out the process on their own
- Raise awareness of nozzle performance and the practicalities of volume application rates, so that there is an increased appreciation of spray variables and appropriate tank mixture preparation.

BACKGROUND INFORMATION

Spray equipment must be correctly calibrated. Calibration ensures that the output of the sprayer is both known and accurate, and therefore ensures that pesticide can be applied at the rate specified on the label. It is important to remember that the application of more than the recommended dose is prohibited.

Sprayers used by tobacco farmers vary considerably, although they are usually of different types of manual (hydraulic) equipment including side-lever knapsacks and “trombone” sprayers. To make matters more complicated, there are also two different types of spray nozzles fitted to manual sprayers used by tobacco farmers: the more common variable cone and the fixed type (usually cones). Depending on the type of sprayer and nozzle, the calibration procedures differ: for example, if the sprayer is designed for non- adjustable nozzles, the farmer must choose which type to select, and if a variable cone is fitted, they must decide which setting is appropriate.

The function of the nozzle is to break the solution into small drops. The nozzles are therefore important as they will determine the size of the drops that come out of the sprayer. The selection of the right nozzle, together with using the correct diameter for the product to be applied is also an important issue that needs to be discussed with farmers. For example a contact product will require a more uniform application, especially when considering formulations based on *Bacillus thuringiensis*. Nozzle condition will also affect performance, as nozzles in poor condition may produce a droplet size that is much larger than required, resulting poor application/coverage.

In many tobacco growing areas, dispensing of pesticide products is aided by the packaging of the products themselves: sachets for powder (WP) formulations and container caps with liquid formulations. This protocol must therefore be modified to adjust to national practices.

It is important to reinforce that the same person who calibrates the sprayer should also carry out the application, as this can add significant differences to the calibration. The amount of solution applied in an area will depend on four variables: walking speed, the pressure selected, spray band width, and the nozzle selected. If any of these are changed then the amount of solution applied will change.

When calibrating the spray equipment it is also important to consider any slope in the area being sprayed, as well as the size

of the plants. When applying in a different area a new calibration needs to be conducted to adjust to the new conditions.

ACTIVITY: Practical exercise to learn how to calibrate sprayers



3 hours



Farmers and field technicians who need to learn how to calibrate sprayers



Field

MATERIALS

Enough of the following for each group of 4-5 participants:

- Printouts of Table 16 (Worksheet for sprayer calibration and dosage guide)
- Backpack sprayers belonging to the participants
- Clean water
- Measuring cups
- 2 litre measuring cup
- Watch (or use the stop watch function on a smart phone)
- Calculator

PROCEDURES

Divide the participants into groups of 4-5 people. Each group should have sufficient supplies to carry out the exercise.

1. Each group should fill in their worksheet (Table 16) by doing the following:
2. Backpack Volume: Record the total volume of the backpack sprayer being used
3. Calibration time: Mark out an area measuring 10 meters (or 10 large paces) wide by 10 meters long. This will be about 100 square meters. Fill one third of the sprayer with clean water and ask a participant from each group to spray the marked area as they would normally spray a pesticide. Record how many seconds it took in the calibration time box in the table.
4. Calibration Volume: Measure how much water comes out of the sprayer in the same time it took to spray the 100 square meters. This can be done by spraying water into a clean water bucket for the same number of seconds recorded in the calibration time box in the table. Measure the volume of water found in the bucket and record the result in the table.
5. Water rate per hectare: To calculate the volume of water-pesticide solution is needed to treat one hectare at the sprayer operator's walking speed and the pressure that they are using, multiply the calibration volume (recorded in the table) by 100 and note the result in the table.
6. Chemical rate per hectare: This is how much chemical concentrate must be applied per hectare. The chemical rate must be determined by the manufacturer or an agronomist.
7. Number of backpack refills per hectare: Divide the water rate recorded in the table by the backpack sprayer volume and record the result.
8. Amount of chemical concentrate per refill: Divide the chemical rate per hectare by the number of backpack refills per hectare and record the result.

9. Number of backpack sprayer refills: Calculate the number of backpack refills needed to treat a field: Multiply the number of backpack refills per hectare with the number of hectares of the field to be treated and record the result.

Ask the participants to present the results of their analyses.

Table 16 Worksheet for calibration of backpack sprayer and dosage guide

Step	Values	Example
1. Backpack Volume: Record the total volume of your backpack sprayer	___ Litres	20 Litres
2. Calibration time: Mark out a square area measuring 10 meters (or 10 large paces) wide by 10 meters long. This will be about 100 square meters. Fill one third of your sprayer with clean water and spray the marked area as you would spray a pesticide and record how many seconds it took.	___ Seconds	300 Seconds
3. Calibration Volume: Measure how much water comes out of the sprayer in the same time required to spray 100 square meters: Spray water into a clean water bucket for the same number of seconds recorded in the calibration time box. Measure and record the volume of water in the bucket.	___ Litres	3 Litres
4. Water rate per hectare: This is how much water-pesticide solution is needed for one hectare at your walking speed and the pressure you are using: multiply the Calibration Volume by 100 and record the result. _____ Multiplied by 100 (calibration volume)	___ Litres	3 Litres multiplied by 100 300 Litres
5. Chemical rate per hectare: This is how much chemical concentrate you must apply per hectare. This can be determined by the manufacturer or an agronomist.	___ Litres(or Grams)	200 grams
6. Number of backpack refills per hectare: Divide the water rate by the backpack sprayer volume and record the result. _____ Divided by _____ (water rate) (backpack sprayer volume)	___ Refills	300 divided by 20 Litres 15 Refills
7. Amount of chemical concentrate per refill: Divide the chemical rate per hectare by the number of backpack refills per hectare and record the result. _____ Divided by _____ (chemical rate per hectare) (number of backpack refills per hectare)	___ Litres or grams	200 grams divided by 15 13 grams per refill
8. Number of backpack sprayer refills: Calculate the number of backpack refills needed for your field: Multiply the number of backpack refills per hectare with the number of hectares of your field and record the result. _____ Multiplied by _____ (number of backpack refills) (number of hectares of your field)	___ Refills	15 refills multiplied by 0.5 hectares 7.5 Refills

QUESTIONS FOR DISCUSSION

Q How did the participants' results differ from each other?

- Q Why was this?
- Q Why is calibrating sprayers important?

TOPIC

Calculating dosage

Rationale: Many farmers do not know how to calculate dosages and some turn to unreliable sources for information on what dosage to use. As a consequence, farmers may inadvertently be applying the wrong dosage. This can result in wasted product, poor pest control, resistance, high levels of pesticide residues and potentially even dead plants.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand the importance of adding the correct amount of pesticide to a mix.
- Learn to carry out correct calculations for mixtures of pesticides.

ACTIVITY: Interactive discussion on calculating dosage



2 hours



Farmers and field technicians



Classroom

MATERIALS

Enough of the following for each group of 4-5 participants:

- Flip chart and markers
- Poster to facilitate discussion
- Calculator
- Examples of pesticide containers

PROCEDURES

Explain that farmers must calculate the correct dosage for every application and for each individual field, **EVEN IF SOMEONE ELSE IS SPRAYING HIS CROP.**

This will ensure that the correct amount of pesticide is sprayed onto their crop.

ALL farmers must calculate the dosage required for every pesticide application

- Too much pesticide is a waste of both time and money, and is prohibited
- Too little pesticide means that the treatment will not be effective

Ask the participants what other potential issues there are that might arise if the wrong dosage is used.

Explain that after the spraying operation has been completed, the area treated and the amount of pesticide used should be checked against the calibration calculations and recorded for future reference. (See record keeping section for more information.)

Explain that there are 4 basic ways in which dosages are stated on a label. (If some of the ways listed below are relevant and others are not, focus only on those that are relevant.)

1. Amount of **active ingredient** (pure chemical) needed per hectare or acre.
2. Amount of **actual formulation needed per hectare or acre**.
3. Amount of **actual formulation needed per litre or gallon of water**.
4. As a **percentage concentration** in the spray water (i.e. solution).

Together with the participants, look at the relevant examples in detail to clear up any confusion. Make sure to engage them in the discussion. For example, give some participants the labels and ask them to read out the dosage information for the examples that are used.

1. Amount of Active Ingredient Needed per Hectare (or Acre): Using Sevin as an example, a dosage might be given as 2 kg active ingredient per hectare. This means 2 kgs of pure (100%) Sevin. Since actual pesticide formulations vary in strength from 1% up to 95%, it takes some calculation to work out how much of a given formulation is needed to supply a given amount of active ingredient. If the local agro dealer store sells Sevin 50% WP, the farmer would need 4 kg for each hectare in order to supply 2 kg active ingredient. This does not indicate **how much water** the farmer should mix with the pesticide when he/she sprays it on the plants. This will depend on plant size, plant density, and the degree of coverage desired. The only way to find out how much water is needed is to **calibrate** the sprayer.
2. Amount of Actual Formulation Needed per Hectare (or Acre): As an example, a recommendation may call for 4 litres of Malathion 50% EC per hectare or another one for 2.5 grams of Sevin 80% WP per acre. This type of recommendation is somewhat simpler than the previous type since it is given in terms of actual formulation rather than active ingredient. However, the farmer still needs to know how much formulation he/she needs for the area of his field and how much water it will take to provide adequate coverage with his sprayer. This requires sprayer **calibration**.
3. Amount of Actual Formulation Needed per Litre or Gallon of Water: For example, 5 cc of Malathion 50% EC per litre of water or 2 tablespoons of Sevin 80% WP per gallon of water. This type of recommendation is much more convenient, since no sprayer calibration or dosage calculation is needed. The disadvantage is that the actual amount of pesticide the farmer actually applies on his/her field depends entirely on how fast he/she walks while spraying, how coarse or fine the spray is, and how much pressure is used. However, if proper application practices are followed, this type of dosage is precise enough for most conditions and is the most feasible for small farmers. This type of dosage should not be used for most herbicides where accuracy of dosage is critical.
4. As a Percentage Concentration in the Spray Water: This is basically the same as the previous type, except that the concentration of pesticide in the spray water is given as a percentage. Such recommendations are usually based on percentage by weight, although sometimes a volume basis is used when dealing with EC's. In addition, the percentage figure given may refer to the active ingredient or to the actual formulation. This will be covered in the calculations in the section below. No sprayer calibration is needed, but dosage accuracy will not be as good as the first two types described.

The following examples show how to convert the dosage from an active ingredient basis to an actual formulation basis for solid and liquid formulations

- a. For solid formulations (e.g. WP, EC, or GR)

$$\text{Kg/ha (or lbs/acre) of actual formulation needed} = \frac{\text{Amount of a.i. (kg/ha, lbs/acre)}}{\% \text{ active ingredient in formulation}}$$

Example: A recommendation for aphids calls for using Malathion at 2 kg active ingredient/hectare. How much

Malathion 40% WP would be needed per hectare?

Solution:

$$\text{Kg/ha of Malathion} = \frac{2 \text{ kg}}{40\%} = \frac{2 \text{ kg}}{0.4} = 5 \text{ kg}$$

NOTE: Remember, to multiply by a percentage you first must move the decimal point *two places to the left* (i.e. 2% = 0.02; 0.1% = 0.001)

b. For liquid formulations (EC's)

$$\text{Litres/ha of } = \frac{\text{kg/ha of a.i.}}{\% \text{ a.i. in EC}}$$

OR

$$\text{Litres/ha of EC needed} = \frac{\text{kg/ha of a.i.} \times 1000}{\text{grams of a.i. per litre of EC}}$$

OR

$$\text{Gallons/acre of EC needed} = \frac{\text{lbs/acre of a.i.}}{\text{lbs of a.i. per gallon of EC}}$$

Example: How much Perfekthion 20% EC would be needed per hectare if a recommendation for mites calls for 0.2 kg a.i. Perfekthion per hectare?

Solution:

$$\text{Litres of Perfekthion 20\% EC needed} = \frac{0.2 \text{ kg}}{20\%} = \frac{0.2}{0.2} = 1 \text{ litre}$$

The examples given below will demonstrate how to determine the amount of actual formulation needed for a farmer's field, given the dosage per hectare (or acre).

Once the actual amount of the formulation is needed per hectare (or acre) is known, the amount needed for a particular field can easily be calculated.

Hectare basis

$$\text{Amount of formulation needed for a farmer's field} = \frac{\text{Amount of formulation needed/ha} \times \text{Field area (m}^2\text{)}}{10,000}$$

Acre basis

$$\text{Amount of formulation needed for a farmer's field} = \frac{\text{Amount of formulation needed/acre} \times \text{Field area (ft}^2\text{)}}{44,000}$$

Example: The local extension service recommends applying Volaton 2.5% strength granules broadcast at 120 kg/ha for controlling soil insects in maize. If the farmer's field measures 35 x 40 meters, how much Volaton will he/she need?

Solution:

$$\text{To find square meters: } 35 \times 40 = 1400 \text{ m}^2$$

$$\text{Kg of Volaton 2.5\% granules needed for farmer's field} = \frac{120 \times 1400 \text{ m}^2}{10,000 \text{ m}^2} = 16.8 \text{ kg}$$

The following examples show how to follow a percentage spray dosage recommendation.

Determine first whether the spray's percentage is to be calculated in terms of *active ingredient* or in terms of *actual formulation*. For example, a recommendation may be seen for 2% spray of pure Malathion for controlling aphids; another recommendation might call for using a 0.1% spray of Lebaycid 50% EC for controlling thrips.

Use the metric system: Percentage spray calculations are much simpler in the metric system compared to using lbs., oz., and gallons. 1 litre = 1000 cc (or ml); 1 litre of water weighs 1 kg (1000 g); 1 U.S. gallon = 3.78 litres; 1 lb. = 0.454 kg or 454 g; 1 kg = 2.2 lbs.

c. For Wettable Powders (WP)

When using WP's, a percentage spray is based on the weight of pesticide to weight of water. Since 1 litre of water weighs 1 kg, the following formulae can be used:

Active ingredient basis

$$\text{Grams of WP needed per litre of water} = \frac{\% \text{ strength spray desired} \times 1000}{\% \text{ a.i. in wettable powder}}$$

Example: How many grams of Malathion 40% WP should be added per litre of water to make up a 2% strength spray (active ingredient basis) for controlling aphids?

Solution:

$$\text{Grams of Malathion 40\% WP needed per litre of water} = \frac{2\% \times 1000}{40\%} = \frac{20}{0.4} = 50 \text{ g}$$

Actual product basis

$$\text{Grams of WP needed per litre of water} = \% \text{ strength spray desired} \times 1000$$

Example: How much Dipterix SP 95 is needed to make up a 0.15% strength spray (actual product basis) for controlling armyworms in maize?

Solution

$$\text{Grams of Dipterex SP 95} = 0.15\% \times 1000 = 0.0015 \times 1000 = 1.5 \text{ g per litre of water}$$

b. For liquids (EC's)

Active ingredient basis

$$\text{cc (ml) of EC needed per litre of water} = \frac{\% \text{ spray desired} \times 1000}{\% \text{ a.i. in the EC}}$$

Example: How much Malathion 57% EC should be added per litre of water to make up a 2% strength spray (active ingredient basis) for controlling aphids?

Solution:

$$\text{cc (ml) of Malathion 57\% EC needed per litre of water} = \frac{2\% \times 1000}{57\%} = \frac{20}{0.57} = 35 \text{ cc (ml)}$$

ACTIVITY: Dosage calculation exercise



1 hour



Farmers and field technicians



MATERIALS

Enough of the following for each group of 4-5 participants:

- Relevant examples of pesticide labels
- Pencils and paper

PROCEDURES

Note to facilitator: Prior to workshop, select pesticides that the farmers commonly use. Select some pesticides that are expressed as a percentage of a.i. in the spray solution and others that are expressed in weight (grams) or volume (litres) of a.i. per hectare.

Give the farmers some pencils and paper and encourage them to use calculators, e.g. on their phones. Work through two examples together, and then let the farmers work through a few more calculations on their own.

At the end, ask a farmer to come to the front and share how he/she calculated the dosage. Ask the rest of the group whether they came up with the same result.

TOPIC

Correct preparation of mixtures

Rationale: In order to correctly mix CPAs, farmers must read the label and follow instructions, and they must also know how to follow and be able to apply certain good practices. They also need to understand why the correct preparation of mixtures is important, both to ensure that the product is effective and for safeguarding their own health.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Learn and be able to apply the process of correctly filling the sprayer tank
- Know what general precautions must be taken when mixing pesticides
- Know how to deal with spillages
- Know how to prepare for potential spills

BACKGROUND

For detailed information on the correct preparation of mixtures, one useful resource is the Community Stewardship training lecture series (www.stewardshipcommunity.com).

ACTIVITY: Interactive discussion and demonstration on mixing CPAs, particularly when there is more than one product



2 hours



Farmers and potentially field technicians



Field

MATERIALS

- Poster with information for display
- Sprayer

PROCEDURES

Begin by explaining the process of correctly filling up the sprayer tank:

- Read the label to ensure that the products are compatible and can be mixed safely.
- Half-fill the sprayer tank with clean water
- Measure out the correct dosage of pesticide and add it to spray tank
 - Remember that wettable powders may need creaming (made into a paste with a small amount of water) before being added to sprayer tank.
 - As a general rule: first add solids, then the liquids

Follow this order when mixing:

Solid formulations first	Then follow with liquids
WG < 100 g/ha WSB WG > 100 g/ha WP	SC SE EW EC SL Adjuvant

Where:

WG = Water dispersible granules

WSB = Water soluble bag

WP = Wettable powder

SC = Soluble concentrate

SE = Suspo-emulsion

EW = Emulsion (Oil in water)

EC = Emulsifiable concentrate

SL = Soluble concentrate

Adjuvant = substance without CPA properties, added to improve effectiveness of the CPA

- Stir with a stick, never with hands.
- Rinse out empty pesticide containers and measuring devices three times. Put all washings into the sprayer tank.
- Top up the sprayer tank with water to the required level
- Place caps on empty containers, pierce with a sharp tool to prevent re-use and store safely inside a plastic bag in a pesticide storage facility prior to safe disposal
- Return any part-empty containers to the pesticide storage facility (see the section on storage for more information on how pesticides should be stored)

Inform the participants of good practices when mixing and applying pesticides:

- Select the target – what are the farmers trying to control? Where does the spray deposit need to go?
- Select the right nozzle for the job. For a sprayer fitted with variable hollow cone nozzle, decide what setting should be selected. Squirting high targets with a jet is usually wasteful. Remember, the high flow rate leads to bigger droplets, causing a greater risk of run-off (dripping from leaves). When there is run-off, most of the pesticide will end up on the soil surface, rather than on the leaves or stems where it is needed.
- Calibrate the right amount of water (volume rate) and pesticide. How many plants per tank load? How many tank loads (thus litres) are required to spray the whole farm?
- Use the proper application technique. Be systematic about treating rows and plants. Are all the plants being sprayed effectively?
- Watch for any dripping from the leaves. This means that pesticide is being wasted.

Activity: Practical exercise to properly triple rinse – the 3 minute shake



3 minutes



Farmers



MATERIALS

- Enough empty bottles (e.g. water bottles) for all participants
- If possible, bottles should be one third full of water
- Timer
- If an internet connection is available, Harry Belafonte's "(Shake, Shake Señora) Jump in the Line" makes a nice soundtrack: <https://www.youtube.com/watch?v=Bk3sLHZzRI>

PROCEDURES

Inform the group that empty pesticide containers are not really “empty”. They have toxic residues on them. To get rid of the toxic residues, they must be cleaned. Studies have shown that proper triple rinsing can eliminate more than 99% of the toxic residues.

Tell the group that “proper triple rinsing” is more than just putting a little water in the bottle, swishing it around a little and then pouring it out. There is a way to do it right.

Explain the method and ask the group to practice proper triple rinsing together:

- Ask the participants to shake the water in the bottles for 30-60 seconds. Alert the participants when the time is up.
- Then ask them to act out pouring the contents slowly into their sprayer tank.
- Ask the participants to shake the bottles for another 30-60 seconds. Alert the participants when the time is up.
- Then ask them to act out pouring the contents out slowly.
- Ask the participants to shake the bottles for 30-60 seconds a third time. Alert the participants when the time is up.
- Ask the group to act out pouring the contents out slowly one final time.

Conclude the session by reiterating the steps for proper triple rinsing.

An online demonstration is available here: <https://www.youtube.com/watch?v=IFZ5-vxbVjw>.

Activity: Demonstration of how to mix the pesticide, filling the sprayer and rinsing empty pesticide containers



30 minutes



Farmers



Field

MATERIALS

- Five pairs of white gloves
- 5 masks
- Red powdered dye
- Spoon
- Water
- Bottles with caps
- Tool for piercing
- Bucket

PROCEDURES

In this exercise, farmers will demonstrate safe practice in mixing pesticides and triple rinsing pesticide containers, together with the piercing and storage of empty pesticide containers.

Ask for five volunteers and give each of them white gloves to put on. Instruct them to transfer a small amount of red powdered dye into a bottle using a spoon, as if they were mixing a pesticide, and then to fill the bottle up with water. The farmers should then replace the bottle cap and shake the bottle to mix the contents. This should then be poured into a bucket as if pouring a pesticide into a sprayer tank.

Farmers should then be instructed to triple rinse their bottles using clean water provided in jugs. Following this, instruct the farmers to pierce their bottle using a knife and to place it into a bag as if storing it prior to disposal.

Remain vigilant throughout the exercise to provide guidance where necessary and to highlight where farmers may be displaying unsafe practice.

After the exercise, inspect the gloves together with the farmers for any red contamination and highlight the importance of using correct PPE at all times when handling pesticides.

ACTIVITY: Interactive discussion on general precautions when measuring and mixing



30 minutes



Farmers



Classroom

MATERIALS

- Poster with information for display

PROCEDURES

Through an interactive discussion, facilitators should make sure that farmers are aware of the general precautions to be observed when measuring and mixing pesticides, described as follows:

- Always wear PPE (follow label recommendation)
- Minimum PPE is as follows: rubber gloves, non-absorbent boots, pants, long sleeved shirt, eye protection and mask (for powders)
- Always read the label
- Never mix or fill a sprayer next to rivers, wells or other waterways.
- Have clean water available for washing and mixing
- Use the measuring device supplied with the product or graduated cylinder. Never use old food containers or spoons
- Pour liquids carefully to avoid splashing
- Handle dry powders with extra care to avoid raising a dust cloud
- Never leave pesticide containers open or unattended – return them to the pesticide storage facility immediately
- Never allow children to mix or apply pesticides. They should not even be around when these activities are taking place, as they are more likely to be harmed by exposure to pesticides than adults.
- After spraying, clean out the sprayer thoroughly first with water and then use a small amount of soap.
- The farmer should not forget to wash himself and his clothes thoroughly afterwards.

Explain also that it is very important that the farmer:

- Does not smoke, eat or drink during the clean-up operation
- Keeps people and animals away

ACTIVITY: Interactive discussion on how to deal with spillages



30 minutes



Farmers



Classroom

MATERIALS

- Poster with information for display

PROCEDURES

Through an interactive discussion, facilitators should make sure that farmers are aware of what to do in case they spill a pesticide. (Note: there is additional information on cleaning up pesticide spills in the section on pesticide storage.)

Key points to take note of are as follows:

- Wear PPE
- Use soil or sawdust to absorb liquids
- Sweep up carefully and dispose of appropriately (burn or bury – more details about this can be found in the next session)
- Wash any contaminated skin and clothing

TOPIC

Mixing products – homogenization of the solution

Rationale: If a spray solution is not homogenous, then coverage may be incomplete, leaving some plants vulnerable to pest attack and other negative consequences. This section covers the need and approach for preparing a homogenised solution.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn why a homogenized solution is important
- Be able to prepare a homogenised solution

BACKGROUND INFORMATION

All pesticides must be mixed thoroughly and agitated in the tank to ensure uniform coverage. Some products (such as wettable powders) tend to settle, others (like emulsifiable concentrates) tend to separate. When using these products, the tank should be jostled or agitated with a brisk sidestep to keep the solution well mixed. Insufficient agitation may be a problem with large or irregularly shaped tanks. This problem is most serious when applying wettable powder-type pesticides. If there are dead spots or sharp corners in the tank, and if the agitation is not sufficient for a given tank, wettable powders may settle to the bottom. In other cases, dry pesticides may float on the surface a long time before a uniform concentration of pesticide in the tank is achieved. As a result, the mixture sprayed may have varying amounts of active ingredient at different times during the spray operation.

Many formulations have very specific mixing requirements in terms of the particular constituents required in the solution, the order of their addition into the solution, and especially the amount of agitation required to dissolve or maintain a uniform pesticide concentration in the spray solution. Though a general term may be used, such as moderate or heavy agitation, it is a critical step to be followed to ensure the solution is thoroughly mixed. If hydraulic agitation is used it will increase the pump flow requirements. Mixing the chemical in a small container first, then pouring it into the sprayer tank helps achieve uniform mixing.

ACTIVITY: Demonstration of the mixing process - homogenization of the solution



30 minutes



Farmers



Field

MATERIALS

- Poster with information for display about the correct preparation of the solution
- 1 20 Lt backpack sprayer
- 1 Lt of milk (liquid)
- A small amount of milk powder
- A small amount of cooking oil
- A small amount of sand
- 3 packages of powder colouring
- 1 table
- 2 buckets with water
- 4 glasses
- 3-5 beakers
- Pesticide containers of different toxicological categories
- 2 sets of PPE, including face mask with carbon filters.
- 4 markers
- 10 sheets of flipchart paper
- 1 flipchart
- 3 erasable markers
- Measuring tools, including a balance, and others as required
- Ideally bring the measuring tools that are provided with some agrochemicals with which the farmers are familiar.
- Plastic bags to demonstrate the proper disposal of the empty pesticide containers

PROCEDURES

Display all the different formulations on a table using the substitute 'products' prepared with water. Use glass or clear plastic beakers for the dilution. Use the following combinations to make the decanting more visible and to highlight the importance of the pre-mixing process: milk+water, water+oil, powder+water, sand+ water.

Introduce the different pesticide formulations, and explain how the formulation is made. The flipchart can be filled out in advance to so that the components are already illustrated.

For this activity milk and powdered dye can be used in order to simulate liquid and powder formulations. Take each one of the substitute products and carry out the dilution in front of the group holding the container in which the product is diluted and the mixture is created so that everyone can see clearly. The idea is to show how easily the milk mixes with water compared to the powder formulation. This can be repeated using sand, water and oil.

Ensure the individual demonstrating is using PPE, to set an example and encourage the participants to do the same.

After the demonstration is complete, the facilitator should invite the farmers to wear their PPE and conduct the dilution and preparation of the solution by themselves.

At the end of the session make sure the participants follow the correct procedures for cleaning and disposal of empty pesticide containers.

Key points to note are as follows:

- Wear PPE when mixing
- Discuss with the farmers the difference in the nature and composition of the pesticides. The formulation will influence the dilution process of the products. For example, a suspension will be denser and more time will be necessary to achieve a homogeneous solution.
- The aim of the mixing process is to obtain a homogeneous solution.
- Discuss with farmers the importance of the pre-mixing process.

TOPIC

Guide for the session on physical and chemical incompatibility of agrochemicals

Rationale²: Mixing incompatible products can have serious negative consequences such as changes in the efficacy of an active ingredient, damage to spraying equipment or toxicity to plants. Many farmers are not aware of these potential issues. This training topic introduces the concepts of physical and chemical incompatibility, and it highlights some of the potential consequences of mixing incompatible products. It also provides some guidance on how to assess whether chemicals are compatible.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn the concepts of physical and chemical incompatibility
- Learn how to determine whether products are compatible

BACKGROUND INFORMATION

Farmers may want to tank mix two or more pesticides, fertilizers or other chemicals in order to save time or labor. Before mixing different chemicals, it is important to understand their physical and chemical properties as CPAs are not always physically or chemically compatible with each other or with water or liquid fertilizer carriers.

- **Physical incompatibility** is a condition that prevents pesticides from mixing together properly to form a uniform solution or suspension. Physical incompatibility can lead to phase separation or the formation of scums, lumps or foams. Tank mixing chemicals which are physically incompatible may lead to loss of the CPA or may render the sprayer unusable. Physical incompatibility can occur, for example, when mixing granular formulations with water or when mixing wettable powders, water and oil.
- **Chemical incompatibility** occurs when the chemical reaction of the spray mixture reduces the effectiveness of one or more materials, or when the chemicals react to form a precipitate. Even when chemicals are compatible and their chemical reaction is beneficial, it is important that the reaction their chemicals' interaction is taken into consideration when preparing and applying a mixture. Types of interactive responses seen when mixing products are as follows:
 - **Synergism:** A synergistic response is one in which a tank-mix of 2 pesticides, or a pesticide with another substance, produces a greater response than the added effects of each substance applied separately. Farmers must be aware of this because lower application rates are required than when the two chemicals are applied separately. A common example of a synergistic response occurs when piperonyl butoxide is mixed with pyrethrum insecticides.
 - **Enhancement:** This response is similar to synergism, with the difference that it involves the mixing of a pesticide with some type of adjuvant³. When enhancement occurs, the response to the pesticide mixed with adjuvant is greater than that which would occur if the pesticide was applied alone. Adjuvants essentially function in the same way as inert ingredients that are added by a manufacturer, by making the product easier to apply and more effective. Examples of commonly-used adjuvants include various formulations of surfactants and crop oils. Many post-emergence herbicide labels will routinely advise the user to add an adjuvant, usually crop oil concentrate or surfactant, for maximizing weed control.
 - **Antagonism:** This is an undesirable response for several reasons. If pesticides are applied in a mixture, the

2. This material is taken from the *Training Guide*. Refer to the Guide for more information on preparing mixtures.

3. For more information on adjuvants, refer to the *Training Guide* section on formulations. Also refer to the UF/IFAS EDIS Extension Document listed in the references.

result may be a lower level of pest control than if either pesticide were applied alone. For example, when post-emergence grass and broadleaf herbicides are mixed, the level of grass control is often reduced. In areas where pesticides, particularly certain insecticides, are mixed with alkaline water, inactivation has been known to occur, especially when the mixture is held in suspension overnight or extended periods. Another undesirable antagonistic response is crop injury. Crop injury due to mixtures of herbicides and certain insecticide families, particularly carbamate and organophosphate insecticides, has been known to occur. Likewise, mixing two emulsifiable concentrates often results in phytotoxicity.

- **Precipitate formation:** Chemicals can react to form flakes, gels, layers, crystals, sludge or other precipitates that are not suitable for application through spraying equipment because they block screens and nozzles. Extreme incompatibility may produce precipitates that harden like concrete in the bottom of the tank and in hoses, pumps and other internal parts of the sprayer, potentially making the sprayer unusable.

Sometimes, pesticide labels provide information on precautions to take to avoid potential physical or chemical compatibility problems when combining the contents with certain substances. For example, a CPA label may specifically list examples of products which are compatible with the CPA or it may list specific examples of known compatibility issues. Even so, label instructions usually refer to only two pesticide active ingredients. They do not cover mixtures of three or more pesticides and they usually give no information on the compatibility of inert ingredients such as emulsifiers and wetting agents. In addition, factors such as type or variety of crop, weather and water chemistry (especially pH) may be important.

Before attempting a new tank mix, farmers should follow these guidelines:

- Seek advice on compatibility from an experienced expert, e.g. the manufacturer.
- Each partner chemical must be used according to the product label.
- Check the label to confirm that each partner is registered for use on tobacco.
- Tank mixes should only include an adjuvant when it is specifically required by one of the mix partners.
- The application timing of each partner must be compatible with the crop and pest stage.
- Check the label to confirm that no partner is specifically excluded on any other partner label.
- Conduct a “jar test” to assess physical compatibility of products (see activity below).
- To test for chemical incompatibility, spray the mixture on a small area and check for crop damage or reduced performance.

Some leaf suppliers advise against tank mixing different CPAs. Any guidance provided to farmers should be in line with relevant policies.

ACTIVITY: Demonstration of physical and chemical incompatibility of agrochemical products



45 minutes



Farmers, field technicians



Field or other well ventilated area

MATERIALS

- Poster with information for display about the 'Correct Preparation of the Solution'
- 1 20 Lt backpack sprayer (optional)
- 1 Lt of milk (liquid)
- A small amount of milk powder
- A small amount of cooking oil
- A small amount of sand
- 3 packs of powder dye
- Two 2 liter bottles of Coca-Cola
- Salt
- Table for display
- 2 buckets containing water
- 4 glasses
- 3-5 clear beakers or jars
- Pesticide containers or labels (use locally relevant examples)
- 2 sets of PPE including face mask with carbon filters.
- 4 markers
- 10 sheets of flipchart paper
- 1 flipchart
- 3 erasable markers
- Measuring tools, including a balance, and others as required
- Ideally bring the measuring tools that are provided with some agrochemicals with which the farmers are familiar.
- Plastic bags to demonstrate the proper disposal of the empty pesticide containers

PROCEDURES

Begin by explaining the concepts of physical and chemical incompatibility of CPAs with other chemicals. Provide locally relevant examples for each of the types of incompatibility. Indicate some of the possible consequences of chemical and physical incompatibility. A flipchart listing the types, consequences and the corresponding examples can be filled out in advance. Have the participants look at the information on compatibility on CPA labels.

Highlight the importance of chemical and physical compatibility by demonstrating the principles using "substitute products". Carry out the mixtures of the substitute products listed in the table below clearly in front of the participants, holding the container in which the product is diluted and the mixture is made. The idea is to show how the products interact when they come in contact with each other. Leave the combinations on display in front of the group as some of the examples will become even more dramatic with time.

Table 17 Examples of combinations of substitute products to illustrate chemical and physical interactions

Type		Substitute products	Description of interaction
Chemical	✓ Compatible	Water + milk	Put some water in a glass or a jar, hold it up in front of the group and then apply the liquid milk in order to show how the particles disperse. This is a good example of good chemical compatibility.
Chemical	✗ Incompatible	Coca cola + salt	Add salt to a 2 liter bottle of Coca-cola. The two will react, and the cola will foam and spew out of the bottle, illustrating chemical incompatibility.
Chemical	✗ Incompatible	Coca cola + milk	Add the milk to a 2 liter bottle of Coca-cola and then put the lid on. Over time (~30 minutes) the phases will separate, illustrating chemical incompatibility.
Physical	✓ Compatible	Water + dye	Powdered dye is used to simulate wettable powder formulations. The dye disperses evenly when mixed, illustrating physical compatibility.
Physical	✗ Incompatible	Water + sand	After mixing with water, sand will settle to the bottom, illustrating physical incompatibility.
Physical	✗ Incompatible	Water + oil	After mixing, oil and water will separate, illustrating physical incompatibility.

Ensure that the individual demonstrating is using PPE, to set an example and invite the participants to do the same.

After the demonstration is complete, the demonstrator/trainer can invite the farmers to wear the PPE and carry out the dilution and preparation of the solution by themselves.

At the end of the session make sure the participants follow the correct procedures for the cleaning and disposal of empty pesticide containers.

QUESTIONS FOR DISCUSSION

- Q What happened when the different products were mixed?
- Q If a farmer uses a tank mix which is incompatible, what are some possible consequences?
- Q What can farmers do to avoid compatibility problems?

ACTIVITY: CPA compatibility “Jar test”



45 minutes



Field technicians, farmers who tank mix



Field or other well ventilated area

MATERIALS

- 1 litre glass jar
- Appropriate PPE for CPA mixing
- Water
- Locally appropriate examples of compatible and incompatible CPAs

PROCEDURES

Begin by introducing the participants to the concepts of chemical and physical computability if you have not done so already.

Inform the group that before they carry out new tank mixes, they should assess whether the products are compatible. They should first begin by checking the product labels for information on compatibility of spray materials. To test for physical compatibility, farmers can conduct a “jar test”.

When conducting a jar test, it is important to always wear appropriate personal protective equipment and to carry out the test a well ventilated area, away from sources of ignition.

Steps for testing compatibility:

- Fill a sealable, 1 L clear glass jar with 500 ml of water. The water used for the test should be the same water which would be used to fill the spray tank.
- Add ingredients according to Table 17, stirring after each addition.
- Let the mixture stand in a well-ventilated area for 15 minutes and observe the results.
- Signs that the chemicals are not compatible:
 - If the mixture is giving off heat, the ingredients are not compatible.
 - If gel or scum forms or solids settle to the bottom (except for the wettable powders) then the mixture is likely not compatible
- If no signs of physical incompatibility appear, test the mixture using a spray bottle on a small area where it is to be applied. Look for phytotoxic indications, such as plant damage, and monitor efficacy (which is hard to do unless you actually fill the sprayer and try it on a few plants).

ACTIVITY: The story of Farmer A and Farmer B (role playing activity / sketch to illustrate consequences of not following labels)



20 minutes



Farmers



Classroom

MATERIALS

- 2 products labels printed in a large size (1 herbicide and 1 fungicide)
- Simulation of pesticide containers
- 2 people representing farmers

PROCEDURES

Introduce the topic in an interactive way by holding a discussion with the farmers about what type of information is provided by the product label in detail.

Choose an example of a particular crop and field situation before the role play starts for a better understanding.

Role Play

One of the farmers (Farmer 1) explains to his colleague (Farmer 2) the importance of properly reading the information provided by the product label. After this explanation he leaves the room.

It is morning and Farmer 2 pretends to be very tired while getting up. He has to make an application and has no time to read the product label. By mistake he confuses the fungicide with the herbicide and makes the application using high doses of the product just to “make sure it works”.

The next day Farmer 1 comes back and sees that all the plants where Farmer 2 made the application are dead. He asks what product Farmer 2 applied, who then remembers that he had not read the label. Farmer 2 realises that he has confused two products with each other, and that he has applied a systemic herbicide instead of a fungicide, which has killed the crop.

Key points to take note are as follows:

- Highlight the importance of using the right product
- Discuss the importance of reading the label and using the right doses.

TOPIC

Nozzle selection and maintenance

Rationale: Many farmers are unaware that the nozzle they use matters, and some may not even realise that there are differences in nozzles. In addition, many farmers do not maintain their nozzles correctly.

LEARNING OBJECTIVES

Through training on this topic trainees will:

- Learn about the different types of nozzles and how they impact on droplet size and dispersion patterns
- Understand how to select the correct type of nozzle
- Learn about nozzle maintenance and safety

BACKGROUND

For more information see: <http://www.stewardshipcommunity.com/best-spraying-practices/spray-distribution.html>

ACTIVITY: Interactive discussion and nozzle demonstration



20 minutes



Farmers and field technicians



Field

MATERIALS

- Poster to aid discussion
- Backpack sprayers
- Different types of nozzles

PROCEDURES

Begin by explaining that nozzles are used to:

- Regulate the amount of spray delivered (nozzle output)
- Break liquid into droplets
- Spread droplets in a given pattern

List and show different types of nozzles, e.g. hollow cone, flat fan, deflector, etc. Talk about colours and flow rates, noting that those with the same colour have the same flow rate at the same pressure.

Hollow cone



Flat fan



Deflector



Air inducing (sometimes called bubble jet)

Flat fan

Low drift

Air inducing (smaller version)

Hollow cone

Flood jets (sometimes called anvil or reflex)



Figure 9 Examples of types of nozzle (Image source: stewardshipcommunity.com)

colour	US GAL at 40 PSI	Litre at 3 bar
Orange	0.1	0.39
Green	0.15	0.59
Yellow	0.2	0.79
Blue	0.3	1.18
Red	0.4	1.58
Brown	0.5	1.97
Grey	0.6	2.37
White	0.8	3.16

Table 18 Nozzle flow rate (source: stewardshipcommunity).

Nozzle selection: spray volume rates

Explain that water volume rates are usually stated on product labels to ensure adequate coverage of target surfaces.

- A volume rate that is too low leads to:
 - Poor coverage
 - Poor penetration
- A volume rate that is too high leads to:
 - Product run-off from the target
 - Over dilution of product and surfactants
 - More time taken to spray the crop

Nozzle selection and use

Cover the following points:

- Patterns and droplet size
- Too small of droplet size can cause drift
- Too large droplets can cause runoff
- More droplets available = more coverage on the target.

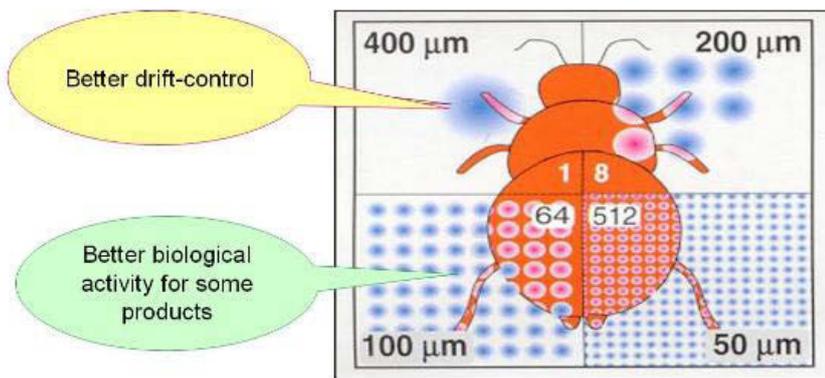


Figure 10 More droplets from the same volume of water are produced if drop size is decreased. (Image source: stewardshipcommunity.com).

Rule of thumb:

Systemic acting products:	20 – 30 drops/cm ²
Contact acting insecticides/fungicides:	50 – 70 drops/cm ²
Contact herbicides:	30 – 40 drops/cm ²

General rule in the field for any product: Aim for an average of 20 drops/cm²

Table 19 General rules for Nozzle Selection and Drop size, (Image source: stewardshipcommunity.com).

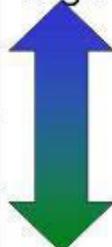
<u>Spray quality [Drop size]</u>	<u>Typical Uses stated</u>	<u>Retention</u> e.g. on waxy leaf surfaces	<u>Drift risk</u>
VERY FINE	Rarely advised. Some mist blowers only	Good	 High Low
FINE	Good cover	Good	
MEDIUM	Standard	Good	
COARSE	Soil herbicides	Moderate	
VERY COARSE	Liquid fertilisers	Poor	

Table 20 Nozzle type and Spray Volume for boom sprayer (in temperate climates), (Image source: stewardshipcommunity.com).

<u>Product-type</u>	<u>Flat Fan</u>	<u>Low Drift</u>	<u>Air Induction</u>	<u>Spray (l/ha)</u>
<u>Herbicide:</u>				
Non-selective	xxx	xxx	xx	200 – 1000
Pre-emergent	xxx	xxx	xxx	200
Post-emergent -contact	xxx	xxx	x	200
-systemic	xxx	xxx	xx	200
<u>Growth regulators</u>	xxx	xxx	xxx	200
<u>Fungicides e.g. cereals:</u>				
early	xx	xxx	xxx	200
Leaf	xxx	xxx	xxx	200
Late	xxx	xxx	xx	200
<u>Fungicides e.g. potato:</u>				
early – mid	xxx	xxx	xxx	200 – 400
mid –late	xx	xxx	xxx	400 –600
<u>Fungicides e.g. s-beet:</u>	xxx	xxx	xx	200 - 400
<u>Insecticide all crops :</u>	xxx	xxx	x	200 – 400

xxx = Preferred xx = Useful alternative

x = Acceptable when used at higher volumes and pressures (e.g. ID: > 5 bar)

** Tables from Stewardship community, similar table in FAO Sprayer Operator Handbook.

Type of Product	Direction of application	Reflex nozzle	Flat fan	Hollow cone
Herbicide, Systemic Fungicide				
Contact Fungicide, Insecticide				
Contact Fungicide, Insecticide				
Drift Risk		Low	Medium	High

Figure 11 Selection for knapsack sprayer. (Image source: stewardshipcommunity.com).

Nozzle Maintenance and Safety

DO NOT –

- Clean a nozzle with an abrasive implement
- Clean a nozzle by blowing through it with your mouth
- Use damaged or worn nozzles
- Use fine spray drop sizes on a windy day

DO –

- Wear gloves when handling nozzles
- Clean a nozzle with water and a light brush
- Protect nozzles from blockages with the use of recommended filters
- Frequently clean nozzles
- Replace the nozzle if damaged
- Change nozzles as necessary depending on the crop, growth stage and product mode of action

ACTIVITY: Nozzles demonstration – effects of nozzle type



20 minutes



Farmers and field technicians



Field

MATERIALS

- Backpack sprayer or “killer spray” type bottle fitted with a flow coefficient (CV) valve
- Nozzles (at least 3 types: cone, flat fan and jet)
- Water
- Dye
- Water sensitive paper (WSP)

PROCEDURES

The objective of this activity is to demonstrate to farmers the effect of different nozzles on droplet size and dispersion pattern.

- Fill the backpack sprayer with water and place x droplets of blue/red dye into a backpack sprayer
- Lay 3 or 4 large squares (approx. 1 x 1 metre) of water-sensitive paper (WSP) or flip chart paper on the ground at the bases of the plants or smaller pieces on the plant.
- Apply one type of nozzle to a backpack sprayer and spray the liquid onto one of the squares of paper.
- Next, remove the nozzle and replace with the second type of nozzle. Spray the liquid out onto another piece of water-sensitive paper.
- Repeat for however many different types of nozzles are available.

QUESTIONS FOR DISCUSSION

- Q Which nozzle had the biggest droplet size?
- Q Which nozzle had the smallest?
- Q Which nozzle provided the most coverage?
- Q Which nozzle provided the least coverage?
- Q How does droplet size or coverage impact nozzle selection?

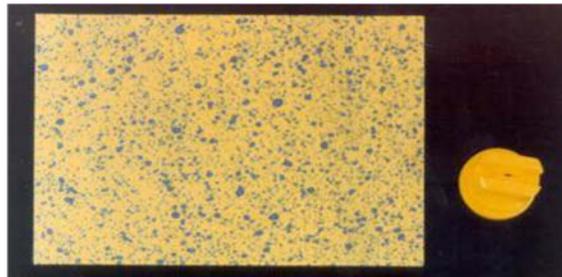
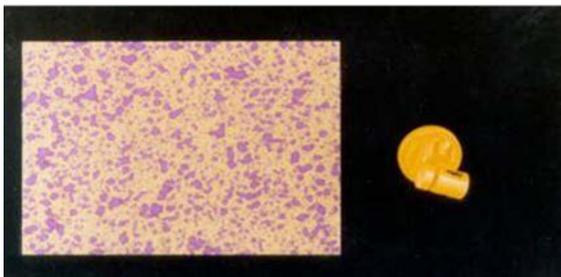
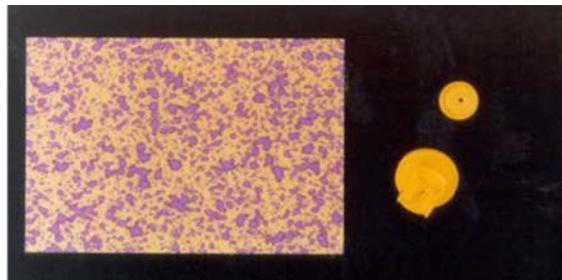
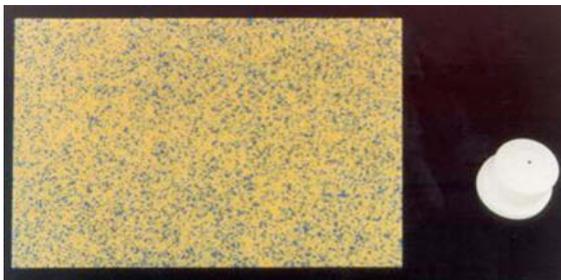


Figure 12 Illustration of droplets patterns for different types of nozzles. (Image source: stewardshipcommunity.com).

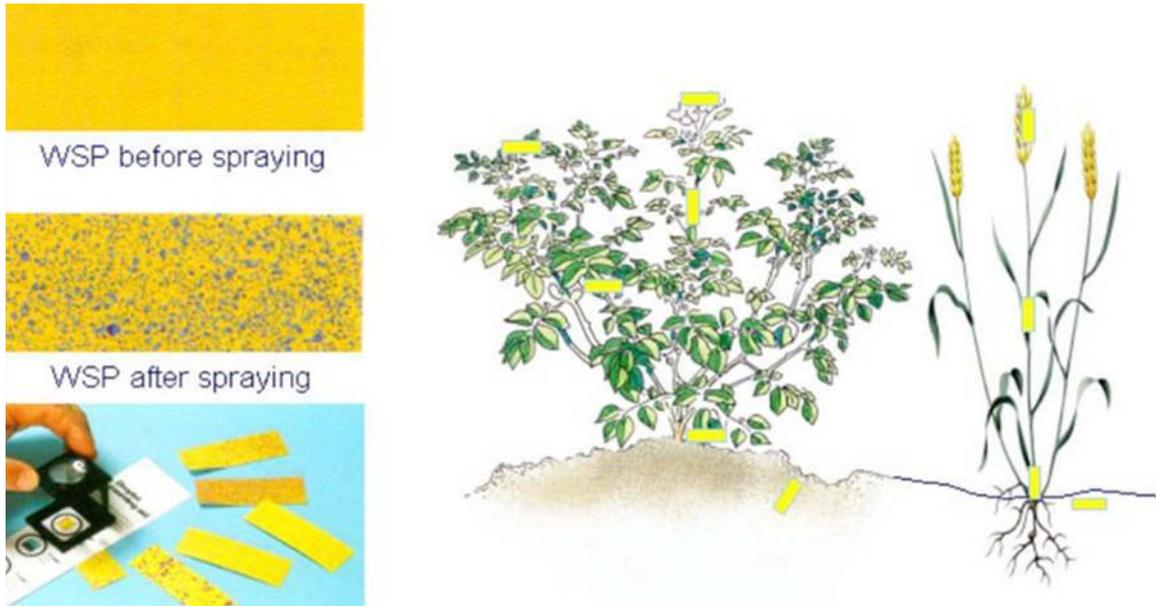


Figure 13 Small pieces of water sensitive paper can also be placed on the plant. (Image source: stewardshipcommunity.com).

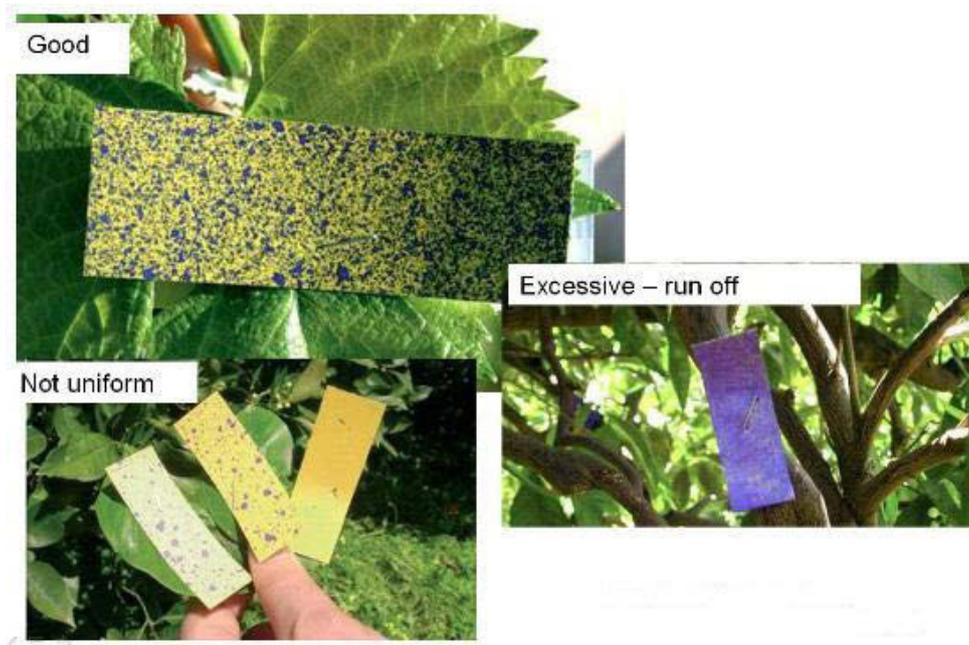


Figure 14 Illustration of good coverage, excessive run-off and coverage which is not uniform. (Image source: stewardshipcommunity.com).

Activity: Nozzles demonstration – effects of nozzle setting



20 minutes



Farmers and field technicians



Field

MATERIALS

- 2 backpack sprayers
- 2 nozzles (wide cone and jet)
- Water
- 2 Litre measuring cup
- Watch
- Paper and pen
- Calculator

PROCEDURES

The objective of this activity is to show differences in flow rate between nozzles.

Divide participants into two groups and give each group a sprayer.

Ask group 1 to fill the sprayer with water and set the nozzle at a wide cone setting. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing the readings by 2. Record the results.

Ask group 2 to fill the sprayer with water and set the nozzle at a narrow jet setting. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing the readings by 2. Record the results.

Ask each group to change the nozzle setting (group 1 should now use narrow jet setting and group 2 should use wide cone setting) and repeat the exercise.

QUESTION FOR DISCUSSION

- Q** Does the output of a nozzle change with different settings? If yes, why?
- Q** Is the output of the different nozzles similar at similar cone angle settings?
- Q** Did the operators operate the pump lever at the same rate? What difference does this make?
- Q** What have the participants learned from these exercises and how will they apply what they learned?

ACTIVITY: Nozzles demonstration – improved spraying technique to reduce wastage



1 hour



Farmers and field technicians



Field

MATERIALS

- Backpack sprayer or “killer spray” type bottle fitted with a CV valve
- Nozzles (at least 3 types: cone, flat fan and jet)
- Water
- Dye
- Water sensitive paper

PROCEDURES

In the third part of the session on nozzles, the objective is to show how wastage can be reduced with improved spraying technique

Mix two batches of 15 litres of water with the dye and fill the tanks with the water and dye mixture. Select a large area (with more than 100 tobacco plants). Cover the base of 25 plants with paper.

Divide participants into two groups. Group 1 should set the nozzle on a wide cone setting. Group 2 should set the nozzle on a narrow-jet setting. Ask a volunteer from each group to spray the 25 plants, each using farmers' normal practice.

Observations

Each group should observe:

- The amount of leakage from the tank and lance assembly (trigger valve, joints, etc.)
- Rate of operating pump lever (if using a knapsack sprayer)
- The amount of run-off from pods
- The amount of liquid falling on the paper
- Amount of residue in each tank after spraying

Questions for Discussion

- Q Does the output of a nozzle change with different settings? If yes, why?
- Q Is the output of the different nozzles similar at similar cone angle settings?
- Q Did the operators operate the pump lever at the same rate? What difference does this make?
- Q What have the participants learned from these exercises and how will they apply what they learned?

ACTIVITY: Nozzles demonstration – effects of nozzle condition



40 minutes



Farmers who are not aware of the importance of the nozzle being in good condition in order to achieve good performance



Field

MATERIALS

- Two sprayers belonging to the participants
- Either* two different types of nozzles if available on the local market *or* use similar variable cone nozzles at two different settings: wide cone and jet
- 1 nozzle in a very bad condition and 1 new nozzle
- 2 buckets
- 2 litre measuring cup
- Watch (measuring seconds)
- Rolls of paper towels or poster papers that have a smooth reverse side
- Non-toxic dye, preferably red
- 30 litres of water

PROCEDURES

Divide participants into two groups and give each group a sprayer. Ask group 1 to fill the sprayer with water and use the nozzle in bad condition. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing the readings by 2. Record the results.

Ask group 2 to fill the sprayer with water and use a new nozzle. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing the readings by 2. Record the results.

To introduce the problem of “run-off”, do the following:

- Mix water with tracer dye
- Allocate 3 sections of a farm where 3 operators can calibrate
- Place paper targets around the base of the tobacco plants
- Fill a sprayer tank with a known amount of water (this will depend on the sprayer)
- Ask at least three of the farmers to spray the tobacco plants according to their normal methods
- Count the number of plants treated until the tank is empty

Ask each group to change nozzles, using one in a very bad condition and a very new one in order to see the sizes of the drops in each case and the uniformity of the application.

TOPIC

CPA application methodology

Rationale:

Match the product to the available equipment for application. Certain formulations cannot be used with a knapsack or other hydraulic sprayers.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Become familiar with the different common methods of CPA application
- Discuss when to use them and the precautions that should be taken
- Be able to select appropriate application equipment and pesticide formulations

ACTIVITY: Interactive discussion on methods of CPA application



20 minutes



Farmers



Classroom

MATERIALS

- Poster
- Flip chart and markers

PROCEDURES

Begin by reminding the group that achieving satisfactory results from pesticides depends heavily on these five major factors:

1. Positive identification of the pest.
2. Choosing a pesticide that has the least persistence and lowest toxicity to be able to work.
3. Selecting the right equipment, particularly the right type and size of nozzle for the job.
4. Applying pesticides accurately and at the right time.
5. Calibrating and maintaining equipment to make sure the amount of active ingredient

Inform the participants that insecticides and fungicides are usually applied as foliar sprays, and herbicides are mostly sprayed either onto the foliage or the soil. Thus spraying of liquid and WP formulations is the most common method of application and consequently a wide variety of hand-operated and power-driven spray apparatus have been developed over the years. Other formulations such as granules, dusts and fumigants require different equipment for their application or none at all. For example, granules can either be applied by mechanical spreaders or broadcast by hand.

To achieve the best result possible using the least amount of pesticide, farmers need to think through the application process carefully. Different application methods are appropriate for different crop and pest types, but the method of application should always be consistent with the label directions.

Ask the participants which application methods they know of or have used. Write down their examples on a flip chart. Fill in any gaps.

Fill in application methods should ultimately include:

- **Band application**, applying a pesticide in parallel strips or bands, such as between rows of crops rather than uniformly over the entire field.
- **Basal application** directs herbicides to the lower portions of brush or small trees to control vegetation.
- **Broadcast application** is the uniform application of a pesticide to an entire area or field.
- **Directed-spray application** specifically targets the pests to minimize pesticide contact with non-target plants and animals.
- **Foliar application** directs the pesticide to the leafy portions of a plant.
- **Rope-wick or wiper treatments** release pesticides onto a device that is wiped onto weeds taller than the crop, or wiped selectively onto individual weeds in an ornamental planting bed.
- **Soil application** places pesticide directly onto or into the soil rather than on a growing plant.
- **Soil incorporation** is the use of tillage, rainfall, or irrigation equipment to move the pesticide into the soil.
- **Soil injection** is the application of a pesticide under pressure beneath the soil surface.
- **Space treatment** is the application of a pesticide in an enclosed area.
- **Spot treatment** is the application of a pesticide to small, distinct areas.

Ask the group to indicate which methods should be used for the CPAs that they commonly apply in tobacco. Write these examples on the flip chart beside the appropriate application method. (An additional column can be added for this purpose.)

Conclude the discussion by asking the group whether they have any questions regarding the use of the different application methods.

General precautions while spraying

Rationale: In order to ensure the CPA applicator is carrying out the correct procedures during the whole preparation and application processes it is necessary to bear in mind the important issues already discussed in this guide.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Become familiar with and be able to apply general precautions for CPA spraying

BACKGROUND INFORMATION

Plan the spray application/operation so that:

- The farmer does not have to walk or drive through the newly treated crop or area
- An area is left untreated for the disposal of sprayer washings
- There is no risk of spray drifting outside of the tobacco field, i.e. wind speed and direction must be taken into account

Pre-notification

Before application, make sure that the treatment area is clear of all unprotected people. Many states require that all persons in the intended treatment areas, or even in adjacent areas, be informed about pesticide applications before the pesticides are applied. This warning is referred to as “pre-notification”. Pre-notification of a pesticide application is intended to protect others from exposure to pesticides.

Take general precautions while spraying

- Do not work in strong winds and ensure any wind blows the pesticide away from the operator
- Avoid spraying near the margins of the field, watercourses and wildlife areas
- Maintain a constant speed
- Do not spray while the vehicle is turning
- Never suck or blow out clogged nozzles or pipe connections by mouth – clean them with water and a soft stick e.g. a grass stem, or use a nylon bristle brush. Ensure that any tool that is used for this kind of job is not used for anything else
- Keep people and animals away
- Never leave pesticides or machinery unattended
- Wash hands and face thoroughly after pesticide use and before carrying out any other activity.
- Never eat, drink, or smoke when handling pesticides. Chemicals may be transferred from hands to mouth during smoking.
- Wash hands carefully before eating, drinking, smoking, or using the toilet. This should be done as soon as the farmer or field technician has finished handling the pesticides.
- Do not smoke in recently treated areas. Smoking with pesticide-soiled hands can also be extremely dangerous if flammable chemicals are being used.
- Not all labels will state it, but pesticide applicators are required by law to prevent direct or indirect exposure of workers and other persons. Keep children, unauthorized persons, and pets out of the area to be sprayed and at a safe distance from sprayers, dusters, filler tanks, storage areas, and/or old pesticide containers.

Avoid sensitive areas

- Avoid spraying near houses, schools, playgrounds, hospitals, bee hives (apiaries), lakes, streams, pastures, or sensitive crops.
- If spraying must be carried out near sensitive areas, never spray or dust outside on windy days.
- Even with low winds, always apply downwind from any sensitive area.
- Plan CPA applications for times when people, animals, pets, and non-target pests (such as honey bees) will not be exposed.
- Notify residents and beekeepers when spraying is planned in their areas and urge them to take appropriate precautions.
- Be sure that children and pets are not present in the area of the pesticide application.

Avoid Exposure

Even moderately toxic chemicals can be poisonous to you when they are used day after day. Pesticides can contaminate clothing and may soak through to the skin. In order to minimise this risk, farmers or field technicians should not work in drift, spray, or runoff unless they are properly protected. If pesticides spill on their gloves, farmers must be careful not to wipe their hands on their clothing.”

Avoid Drift, Runoff, and Spills

Pesticides that fall anywhere but on the target area can injure people, crops, and the environment. This risk can be managed by choosing weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that minimize drift and runoff hazard. Spills can be avoided by taking simple precautions.”

ACTIVITY: Are we doing the right things? Role play on issues to consider when both preparing and applying pesticides.



15 minutes



Farmers



Classroom

MATERIALS

- Poster displaying the check list
- Cigarette
- Shorts and t-shirt for pesticide applications
- Food

PROCEDURES

- Ask for at least three volunteers from the participants to play the roles of a farmer, a farmer's wife and a field technician.
- The other farmers will be invited to write down all the mistakes that they observe during the role play in order to discuss them afterwards.
- The actor playing the role of the farmer initiates the role play by getting ready to make the CPA application, wearing shorts, a t-shirt and no shoes. He will make as many mistakes as possible, such as eating and smoking while applying, pretending to apply CPAs in the same direction as the wind resulting in the liquid entering in his eyes.
- The farmer's wife and the field technician should offer advice to the farmer to follow better practice, e.g. not to eat or drink while working with CPAs. The participant playing the farmer should ignore or reject the advice.
- At the end of the role play, the participant playing the farmer can simulate becoming ill as a consequence of CPA exposure.
- The other farmers participating will then be invited to discuss the mistakes they observed and what the farmer should have been doing instead when he was applying the CPAs. Summarise what the key considerations are that should be taken into account throughout the whole procedure.

The influence of the weather conditions on an effective CPA application

Rationale: Weather conditions can significantly affect the efficiency of the application of CPAs and requires special attention.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn the role that weather conditions can play both in helping and hindering the applicator.
- Understand the hazards of windy day application and who is legally responsible for any mistakes made.
- Learn the advantages of early morning or evening application.
- Understand the roles of humidity and temperature inversion in regard to CPA application.

BACKGROUND INFORMATION

Weather-wise application can reduce pesticide hazard to the environment. A good applicator carefully checks the weather conditions before beginning spray procedures. Not only can a few simple precautions protect the environment, but they will also save money. CPAs that do not reach or remain on the target areas are wasted, which means that more CPAs, time, and money will be needed to control the pests in those target areas.

Temperature and humidity affect CPA drift; high temperature and low humidity increases the rate of evaporation of the CPAs. Small droplets that completely evaporate leave CPA particles in the air, which may be carried several miles away from the treatment area (this is known as vapour drift).

High winds increase drift and result in the loss of CPA from treated areas. Drifting CPAs increase the possibility of injury to wildlife, pollinators, and domestic animals. They may settle on forage, pasture or wildlife areas or contaminate water. Carrying out CPA application on quiet days will reduce the risk of inhalation and contact hazard to the applicator and any bystanders. Drift onto sensitive crop areas can also be avoided in this way. The applicator is legally responsible for any injury or money loss due to CPA drift onto non-target areas, so they should not take the risk by spraying in the wind.

ACTIVITY: Evidence of the influence of the wind during application



20 minutes



Farmers



Field

MATERIALS

- 20 L backpack sprayer
- Flip chart and markers
- Flipchart paper
- Dye – red solution
- Water

PROCEDURES

Place the flipchart paper at the base of the plants in the area of the crop where the application will be carried out.

Dilute the colouring powder in water to simulate a CPA and place it in the 20 L backpack sprayer.

Assess which direction the wind is blowing in order to make an application in the opposite direction, and then repeat the operation making the application in the same direction as the wind.

Examine the white flipchart paper for the dye droplets after the applications of the simulated CPA both into and away from the direction of the wind, and discuss the results with the farmers.

TOPIC

Environmental and wildlife considerations while spraying

Rationale: Farmers need to be aware of special risk areas and practices that can be employed to minimise any environmental impacts.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be made aware of the negative impacts of indiscriminate pesticide use on wildlife and the environment
- Learn the general principles that can be employed to avoid impacting negatively on the environment.

ACTIVITY: Interactive discussion on special risk areas to be aware of when spraying



20 minutes



Farmers



Classroom

MATERIALS

- Flip chart and markers
- Poster display
- Examples of news stories about the impact of CPAs on wildlife and the environment

PROCEDURES

Whenever a pesticide is used, there is a possibility that some of it will end up outside of the tobacco field being treated. The resulting contamination of the environment can be a hazard to wildlife and people.

Begin by asking the participants whether they have ever observed or heard of any negative impacts on wildlife or the environment. For example, have they ever heard of fish dying because of pesticide containers being rinsed in streams or have they seen birds die after eating treating seeds? Write the examples down on the flip chart. Facilitators can also circulate examples of news stories from the local press which might be relevant. Many international news stories are also available online.

Mention that special risk areas include:

- Open water, such as rivers, water reservoirs, ditches and streams
- Cultivated land, where existing or subsequent crops may be contaminated
- Uncultivated land, where wild plants and animals may be contaminated

Engage the group in a discussion about the measures that can be taken to avoid such contamination. Ask the group for their suggestions and then fill in any gaps. Some general principles are as follows:

- Do not spray in strong winds - check the weather forecast and the actual weather conditions for wind speed and direction before you start
- Do not treat the areas closest to the downwind border of the field being treated; a row of plants should be left untreated
- Do not spray close to special risk areas if they appear to be at risk from spray drift
- The safest conditions in which to spray are when the weather is cool and humid, with a light breeze blowing away from any sensitive areas
- Do not spray when temperature is above 30°C as rising air currents may spray droplets and vapour in an unexpected way
- If using a tractor-mounted sprayer, do not drive too fast
- Avoid spillages and leaks of CPAs
- Minimise the area of pesticide application (e.g. by treating only affected plants)
- Ensure the correct disposal of empty containers, waste CPAs and sprayer tank washings

If farmers store large quantities of CPAs, suggest that they consider setting up an environmental monitoring system. Under a monitoring system, samples would be periodically taken from water, wildlife, and plants near the storage area. The samples would then be assessed to make sure that no CPAs are getting out into the environment.

ACTIVITY: “And then...” (A story game to review the steps involved in appropriate CPA use)



1 hour



Farmers



Classroom

MATERIALS

None

PROCEDURES

The objective of this game is to get the participants to think through and apply what they have learned about the correct application of CPAs. In this game, each person in turn will fill in the next step in the “story” of how to prepare and apply CPAs correctly. Each participant should only fill in one step. Once they have finished with their step, they should say “**and then...**” If a participant is going on for too long or if the participant forgets to say “**and then...**”, the facilitator can intercede to keep the story moving.

The facilitator starts the “story” with a scenario, e.g. “*Early one day, Farmer Joe was monitoring tobacco plants in his field and saw that budworm was over ETL. He decided to take action. And then...*”

After the facilitator begins the story, they then pass the story on to the first participant. This person should fill in the next step, for example, they could say “*Farmer Joe checked the weather to make sure it was clear and then...*”

If a participant forgets to fill in a key step, the facilitator can prompt by asking “*Didn’t he do something before that?*” Try to elicit as many steps as possible.

To make the activity more lively, facilitators can ask the participants to act out the steps, e.g. they can mime checking the weather, putting on PPE, reading the label, pouring the CPAs, piercing containers, etc.

Also, facilitators can introduce new elements to the story, e.g. wind blowing.

Records that must be kept after each CPA application

Rationale: According to baseline study findings, record keeping on CPA application is something that few farmers do, and even in the places where record keeping is done, it tends to be something that farmers struggle with. The expectations and requirements for record keeping are growing. Farmers need to know what they have to do in order to comply with these requirements and they also need to be aware of the ways in which record keeping can be of benefit to them.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Learn the potential benefits of maintaining records of CPA usage
- Be able to fill in and maintain records on CPA usage

BACKGROUND INFORMATION

Record keeping is a fundamental requirement of all quality assurance schemes, including PMI's GAP programme. The GAP programme requirements state that, where possible, spray application details for each spray event (including in seedbeds) should include:

- Field name or location
- CPA name or active ingredient, and dosage rate
- Date and method of application
- Re-entry period and PHI
- Targeted pest
- Prevailing weather conditions
- Applicator name

Maintaining CPA records can also help farmers to remember when something was applied and how many times. They can use this information to assess what worked well and what did not work as well across seasons.

The spray record should be completed at the time of application and kept for a minimum of two seasons or longer if specified by applicable regulations. CPA application records must show that CPA label instructions have been followed and will help demonstrate that a duty of care has been taken.

ACTIVITY: Brainstorming and group work on records to keep on pesticide applications – why, what and how



1 hour



Farmers and field technicians



Classroom

MATERIALS

- Flip charts and markers
- Example record sheet

PROCEDURES

Begin by asking the participants why it might be a good think to keep records of CPA usage. Urge the participants to think of reasons why this information might be useful for farmers, for the company and perhaps even for other stakeholders. Record their ideas on a list on the flip chart. Fill in any gaps in the list.

Types of information to be included in the list:

- To help the farmer remember when something was applied and how many times – for example, to assess what worked well and what did not work as well
- To enable the farmer to calculate costs and profits from crops
- For health and safety reasons
- For quality assurance
- To be able to recall
- To be able to demonstrate that there were no deviations from requirements such as PHI and maximum number of applications
- To comply with GAP certification requirements or contractual requirements

Once a comprehensive list of reasons for maintaining records of CPA usage has been compiled, ask the group for examples of the types of information that should be recorded. Record this information on another flip chart page.

Types of information to be included in the list:

- Field name or location
- Date of CPA application
- Crop growth stage
- Target pest
- Prevailing weather conditions
- Applicator name
- Name/number of sprayer
- Method of application
- Product used
- Formulation type
- Dosage (l/ha)
- Observed result (report on the product effectiveness)

With gentle steering, the group should arrive at an appropriate list of types of information to be recorded. If a record keeping form already is available in the country, then distribute this form. If not, use the data types which the group has listed to construct a form and share it with the participants.

Divide the participants into small groups and give each group an example pest, crop stage and CPA product (e.g. the container or a label). Tell the group to then practice filling in the form as if they were applying the CPA right then (e.g. the date, prevailing weather conditions, location, etc. will be the same as the day of the exercise). For equipment type, they should fill in the type of equipment that one of the group member has.

QUESTIONS FOR DISCUSSION

- Q** In general, why should records of CPA use be kept?
- Q** What value do records have to farmers?

TOPIC

Understanding residue problems and how to avoid them

Rationale: From the perspective of the company, problems with CPA residues can result in millions of dollars of losses. From the perspective of farmers, the presence of residues of CPAs that are not allowed for use on tobacco or of residues in quantities above the Maximum Residue Limit (MRL) can result in tobacco being rejected, resulting in significant personal losses. Meanwhile, some farmers are not aware of the issues associated with CPA residues, nor are they aware of the strategies that they can employ to avoid residue problems.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be made aware of what residues and maximum residue levels are
- Learn under what circumstances residues can be a problem
- Be able to apply strategies to avoid residue problems

BACKGROUND INFORMATION

A residue is any substance in or on an agricultural product, as well as in the soil, air and water, resulting from the use of a pesticide. Once applied, pesticides break down over time due to natural degradation processes, e.g. sunlight, rainfall, plant growth. The speed at which they break down varies by chemical, and residue levels per time are assessed through residue-level field and lab trials. The MRL is the maximum concentration of a residue that is legally permitted or recognised as acceptable in or on an agricultural product.

Tobacco is an internationally traded crop so there are also market requirements for a “compliant crop”. Fundamentally, residues of WHO Class 1 CPAs or CPAs not registered for use on tobacco in the country of origin are problematic. Residues are also an issue if they are found to be above MRL.

Through green leaf testing and TLI, residues are measured and monitored for dozens of different active ingredients. In many countries, there are clauses in farmer contracts regarding which CPAs can be used. Likewise, there may be a clause which states that contracts can be cancelled or tobacco can be rejected if CPA residue problems are detected. If residue problems are chronically a problem in a particular country or region, then PMI or its leaf suppliers may cease to buy tobacco from that area. At an international level, detection of residues could have serious implications for market access.

Strategies for avoiding problems with CPA residues include the following:

- In general, e.g. do not apply CPAs that are not labelled for tobacco, and do not apply CPAs that are not acceptable to PMI
- Use CPAs that are on PMI's preferred list of products
- Follow the label directions. In particular, rate, application number and pre-harvest interval
- Avoid unnecessary applications of CPAs, spray crops based on monitoring, and use IPM approach for managing pests
- Follow contract restrictions
- Follow proper application procedure as follows:
 - Calibrate the sprayer
 - Use proper nozzles/sprayer tips and arrangements
 - Follow guidance regarding the timing of applications relative to weather conditions

- Rinse and maintain sprayer equipment, and avoid using contaminated sprayer equipment
- Keep CPA application records
- Do not trade cows, farm equipment, etc. for bales of tobacco. Other farmers may not be growing a compliant crop.

ACTIVITY: Can you use it? Yes or No (Game)



1 hour



Farmers and field technicians



Classroom

MATERIALS

- CPA containers or CPA labels, at least one per group
- Pieces of paper (e.g. poster paper) with scenarios written on them
- Paper with blank tables for participants to fill in
- Optional materials for the exercise could include a record of CPA application filled in showing that some CPAs have already been applied the maximum number of times, the PMI preferred list &/or the nationally harmonised list (which includes the PMI preferred products registered for that country), a weather forecast

PROCEDURES

In advance, obtain CPA containers or labels from CPA containers. Have several realistic examples of CPAs that are both allowed and not allowed. Have enough labels for each group to have more than one example of a CPA. Examples of types of CPAs could include:

- CPAs on the recommended list that are distributed by the leaf supplier; make sure to have several types with different MoA, target, PHI, etc.;
- CPAs that are not registered for use on tobacco but are allowed on other crops;
- CPAs that are clearly illegal in some respect (e.g. in countries with a language requirement, where the CPA label is in the wrong language);
- CPAs that are registered for tobacco but not allowed by PMI (e.g. WHO Class 1 CPAs)

Also prior to the activity, prepare sheets with simple scenarios written on them. Writing should be large enough to be seen at a distance. Make sure to have examples that will oblige participants to look closely at the labels. Have some examples where no CPAs should be applied. Also have some examples where many of the CPAs provided could be appropriate. Give each scenario a number. Examples of scenarios could include:

- Before planting against nematodes
- Before transplanting for aphids
- Post-transplanting for xyz...
- Before button for xyz...
- Before topping for xyz...
- Post-topping for xyz...
- All season for xyz...
- Before harvest for flea beetles;
- Before harvest for caterpillars, and so on.

Begin the exercise by explaining to the participants what CPA residues and MRLs are and why they are important. Inform the group which CPAs in particular cause problems if they are detected, regardless of how much is present (e.g. residues of WHO Class 1 CPAs, residues of CPAs that are not registered for use on tobacco). Remind the group

of any contractual requirements that they have in terms of CPA use and the consequences for the detection of residue problems.

Remind the participants of some key concepts they have already learned, e.g. using CPAs that are recommended/allowed; avoiding CPAs that are prohibited; avoiding CPAs of questionable provenance or quality; following the instructions on CPA labels; contractual restrictions; using proper equipment, e.g. nozzles; sprayer calibration; keeping CPA application records; etc. Refer to the background information for details on steps to take to avoid residue problems.

Divide the participants into small groups. Give each group a few CPA labels or CPA containers with their labels. Tell the groups that they will be presented with scenarios and ask them to write down for each of the CPAs they have, whether or not it could be applied under that scenario (see Table 21 for a recording format). To get them started, lead them through one example. Then show them the other scenarios one by one, and ask them to fill in whether or not each CPA could be used under the circumstances described in the scenario.

Table 21 Format for recording whether a CPA can be used under a particular scenario

Scenario	CPA 1:	CPA 2:	CPA 3:
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Once the groups have finished filling in the table, ask them to present their results for the CPAs they were assigned. They should state whether they thought that these CPAs could be used under each of the scenarios presented, and their reasons for coming to these decisions.

QUESTIONS FOR DISCUSSION

- Q For those CPAs that could be used in at least some of the instances, are there limitations that would prevent the CPA being used in all instances? For example, what is the maximum number of applications for the CPA?
- Q Are there any other considerations, aside from what is on the label, which could affect whether or not residues could be a problem?
- Q What are some of the key steps to be taken to avoid residue problems?

OTHER POTENTIAL KNOWLEDGE TRANSFER METHODS

- Infographic with the explanation of the problem down one side and an explanation of how to address/avoid it down the other side
- Newsletter (see GAP Connections example)
- Video with short clips/interviews with people from various levels in the production process on up to the sale of tobacco e.g. from other farmers, a residue testing lab or national authority, consumers, etc.

3.6 Post-spraying activities

After spraying a CPA, there are a number of activities to be followed up on to protect the people on the farm, as well as those in the community from unwanted effects of CPAs. Furthermore, these post-spraying activities are intended to ensure that the environment is affected as little as possible and finally that farmers do not come into conflict with national laws.

Topics covered in this section include:

- Re-entry intervals and safeguarding areas after spraying
- Sprayer decontamination and maintenance
- Disposal of containers
- Disposal of waste CPAs

ΛΟΓΟ ΤΩΝ ΚΕΝΩΝ ΣΥΣΚΕΥΑΣΙΑΣ
ΡΓΙΚΩΝ ΦΑΡΜΑΚΩΝ

ά από 3ηλο ξέπλυμα



Τρύπημα των
συσκευασιών

Συλλογή σε
σακούλες

Τοποθέτηση σακούλες
στον ειδικό κόκκινο

ΕΥΕΤΑΙ Η ΡΙΨΗ ΣΚΟΥΠΙΔΙΩ

TOPIC

Re-entry intervals and safeguarding areas after spraying

Rationale: To limit CPA exposure of farmers and farm workers as well as others in the wider community such as children, it is important to safeguard the field after spraying and to make sure that re-entry intervals are observed.

LEARNING OBJECTIVES

After training on this section, participants will:

- Learn the importance of observing re-entry intervals
- Be able to safeguard the area after spraying to ensure that re-entry intervals are followed.

ACTIVITY: Interactive discussion on re-entry intervals



20 minutes



Farmers and field technicians



Classroom

MATERIALS

- Flip chart and markers
- Examples of signs

PROCEDURES

- Facilitators begin by asking the group if anyone knows what “REI” stands for and ask for a definition of the term.
- REI stands for “re-entry interval” (or, in some countries, “restricted entry interval”). It is the time after the end of a CPA application during which entry into the treated area is restricted.
- Next ask the group why REI is important.
- Observing the REI is important because people can be exposed to CPAs if they enter a treated area too soon after application. When treated plants are touched during work activities such as weeding, thinning, or simply by brushing against plants, some CPA may be transferred to the skin. People in treated areas may also breathe fumes from a recent CPA application. REIs have been established to prevent people from being exposed to CPAs immediately after application. Following the REI allows residues to disperse so that they do not pose a risk.
- Next ask the participants, based on what they have learned about toxicity, dosage, persistence, etc., whether they think REIs are the same for all CPAs or if they differ. Explain that they do differ and, since dosages used on different crops will vary, the REI will also be different from crop to crop.
- Ask participants what they think (or know) is the REI for some specific CPAs. The facilitator will provide the correct answers at the end of the discussion. This should allow the participants to gain a better understanding of how long the REIs are for toxic compared to less toxic CPAs.

- Following this discussion, ask the participants how they think they could find out what the REI is for a particular CPA on tobacco.
- REIs can be found by reading the CPA labels (or the information provided by the leaf supplier). The CPA label will also state what protective equipment is needed if someone enters an area that has been sprayed before the REI has elapsed. If the REI is not on the label, a general rule of thumb is to establish an REI of 24 hours for a slightly toxic CPA and 48 hours for moderately or very toxic CPAs.
- Once the participants understand what REI is and why it is important, ask them how they think the area that has been sprayed can be safeguarded such that others know not to enter. What have they found to be successful for securing an area after spraying?
- Post warning signs that state when treated areas can be re-entered. Warning signs should also incorporate symbols, e.g. a stop sign or skull and cross bones, so that it is clear to everyone that the area is restricted.
- Optionally, a demonstration of the importance of complying with re-entry intervals can be included in the activity on *Personal Protection Equipment (PPE) and its use (Dye exercise)* in section 3.4. After the plants have been sprayed, a volunteer wearing a white coverall can walk through the sprayed section of the field. The participants can then observe the red dye on the coverall which has been picked up from the treated plants.

Sprayer decontamination and maintenance

Rationale: The proper maintenance of spraying equipment ensures that it functions correctly, which in turn ensures that the CPA is distributed properly on the crop. The sprayer must be decontaminated in order to minimise the exposure of the sprayer operator and any other people who may come into contact with it. Decontamination is important for avoiding residue problems. In addition, the external surfaces of sprayers could also present a significant route of exposure for the spray operator so they must also be properly maintained and decontaminated.

LEARNING OBJECTIVES

After training on this section, participants will:

- Recognize the importance of sprayer decontamination and maintenance
- Know how to carry out these procedures

BACKGROUND INFORMATION

Once a knapsack sprayer or tank has been emptied after use, it should always be washed carefully before being stored. This will avoid damage to crops from harmful spray residues, such as the remains of herbicides, and it will limit damage to the sprayer from corrosion or abrasion, thus ensuring its sound functionality and prolonged life.

The exterior surfaces should be thoroughly rinsed off while the sprayer placed in a special wash area. It has been shown that CPAs that are allowed to dry onto a surface are more difficult to remove than when they remain wet. Rinse water should not be allowed to reach the ground as it then has the potential to get into streams, ponds, or other sensitive areas.

To maintain CPA application equipment correctly, it should be carefully checked for proper functionality of all the important parts once a year by a qualified specialist. This is because damaged or worn nozzles can lead to over application, and drips or leaks can have environmental implications. A certificate must be obtained to prove the equipment has undergone mechanical service and is in good working order.

ACTIVITY: Practical activity to wash, dismantle and reassemble a knapsack sprayer



2 hours



Farmers using knapsack sprayers and field technicians not fully familiar with the topic



Appropriate wash area

MATERIALS

- Sprayers belonging to participants, ideally one for every two participants
- Basic assembly tools such as a screwdriver etc.

PROCEDURES

The facilitator should divide the participants into two groups, each of which will work on one sprayer. The facilitator will guide the groups through the whole exercise of washing, dismantling and assembling the sprayer. During this activity the participants' attention should be directed towards all of the relevant sprayer parts, in particular the nozzles and the pumping device.

After the activity, a discussion can be held during which the facilitator will raise a number of questions for the group to discuss.

QUESTIONS FOR DISCUSSION

- Q** Does the backpack sprayer conform to standards?
- Q** Are all parts functioning as required?
- Q** Did the participants find any issues with the one sprayer they worked on? If so, demonstrate this to the group.

Disposal of empty CPA containers

Rationale: In some countries, systems for the disposal of empty CPA containers are not in place, whereas in other countries systems have either only recently been introduced or they may have been in place for some time but are under-utilised. Where container disposal systems exist, an important goal is to see that they are being used. In all locations, regardless of what systems are in place, the aim is for empty containers to be disposed of safely and according to established best practices. Training on container disposal is intended to raise awareness about the issue and to promote disposal of empty CPA containers according to local best practices.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Be made aware of the hazards associated with unsafe container disposal.
- Find out what the relevant policies and/or best practices are for container disposal, and be able to comply with them.

BACKGROUND

- The specific list of best practices for a given location will depend on local context. Some general guidance is provided below.
- Follow label guidelines and local regulations / best practices for disposal.
- Do not discard empty containers in the field, ditches or in water sources such as lakes and rivers.
- Triple rinse and drain all containers immediately upon use. Regardless of the disposal method (recycling, incineration, burning on the farm, burying on the farm), triple rinse first. Never dispose of containers that have not been triple rinsed.
- Empty CPA containers should be washed in a location where the rinse water will not contaminate water sources. Rinse water should be put in the sprayer and used on the crop.
- Do not reuse empty CPA containers for any other purpose.
- Damage all empty CPA containers so that they cannot be reused (e.g. pierce empty containers). Place glass containers in a bag and then crush. Pierce and crush metal and plastic containers.
- If empty CPA containers must be stored before disposal, make sure to store them in a secure location. Store empty containers in a CPA store until they are collected and finally disposed of. Empty containers should be put in special bags for collection.
- Where recycling or collection systems exist, they should be used.
- Only bury or burn containers in areas where collection systems are not in place.
- If empty containers are taken to a collection site, they should be kept separate from the driver, passengers and animals. Avoid carrying empty CPA containers in the passenger compartment of a vehicle because of the potential for fumes. If it is not possible to avoid this, make sure the vehicle is well-ventilated during transport (e.g. keep the vehicle's windows open).
- When burning empty CPA containers take note of the following:
 - Prior to burning, check that the container can be burned. Do not burn glass or metal containers. Avoid burning plastic / PVC containers. Do not burn containers which held 2,4-D.
 - Only burn CPA containers which have been triple rinsed
 - Burn away from people, livestock and buildings
 - Only burn in locations where burning is permitted; burn away from water sources, sensitive areas, etc.

- Check the weather conditions before burning. Do not burn if the wind direction is unfavourable or if there is a risk that a fire could get out of control.
- During burning, avoid coming into contact with smoke and take special care to avoid inhaling any smoke; stay upwind of the fire
- Bury the ash in a deep pit (>0.5 m). The bottom of the burial pit must be at least two metres above the water table.
- Never burn large quantities of containers at the same time.
- Burn CPA containers in a metal container to ensure hot temperatures are reached and to prevent contamination of the surroundings.
- For the burial of empty containers and ash from burned empty containers take note of the following points:
 - Only bury containers in locations where this is permitted by law and where alternative disposal systems are not available.
 - In most instances, containers should be burned before they are buried. For containers which cannot be burned (e.g. glass or metal), compress them as much as possible prior to burial.
 - Burial pits should be located so as to reduce the risk of water contamination. Do not locate them near water sources such as wells or surface water, or in flood prone areas.
 - Use biodegradable waste to cover buried materials and to promote their biological degradation.
 - Fence off and clearly sign the burial pit area. Cover filled burials pits with soil and plant bushes on top to limit the drainage of rain water. This is particularly important if organic material is also incorporated into the pit.

Note: Other materials contaminated with CPAs (such as old PPE) should also be disposed of appropriately following the above guidelines.

ACTIVITY: Interactive discussion and demonstration of empty container disposal



45 minutes to 2 hours, depending on whether the process is explained or demonstrated



Farmers and field technicians in countries not having access to a PMI-based or national disposal system



Classroom and an appropriate area for empty container disposal (optional)

MATERIALS

- Flip chart and markers
- Examples of empty CPA containers (use relevant examples of containers)
- Depending on the types of containers to be disposed of and local regulations and/or best practices, a site for burning and burying the residues
- Poster (optional)

PROCEDURES

Make two columns on the flip chart. One column will be used for writing down best practices for disposal and the second column will be used for writing down the motivations for these best practices.

The facilitator should begin by brainstorming with the group a list of precautions and practices which should be observed when disposing of empty CPA containers. The facilitator should fill in any gaps in the group's knowledge; in particular, they should make sure that the participants are aware of any applicable regulations or policies which have a bearing on the disposal of empty CPA containers.

As each best practice is added to the list (or afterwards in a follow-up discussion), ask the participants why the best practices are necessary. What is a potential motivation for following these practices? What are some of the potential problems that could occur if the guideline is not followed and empty CPA containers are disposed of improperly? Write the motivations beside each guideline. Refer to the background information provided above and see Table 22 below for an example.

Table 22 Motivations behind guidelines for the disposal of empty CPA containers

Best Practice	Motivation
Triple rinse all containers	"Empty" CPA containers are not really empty – they have toxic residues inside which can cause harm. Thoroughly triple rinsing containers has been found to remove ~99% of CPA residues
Do not reuse containers	People have been poisoned and even died from food being stored in empty CPA containers
Damage (e.g. puncture) empty containers	To prevent containers being reused.
Place glass containers in a bag to crush them	This prevents glass shards from flying out and becoming a hazard
Do not burn PVC containers; they should be buried instead.	Smoke from PVC containers is carcinogenic.
Regulations should be followed	Fines may be imposed if regulations are not followed (this is in addition to all of the very good reasons that the laws exist)
Follow company policies for best practices	Incentives may exist for following best practices Contracts may be cancelled if best practices are not followed

Explain best practices either by using an illustrated poster or by demonstrating real life examples of locally relevant empty CPA containers. Make sure that the participants are aware of the proper disposal methods for each type of container that they may use. If other types of containers (e.g. metal or glass) are also sold in the area and commonly used, the facilitator should make sure that the farmers are aware that disposal practices for these container types will differ.

ACTIVITY: Group work on planning empty container disposal



30 minutes



Farmers who use CPAs of different container types; farmers who do not have access to collection systems



Classroom

MATERIALS

- Flip chart (or a piece of paper) and markers

PROCEDURES

Divide the participants into small groups. Ask the groups to write down which CPAs they use, the type of container the CPA comes in and how it should be disposed of. The format given in the table below can be used for this exercise.

Table 23 Table for planning empty CPA container disposal

CPA	Container type	Rinse? (Y/N)	Damage? (How?)	Burn? (Y/N)	Bury? (Y/N)	Other considerations

Ask each group in turn to present their plan for one CPA. Once the group has finished, ask the others whether they think the plan is correct and if they have anything they would like to add. The facilitator should make sure that the minimum country and/or leaf supplier requirements are mentioned for each CPA.

Disposal of waste CPAs

Rationale: Excess CPAs (both from material left over after application as well as from the storage facility) can cause problems. They are a common cause of environmental contamination. Steps can be taken to avoid excess CPAs being generated (refer to section 3.5) but even when these measures are applied, it is sometimes impossible to avoid having some excess CPAs. Training on this topic covers how to avoid creating excess CPAs and what to do with CPA waste.

LEARNING OBJECTIVES

After training on this section, participants will:

- Be made aware of the hazards of associated with unsafe disposal of waste CPAs.
- Learn about the policies and best practices for CPA waste disposal and be able to comply with them.

ACTIVITY: Interactive discussion and group work on waste CPA disposal



30 minutes



Farmers



Classroom

MATERIALS

- Flip chart and markers

PROCEDURES

Begin by brainstorming with the group a list of potential issues with excess CPAs, and write their suggestions on the flip chart.

Write down the reasons why excess CPAs may be generated on another flip chart page. If they feel it is appropriate, the facilitator may create a second column to write down the steps that can be taken to avoid creating excess CPAs or they may decide to drive home the message directly while talking about each particular point.

Ask the group if they have ever had any left-over CPAs. Ask them why this was the case. If there are any major omissions, help to fill in the gaps by suggesting some additional reasons. Examples of reasons a farmer might have excess CPAs include:

- Registration of a particular CPA is cancelled and its use is no longer permitted
- Newer, better CPAs are available so an older one is no longer recommended or used.
- The expiry date has passed or the product has been rendered ineffective (e.g. due to poor storage conditions)
- A CPA was purchased but the pests never reached threshold levels meaning that the CPA was not applied

- The farmer bought more CPA than they needed for another reason, e.g. pressure from retailers
- Excess CPA was mixed. Either the calibration or the field application was not carried out correctly or the dosage was calculated wrongly.

Next, ask the group for their suggestions for things that can be done to avoid having surplus CPAs. Examples include:

- Only buy CPAs when needed and in the quantity needed.
- Avoid storing CPAs for long periods (e.g. do not carry CPAs over from one season to the next. Practice stock control (see the section on CPA storage for more information). Under good stock management, the first product in should be the first out.
- Estimate needs and only buy what is needed.
- Resist temptation – do not let unscrupulous retailers convince them to buy more than they need.
- Always check the size of the job before mixing.
- Make sure the sprayer is calibrated and the dosage is calculated correctly.

Finally, discuss what to do in case there is left-over CPA, making sure to cover the following points:

- Follow local laws and best practices.
- If the CPA is still factory-sealed, it is possible that it could be returned to the point of sale and/or the manufacturer.
- If there is another site where the target pest is a problem, then excess tank mixture could be applied there.
- Be careful with herbicide-contaminated rinse water – it can potentially damage plants.
- Be careful not to reuse rinse water in mixtures of other CPAs. This could cause residue problems.
- Spray remaining CPAs in another 1:10 H₂O dilution over crop, or spray on a biobed
- Never dispose of CPA-contaminated rinse water or excess tank solution where it could contaminate water sources.

ACTIVITY: Practical activity to construct a biobed



2 hours



Farmers and field technicians



Outside in an appropriate location for CPA disposal

MATERIALS

- Grass layer
- Blocks or 54 gallon cylinder
- Carbon (optional)
- Lime
- Clay
- Crop residue
- Soil
- Peat

PROCEDURES

- In this exercise, facilitators will introduce the participants to biobeds.

What is a biobed? A biobed is a tool for disposing of rinsate and small quantities of excess tank mix. In its simplest form, it is basically a hole in the ground (or a drum with the bottom cut out) that is lined with clay and filled with a

mixture of topsoil, peat or compost, and straw. This mixture provides an ideal habitat for microbes which essentially “eat” CPAs by breaking them down to the point at which they present no threat of contamination (see Figure 15 below for an illustration of the layers in a biobed).

Once the concept of biobeds has been introduced to the participants, ask them to construct a biobed by following the steps below (Castillo *et al.*, 2008):

- Dig a 60 cm deep pit in the ground
- Line the bottom of the hole with 10 cm of clay
- Add a layer of lime on top of the clay
- Add a layer of carbon on top
- Add a layer of “bio-mixture” containing straw, peat, and soil (in the ratio of 50:25:25) to fill the remaining 50 cm depth
- A grass layer should be used to cover the surface

Alternatively, a simplified biobed might be established as shown in the lower part of Figure 15 consisting of layers of clay, lime and a biomixture consisting of maize residues (50%), peat (25%) and soil (25%).

Tips for creating a biobed and how to maintain it:

- Biobeds should not be placed in low-lying parts of the farm; this will prevent any runoff from the areas around the bed from entering it.
- The biomixture should be changed from time to time to prevent leakage out of the biobed.
- The clay layer is important to avoid leaching
- Using the correct biomix is important to ensure microbial activity.

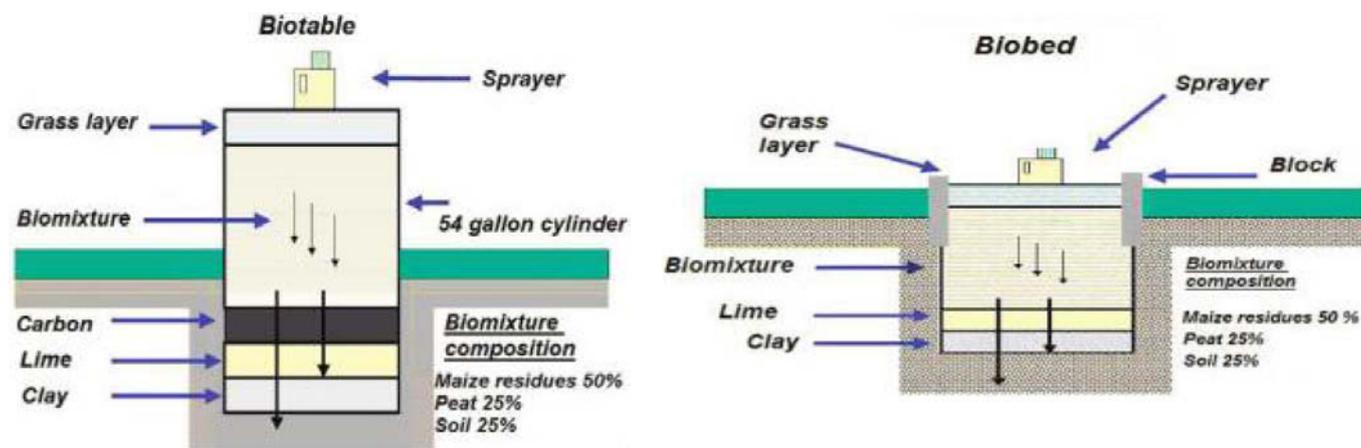


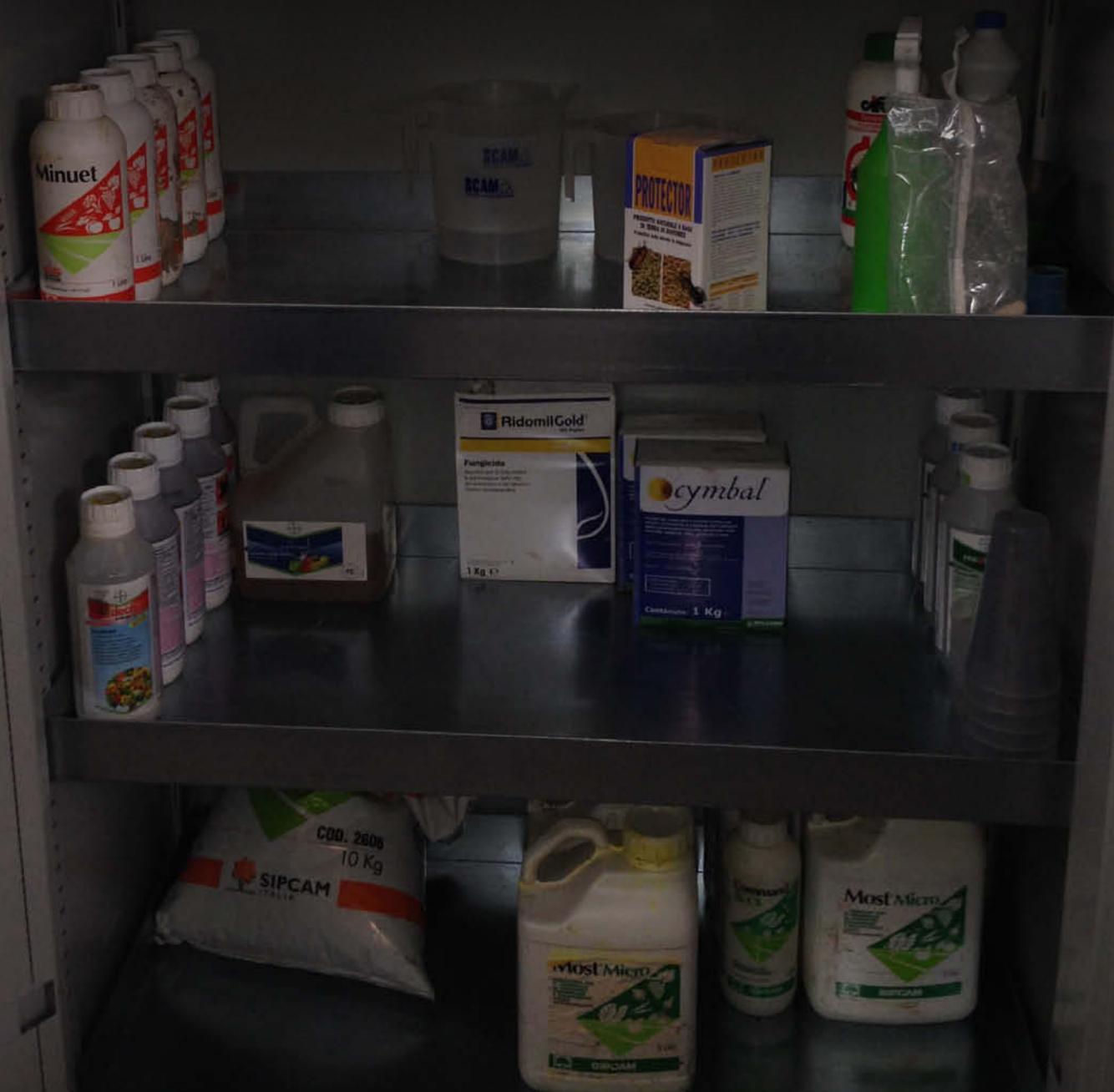
Figure 15 Illustration of the layers in a simple biobed. Reprinted with permission from Castillo *et al.*, 2008. Copyright 2008 American Chemical Society. Figures modified from Agrequima, www.agrequima.com.gt.

3.7 CPA storage

Pesticides are valuable products, which may deteriorate and become useless if they are not stored under proper conditions. They are also hazardous substances, and accidents are liable to happen if precautionary measures are not put in place. Correct and secure storage of crop protection products is essential in order to protect human health, safeguard the environment, reduce the risk of theft and maintain product integrity and effectiveness. The correct storage of pesticides is an important part of GAP. Farmers and farm workers should know the basic safety rules for CPA storage and be sure to follow them.

Topics covered in this section include:

- CPA storage characteristics, optimal environmental conditions, organisation and safety
- Maintaining a CPA inventory



CPA storage

Rationale: This section provides information on the practices to follow to ensure the safe and secure storage of CPAs, and describes how to lead farmer training on this topic.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand the importance of storing CPAs properly.
- Be able to choose and arrange a storage area for CPAs.
- Know how to identify the components of a properly secured and ventilated storage area.
- Know how to store CPAs according to label directions, GAP requirements and local regulations
- Know how to maintain CPA containers.
- Know how to post warning signs around storage areas.
- Know how to restrict access to CPAs by unauthorized personnel.
- Know how to prepare for potential spills in the CPA store, e.g. maintain spill kit and keep accessible material safety data sheets.
- Learn what to do in case of a CPA spill in the CPA store.

BACKGROUND INFORMATION

If CPAs are to be stored on the farm, they must all be kept together in one location in a storage facility. Trainers should consult local regulations and company policies as they may detail specific requirements for the conditions of storage of CPAs. Some general rules that apply regardless of the type of CPA storage area are as follows:

- CPAs and empty CPA containers should not be stored in areas of the house or farm where people or animals live.
- The CPA store should be marked with a warning sign and locked (and the key must not be kept in the lock) to ensure that CPAs are kept away from children, unauthorized persons and animals. Keys and access to any product store must be controlled by someone who has been trained in CPA storage.
- The CPA storage area should only be used for CPAs and CPA application equipment. Never store or use food, drinks, medicine, silverware, tobacco products, PPE or any other farm materials (e.g. oil, fertilisers, fuel, tools, etc.) in the CPA storage area. Seeds and living plants, as well as livestock feed should never be kept with or near CPAs.
- Do not keep unapproved or unwanted CPAs in the CPA storage area.
- The location where CPAs are stored should have easy access for use as well as for emergency services in the event of an accident.

The type and size of the CPA storage area will depend on the amount of product to be stored and any local legislation relating to that storage. A simple locked box, cabinet or cupboard - mounted on the wall away from the reach of children when not in use - may be appropriate for the safe storage of small product volumes (<200 litres or kg of CPAs). Larger amounts of CPAs (>200 litres or kg) should be kept in a dedicated building or room.

Storage box for relatively small quantities of CPAs (e.g. <200 litres or kg)

- Small quantities of CPAs may be kept in cupboards (preferably metal) or boxes, which must be kept outside of the house.
- The box should be kept locked at all times to avoid unauthorised access and to keep it out of reach of children
- A warning sign, e.g. titled 'Pesticide Storage', should be fixed on the front of the cupboard or box
- The locked CPA storage box should be placed on supports that lift it off the ground, or it should be mounted on the wall.

- The box should have adequate space to enable products to be stored neatly and safely inside it.
- The box or cabinet should be large enough to store products on trays or within secondary containers that would be able to retain the contents in the event of a leak.

Storage buildings for larger amounts of CPAs (e.g. >200 litres or kg)

If farmers use large amounts of CPAs and/or equipment, they should have a dedicated storage facility just for their CPAs. If it is not possible to have a separate building, they should choose a room or corner of a room on the first floor of a building.

The storage area should be fenced in or at least able to be locked tightly to prevent unauthorised access. The area should be marked with appropriate warning signs, e.g. “danger”, “no entry” and “no smoking” signs. This would include weatherproof warning signs hung over every door and window.

The CPA storage building should have a solid floor, preferably made of non-porous material like sealed cement or ceramic tile. Good lighting is important in that it allows handlers to read CPA labels, monitor the condition of the stored materials, and detect and clean up leaks. The building should also be well-ventilated, thus fans are an important feature of any CPA storage facility. A properly installed ventilation system will include a switch outside, allowing the fan to be turned on before anyone enters the facility. Exhaust fans should be directed to the outside of the building. Large CPA warehouses should also be, fire- and flood-proof, and temperature controlled. Ideally, large CPA warehouses should also have retaining walls designed to prevent inundation or breaches from a known source.

Emergency preparedness and procedures for large CPA storage facilities

Know what to do in case of an emergency. Make a list of safety procedures and post it in the storage area. Follow all the safety precautions for CPA storage that are specified on the label and any accompanying label information.

Safety equipment associated with the CPA storage should include:

- Hazard warning signs, outside and inside the storage facility
- Emergency procedures in the event of an accident (with contact telephone numbers)
- Fire extinguisher
- First aid kit
- Absorbent material to soak up any spills (e.g. activated charcoal, absorptive clay, vermiculite, pet litter, sawdust, or hydrated lime)
- Shovel, broom, dust pan
- Sprinkler for decontamination and clean-up
- Waste bin for contaminated waste
- Soap / high pH commercial detergent and clean water
- PPE in a separate store close to the product store

Even if safety precautions are applied, accidents can still happen. If a CPA spills in the CPA storage area, quick action must be taken. If the CPA gets on anyone, wash it off immediately. Remove the exposed person from the area, ensure that they wash thoroughly, change their clothes and see a doctor if necessary. Clear the storage area except for a small clean-up crew. Be sure the crew wears the proper PPE.

For spills and leaks of liquid CPAs, cover the entire spill with absorbent material. Use enough to soak up most of the liquid, then sweep or shovel the material and put the waste in the bin for contaminated materials. If the spill is a dust, granular, or a powder, sweep or shovel it directly into a large drum. Sweeping compound can be useful when picking up spills of dry pesticides. Once the spilled CPAs have been cleared away, cover the spill area with a decontamination agent recommended for that particular CPA. The manufacturer or supplier may have to be consulted. Hydrated lime and high pH commercial detergents are often recommended as they can neutralise many CPAs. Repeat this procedure several times. Rinse the whole area with plenty of water to wash away any remaining poison. Collect the rinse water and hold it for proper disposal. Check the storage area carefully to see if any other CPAs were contaminated by the spill. If so, do not take a chance on using them but dispose of them as well. When finished, seal the bin for contaminated waste tightly and dispose of properly.

Optimal environmental conditions for CPA storage

Some farmers store CPAs haphazardly, with little regard for the environmental conditions of storage. This can result in problems such as the contamination of soil and water; deterioration of the CPA containers or the products inside them; human exposure to CPA fumes or splashes; or even fire. CPAs should be stored in locations where risks of environmental hazards like floods or fires are minimal. Likewise, CPAs should not be stored under extreme temperatures, either hot or cold.

The environmental conditions under which CPAs are stored are important in many respects. Flooding or percolation in the CPA storage can result in the contamination of surface or groundwater. Moisture can cause metal containers to rust, cardboard containers to deteriorate, labels to peel or smear, and dry formulations to clump or dissolve. Heat is also an issue: it may cause liquid CPAs to expand, putting the contents under pressure and causing the CPA to splash out when opened. When some formulations get too hot they vaporize, becoming a health hazard. Some formulations lose their strength and break down when exposed to heat. Certain CPAs will catch fire if they are too hot or are exposed to flame. Freezing will destroy the usefulness of some CPAs, and it may also cause liquid CPAs to break their containers and leak.

Some recommendations for the optimal environmental conditions for CPA storage are as follows:

- CPAs should be protected from the rain and should not be stored in damp, humid locations.
- Avoid locating the storage facility near streams that are prone to flooding, sites where run-off can be a problem and sites that are close to wells or other water sources.
- Consult CPA labels for specific information on the temperature limits for storing a particular CPA. In general, avoid storing CPAs under extreme temperatures (below 4° C or above 38° C).
- CPAs should be stored in a cool, dry, airy place, which is fireproof. Never store CPAs in direct sunlight, as this can lead to overheating.
- Beware of fire hazards resulting from cigarette smoking, use of open fire or direct sunlight coming in through glass windows.
- Avoid storing CPAs in hot places. Glass and metal containers of liquid CPAs should not be stored near heat sources such as steam pipes, furnaces, etc. or in direct sunlight.

Organisation of the CPA storage facility

- The CPA storage area should be kept clean and organised. CPA storage areas should have adequate space for CPAs to be stored in orderly rows with the CPA labels plainly visible.
- Storage facilities must contain shelving so that CPAs can be kept off the floor. This helps to contain spills and to prevent damage from dampness, and prevents people from tripping or knocking over containers
- Containers should always be set in an upright position so they cannot spill.
- Liquid CPAs must be stored below dry CPAs.
- CPA dosage and application recommendations (e.g. Green and Yellow lists). should be displayed in the CPA storage facility or on the cupboard or box
- Dosage measuring devices must be kept inside CPA storage facility.

Follow the storage instructions on the CPA labels. Some products require separation from other products. For example, some herbicides can vaporize and get into other CPAs nearby. When the contaminated CPA is used, the herbicide vapours in it could injure or kill crops and sensitive plants. Hence, herbicides which can vaporize should be stored in a special place set apart from other CPAs and fertilizers, and seeds or bulbs.

Maintaining stored CPAs and stock management

Check the condition of products at delivery. Do not accept damaged or opened containers.

After use, CPA containers that are not completely empty should be resealed and returned to storage. Caps should be securely closed.

CPAs should only be stored in properly labelled containers with the label in plain sight. The original packaging should be used. CPAs should never be stored in soda bottles, fruit jars, milk cartons, etc. Storing CPAs in improper containers such as these is a common cause of CPA poisoning. Never put a tank mix into a jar or give it to someone in an unlabelled container. Unlabelled CPAs are dangerous since their contents and instructions for use are not known.

All CPA containers in the storage should be checked regularly for signs of corrosion, leaks, loose caps, or dents. Inspect all containers before handling. Correct any problems immediately when detected. If the containers are damaged but the contents are still in good condition, the CPA should be re-packed in a sound and suitable larger container which can be sealed and labelled. Never use empty food or drink containers to re-pack CPAs. Firmly fasten the label from the damaged container onto the new container.

Avoid storing CPAs for a long time because they may become ineffective or begin to leak. It is important to plan purchases carefully to reduce storage time and avoid surpluses. Only buy sufficient amounts for the area of crop to be treated. Containers should be dated when purchased. Stock control must be applied to ensure that older CPAs to be used first. Put the oldest products in front and use the oldest CPA first. Expired CPAs should be discarded. (See the section on the disposal of unwanted CPAs for more information.)

Avoid storing CPAs that have been mixed with another substance (such as a diluent, carrier, marker or adjuvant). Do not mix more than what is needed for that day.

CPA application equipment storage

All equipment used should be rinsed thoroughly before storing. Even after rinsing, there is still a risk that pesticide application equipment could be contaminated with pesticides; consequently it should be stored in a special area that is inaccessible to children and other unauthorised persons. All items used for handling pesticides should be labelled "Danger - contaminated with pesticides" and should not be removed from the site. This is particularly true of equipment such as measuring cups which could inadvertently be used for other purposes. Never let children or uninformed people play on or around spray equipment.

ACTIVITY: What's wrong with this picture? (Game to identify problems with CPA storage)



30 minutes



Farmers



Classroom

MATERIALS

- Projector
- Pictures of local CPA storage boxes or facilities which illustrate different incorrect practices (e.g. CPAs stored in insecure containers; CPAs stored in homes; CPAs stored with household goods such as food, etc.; CPAs stored in inappropriate containers; leaking CPA containers; liquid formulations stored above powders; etc.)

PROCEDURES

Project the pictures of the incorrect storage practices. Ask the participants to point out what is wrong with each picture. They can write their answers down and then the group can review them together later or you can ask volunteers to point out the problems as the presentation is gone through together.

ACTIVITY: Practical exercise to organise a CPA storage cabinet



1 hour



Farmers who store small quantities of CPAs



Classroom or at an appropriate location for keeping a CPA storage locker

MATERIALS

- At least four CPA storage cabinets
- At least four 'Danger - Pesticide Storage' signs
- Containers with liquid and powder CPAs, some of which are allowed and some examples of which are not allowed for use in tobacco
- PPE
- Dosage measuring device
- Bag of empty (clean) CPA containers
- Green and Yellow List
- Items that should NOT be kept inside the storage cabinet, for example, tools, fertiliser and/or oil
- Factsheet describing best practices for CPA storage, according to relevant regulations

PROCEDURES

Ask the farmers to work in groups to organise everything inside the cabinets that has been brought to the training session. Check how they have arranged everything and correct any mistakes, explaining the reasoning behind the correct organisation of a CPA cabinet.

QUESTIONS FOR DISCUSSION:

- Q** Was there anything that did not belong in the CPA cabinet? If so, what would they recommend doing with it?
- Q** Where would they recommend putting the cabinet if it was kept on their own farms?

ACTIVITY: Practical exercise to organise a large CPA store



1 hour



Farmers who store >200 kg or L of CPAs



Large CPA storage facility

MATERIALS

- Large CPA store room
- Containers with liquid and powder CPAs, some of which are allowed and some examples which are not allowed for use in tobacco
- Tape
- PPE
- Dosage measuring device
- Bag of empty (clean) CPA containers
- Green and Yellow List
- Items that should NOT be kept inside the store, for example, tools, fertiliser and/or oil
- Factsheet describing best practices for CPA storage, according to company policy and local regulations
- Checklist for large CPA stores (see below; modify as appropriate)

PROCEDURES

In advance of the exercise, arrange the storage facility contrary to guidelines. For example, create trip hazards or put liquids above powders. Using tape, mark off a box on the floor.

Ask the farmers to organise everything inside the store. Tell them that if there is anything that does not belong in the store, they should put it in the taped off area.

Once they have finished arranging the storage, ask them to review the checklist for large CPA storage facilities and to take note of any issues.

Check and correct any mistakes in their organisation of the storage; explain the reasons for the correct organisation of a large CPA storage.

QUESTIONS FOR DISCUSSION

- Q** Was there anything in the storage facility that did not belong there? What would they recommend doing with it?
- Q** Were all of the features on the checklist present or were there any missing? If so, what could be the consequences?

Checklist for storage locations for large quantities of CPAs (>200 kg or L)

- Locked room with controlled access (key, digital code, magnetic card) reserved specifically for storage purposes
- Facility identified as the “Storage Room”
- Facility to be located away from residential buildings and watercourses
- Space is ventilated, e.g. high and low-level ventilation grilles on opposite walls
- Room temperature controlled (+2 to +30C)

- Leak-proof stone/tiled floor with surrounding edge and/or system for recovering any spillage to prevent contamination of the exterior environment
- Electrical installations conform to local regulations
- Clearly displayed safety instructions (no smoking/drinking/eating; evacuation procedure)
- 9a. Storage equipment made from non-absorbent, impermeable, non-combustible materials
- 9b. Keep products off the ground by using wooden pallets or retention pans
- Products classified as T, T+, carcinogenic (R40, R49, R45), mutagenic (R46, R40, R68) and toxic to reproduction (R60, R61, R62, R63) must be grouped separately
- ABC powder extinguisher located outside the store
- Raised door threshold (i.e., floor slightly lower than door level)
- Door that opens towards the exterior
- Fire door with anti-panic handle
- Nearby water supply
- First aid cupboard with eye shower
- Container for stocking empty packaging
- Telephone and emergency phone numbers close at hand
- Safety data sheets for all products held in stock
- Stock management book
- Shower for cleaning up after using products (may be in house)
- Cupboard for Personal Protection Equipment (PPE)
- Dual-compartment cupboard (for normal clothes and PPE)
- Wrapped seeds
- Absorbent material for spills (e.g. vermiculite, cat litter)
- Brush, broom, shovel and other tools reserved solely for CPAs
- CPAs stocked in their original packaging
- Separate storage for out-of-date or non-useable products
- Bin for soiled disposable PPE
- System for recovering soiled rinse-water (drums or draining to retention tank)
- Cleaning equipment to clean the store room on a regular basis

TOPIC

Maintaining a CPA inventory

Rationale: Maintaining a CPA store inventory is important for farmers who use larger volumes of CPAs, particularly if they carry them over from one season to another.

LEARNING OBJECTIVES

Through training on this topic participants will:

- Understand the importance of and be able to maintain an inventory of all of the CPAs in their CPA storage area.

BACKGROUND

To reduce the risk of improper storage, farmers should keep updated and accurate inventories of all chemicals in their possession. A complete inventory should indicate the identity, batch number, product use, quantity stored, date of arrival and expiry date of all products purchased. The inventory should be easily available and, in case of emergency, a copy should be kept away from the storage facility for safekeeping.

ACTIVITY: CPA inventory brainstorming – why, what and how



1 hour



Farmers and field technicians



Classroom

MATERIALS

- Flip charts and markers
- Example inventory sheet

PROCEDURES

Begin by asking the participants why it might be a good thing to keep a CPA inventory. Urge the participants to think of reasons why this information might be useful for farmers, the company and perhaps even for other stakeholders. List their ideas on a flip chart. Fill in any gaps in the list.

Reasons why it is important to keep a CPA inventory will include:

- To be able to see when products are about to expire and to avoid keeping products past their expiry date
- To avoid having excess amounts of CPAs in storage
- For health and safety reasons, e.g. if there is a fire or other emergency, the inventory can be shared with emergency personnel
- To comply with local regulations

Once a comprehensive list of reasons for maintaining a CPA inventory has been compiled, ask the group for examples of the types of information that should be recorded. Record this information on another flip chart page.

Types of information to be recorded on a CPA inventory:

- Product name
- Quantity
- Batch number
- Expiry date
- Product use

With gentle steering, the group should arrive at an appropriate list of the different types of information to be recorded. If an inventory form is already available in the country in question, then distribute this form. Ask the participants if they have any questions. If no inventory form is available, use the data types that the group has listed to construct a form during the session and share this with the participants.

44

4. Assessing the rollout, uptake and impact of training

4.1. Levels of assessment

4.2. Planning for monitoring and evaluation

4.3. Collecting data

4.4. Using M&E data

4.1 Monitoring the training cascade

As described in Chapter 1, national training programmes are intended to build the knowledge and commitment of field technicians and farmers so that they are able and willing to reduce unnecessary CPA use, select appropriate CPAs and manage CPAs responsibly. Training alone will not necessarily lead to changes in practice, but it will provide farmers with the know-how and instil in them recognition of the importance of following good practice.

The steps to designing and implementing a national training programme were described in previous chapters. Each of these steps must be monitored and assessed to determine whether goals have been met (Table 24). In order for farmers and field technicians to gain new knowledge and build commitment, the training programme must reach those who are in need of new information (Level 0: Training delivery) and the training programme must respond to the participants' training needs and expectations, e.g. the curriculum must be appropriate and participants must feel that it is useful (Level 1: Trainee reaction). Trainees must learn the new material and be sufficiently convinced by it (Level 2: Learning), then they must change their practices and apply what they have learned on their own farms (Level 3: Implementation). This change in practice must ultimately have an impact and contribute to achieving the programme's overall objectives and targets (Level 4: Impact). These changes can also lead to a business impact.

Table 24 Five levels of measurement for monitoring and evaluation of training programmes

Measurement level	Measures for assessment	Means of verification	How the data can be used
0. Training delivery	Materials adapted to local conditions Attendance, e.g. percentage of farmers and field technicians trained Costs	Adapted materials Participant lists (by gender) Budget and expenditure reports	Verify that targets have been met for the number of field technicians and farmers trained Ensure that trainings are taking place on time and within budget
1. Trainee reaction	Relevance Importance Usefulness Concreteness New Information Motivation Appropriateness Intent to Use	Participant evaluation of training (by gender) Action plans by participants	Determine participant satisfaction level with the program Identify changes to be made to improve the training Determine participant needs Obtain quantitative data that can be communicated to management Link with follow-up data

2. Learning	Knowledge Understanding Capability Confidence Perceptions Skills	Data on farmer knowledge from baseline study and follow-up longitudinal surveys Pre- and post-training knowledge and skills assessment Interviews with participants	Provide individual feedback to build confidence Ensure that learning has been acquired Improve training programs
3. Implementation	Use of Knowledge Use of Skill Following the Policy Use of Procedure Following Regulation	Data on farmer practices from baseline study and longitudinal surveys Follow-Up questionnaires On-farm observation Follow-up interviews Follow-up focus groups Recommendations (e.g. policy briefs)	Determine whether behavioural changes have taken place Identify enablers and barriers to implementation Program improvement
4. Impact	Productivity Quality Reduced incidents, e.g. residue hits Compliance Costs	Progress on outcome and objective level indicators (e.g. elimination of tox 1 and non-tobacco CPA residues, residues below MRL, etc.) CPA records Farmer records	Assess whether targets have been met and progress towards objectives Determine whether to proceed to the next phase Gauge whether program has been cost effective Assess programme's contribution to change

4.2 Planning for monitoring and evaluation

Planning for monitoring and evaluation should take place before roll-out of the training programme. Plans typically include the following:

- Indicators for each level, these indicators should be “SMART” (specific, measurable, assignable, realistic and time bound). They should also relate directly to the country action plans and the global logframe.
- Specific measures for assessing whether these indicators have been met (see Table 24 for some examples at each level).
- Means of verification for each measure (see Table 24 for some examples at each level). The sources of the data that serve as the means of verification should be identified.
- The timeframe for collecting the data should be noted for each data collection method. This is particularly important for follow-up activities like surveys and questionnaires.
- Responsibility for collecting the data should be assigned.

Thought should be given to the time required for activities envisioned in the M&E plan and budget constraints. It is important to balance the resources required versus those available. Where possible, M&E should be aligned with existing systems for data collection. For example, can GAP audit data be used as a data source for some indicators of achievement?

4.3 Data collection

Once a plan for M&E has been established and the training programme is underway, implementation of M&E can begin. Data is at the core of M&E, and data collection for the different levels takes places at different times.

- For Level 1, expectations can be gauged at the start of the training workshop and participant evaluations can be collected at the end.
- For Level 2, pre- and post-training tests can be administered on either side of the training workshop.
- For Levels 3 and 4, assessment is generally less frequent and it only comes after the training activity, usually at the end of the stage or programme. While changes in behaviour can potentially be observed shortly after the training takes place, collection of data to assess any impact should be given more time.

For each of the above levels, some thought should be given to other factors such as the crop calendar, harvest, timing of measurement of residues, etc. since all of these things can also affect whether the data collected is meaningful.

4.4 Using M&E data

Data collected at each level of the M&E system can be used for different purposes. For example, regular collection and analysis of the data on training delivery (Level 0) is used to check whether implementation is on track, for example, whether the activities have been carried out on time and within budget. The findings can also be used for minor course corrections.

Participant feedback on the training (Level 1) can be used in a variety of ways to improve the trainings themselves, for example, to adjust the course contents, change how the material is presented or alter the facilitator's style of leading the training sessions. Similarly, an assessment of learning (Level 2) can highlight whether the training provided has been pitched at the right level or whether adjustments need to be made to go further in-depth.

Information about the implementation of new skills (Level 3) can be gathered along with an explanation from the trainees about why, or why they are not, applying the new skills they have learned. Adjustments to the overall program can then be made to promote enablers of behaviour change and to address any barriers that stand in the way.

Information on impact (Level 4) seeks to assess whether the targets set at the start have been met and to attribute the cause of the change. This information can also be used to determine whether to proceed to the next phase. At this level it is also possible to make assessments of effectiveness. This can support programme improvements by seeking answers to the question of whether the programme worked and, if not, why not?

5

5. Useful references

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6. Review games

This section has review games which can be used to re-enforce terminology and concepts from many different sections of the course material. They can be interspersed immediately after training on a topic or later on as a refresher.

GAME: It's time to play Family Feud!

MATERIALS

- Projector
- PPT display for game (see template)
- Chalkboard or dry erase board for keeping score
- Timer

PROCEDURES

Course participants are divided into two “families”. Each family should designate a captain. Representatives of the family (course participants) are posed questions that they should know the answer to (based on their participation in previous trainings). An answer is considered correct if it is one of the concealed answers on the game board or judged to be equivalent.

To start each round of the main game, the two opposing captains “face-off” to see which family will gain control of that particular question. (Traditionally, the contestants greet each other with a handshake before the question is read.) Whoever gives a correct answer is given control of the board. If both contestants give correct answers, control goes to the player that buzzed in first. If neither contestant gives a valid answer, the next member of each family provides an answer, with control going to the family giving a correct answer.

Once control of the board has been established, the family members take turns giving an answer to the host. Family members may not confer with one another while in control of the board. There is a time limit. An answer not on the board or a family member failing to provide an answer within the time limit results in a strike being charged to the family. When a family is able to reveal all the answers on the board before accumulating three strikes, they win the round.

When a family in control accumulates three strikes, control passes to the other family, who then has one chance to steal the points in the bank by correctly guessing one of the remaining unrevealed answers. The family is allowed to confer before coming up with an answer, which then must be given by the team's captain. If the family guesses a remaining answer correctly, they receive the points accumulated by the other family. If unsuccessful, the opponents keep the points they scored during the round before three strikes.

For an example of *Family Feud* in action: http://www.youtube.com/watch?v=mbhkgNp7_Hc

For those who are not familiar with *Family Feud*, watching a clip can make the process more clear. Play several rounds so that players can get into it and competition heats up!

Examples of topics for the feud are given below. (Make sure to have a list of answers you will accept handy when leading the game.)

- Name types of information that can be found on a CPA label.
- Name the principles of integrated pest management; name IPM practices
- Name types of IPM practices
- Name different ways for grouping pesticides (e.g. specificity, toxicity, active ingredient...)
- Name different tactics which can be used in a resistance management strategy
- Name good practices for pesticide storage

GAME: Win, Lose or Draw

MATERIALS

- Timer
- Chalk board for keeping score
- Flip charts and markers
- Slips of paper with terms written on them
- A bowl or other receptacle
- Coin

PROCEDURES

The slips of paper with the terms on them should be prepared in advance. Terms can potentially be colour coded by category (e.g. "health and safety", "post-spraying activities"). Select terms that can be visualised (e.g. "Environmental hazard") but also do not be afraid to test participants' creativity with terms that are a bit harder to draw or more abstract, e.g. terms for nozzle type or "beneficial organisms". Optionally, you can include explanations of the terms on the slip of paper as well.

Divide players into two teams. Each team will have a flipchart and markers.

Each team should pick one person to select and draw the first word. Decide which team goes first by coin toss.

The person who won the coin toss will select the first slip of paper. Give the player five seconds to read the slip of paper, and then start the timer. The player who read the slip of paper will attempt to illustrate the term using the marker and paper. Everyone else on the team will try to guess the term as they draw. Give the player 60 seconds to draw the term and then call time. If their team guesses the term within the 60 seconds, they get a point. If they do not, then the other team is given the opportunity to "steal" the point by guessing the term.

If a team is able to guess the term, ask them if they can also explain what it means. If they can, then they are awarded a bonus point.

Teams take turns drawing terms until all of the slips have been used. The team with the highest score wins.

Examples of terms to include on the slips of paper: Pesticide life cycle, residue, systemic herbicide, very toxic, corrosive, sprayer calibration, PPE.

GAME: “Pub quiz” for health and environmental effects

MATERIALS

- Pens and paper
- Projector

PROCEDURES

Live trivia

Format

Live trivia (also known as pub quizzes or table quizzes) are often weekly events and will have an advertised start time, most often in the evening. While specific formats vary, most pub quizzes depend on answers being written in response to questions which may themselves be written or announced by a quizmaster. Questions are asked over the course of various rounds.

Teams

It is up to the quizzers to form teams, which are generally based on tables. The team members decide on a team name, often a supposedly humorous phrase or pun, which must be written on all papers handed in.

Questions

The person asking the questions is known as the quizmaster. Quizmasters also mark and score answers submitted by teams, although formats exist where teams will mark each other’s answer sheets.

Some sample rounds with questions related to integrated pest management, rational pesticide use, etc. are provided here but country teams can create their own questions.

Rounds

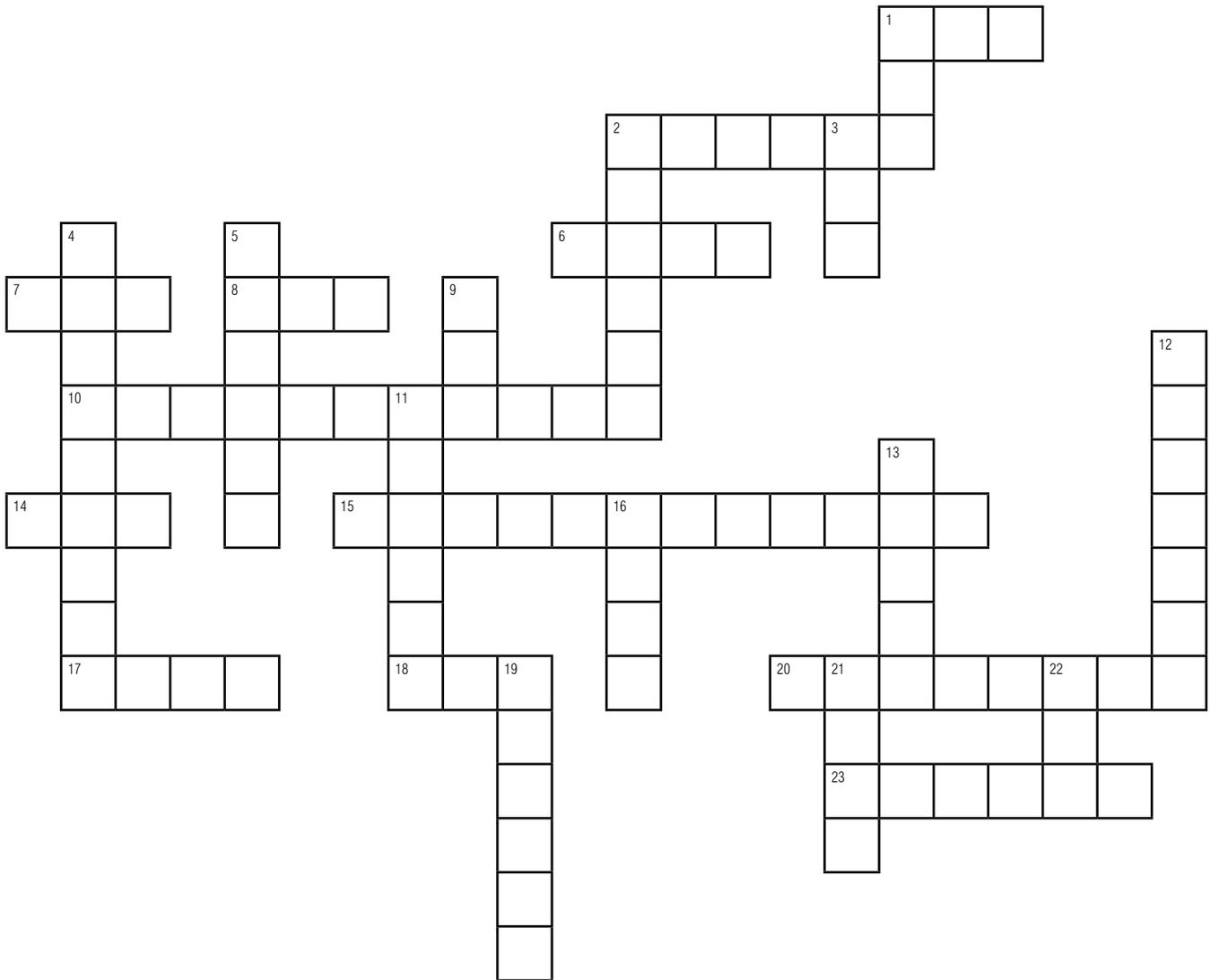
There may be between one and six rounds of questions, totalling anything from 10 to upwards of 80 questions. Rounds may include the following kinds (most common first):

- Factual rounds – these are usually spoken, either over a public address system or just called out. Common topics include:
 - General knowledge – covering topics such as IPM, RPU, regulatory, biology, etc. There may well be more than one of these rounds.
 - Sport – comprising the statistics and minutiae of popular, well-known sports and general facts about others.
 - True or False – questions to which the answer is True or False.
- Picture round – these use photocopied or computer-printed hand-outs and consist of pictures to be identified.
- Music round – these consist of excerpts (often only the intro or other non-vocal segment) of songs played over the PA system. Usually the teams must identify the song and also the singer or band (sometimes the year the song was released is also required). A bonus question can ask what all of the songs have in common, e.g. what is the unifying theme. For example, participants could be asked to identify snippets of songs like Outkast’s Hey ya, Harry Belafonte’s Jump in the line, Taylor Swift’s Shake it Off, Peaches and Herb’s Shake your Groove Thing, etc. A unifying theme would be that all of the songs have something to do with shaking. In RPU, you have to shake containers as part of proper triple rinsing.

For each round, the quizmasters should distribute will come around with pens and quiz papers, which may contain questions or may just be blank sheets for writing the answers on. A mixture of both is common, in which case often only the blank sheet is to be handed in.

Marking

Quizmasters should check the teams’ answers for each round. Each correct answer is awarded one point. The team with the most points at the end wins.



GAME: CPA management crossword puzzle

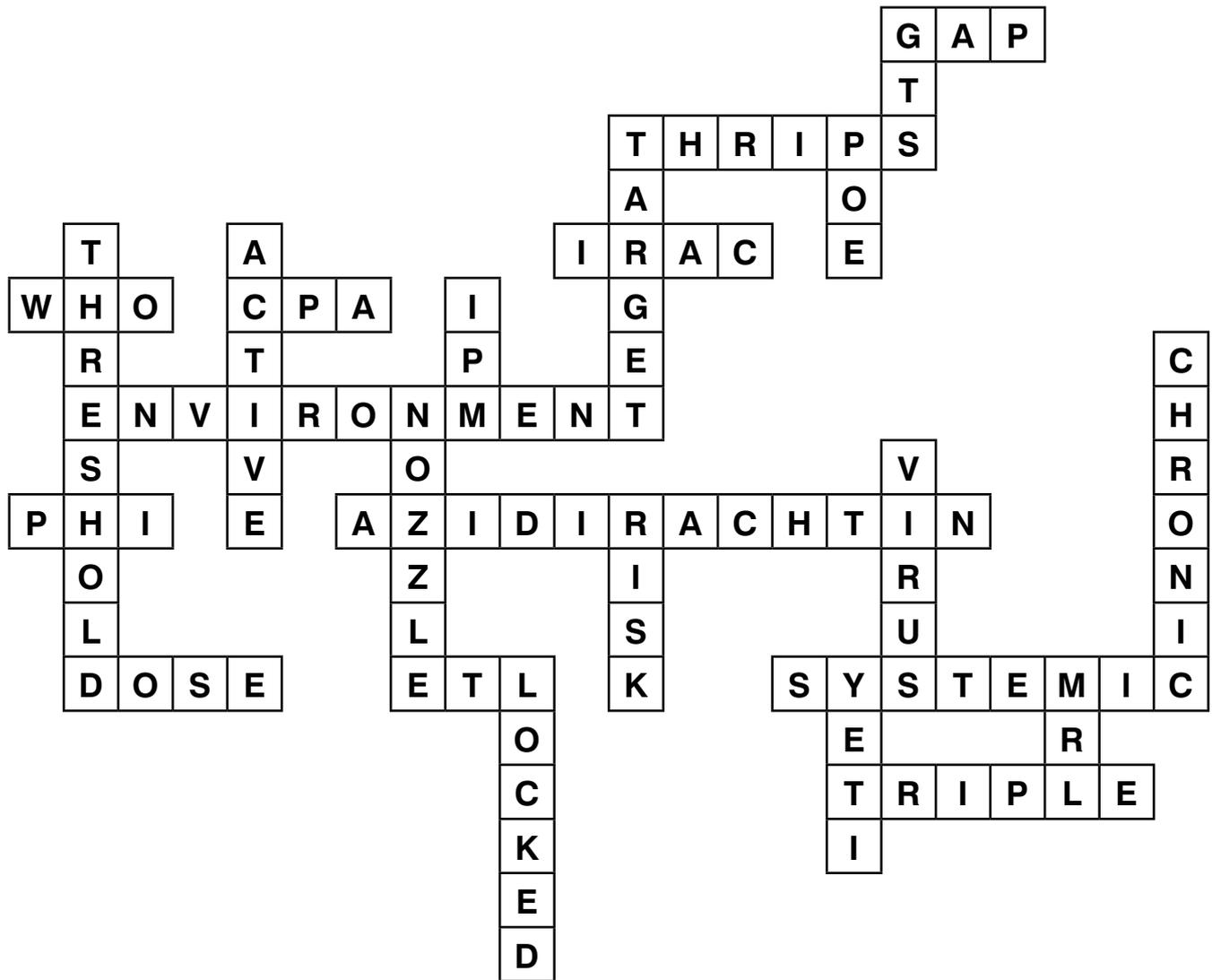
Hand out the crossword puzzle and have participants fill it in.

ACROSS

- 1 Practices that address environmental, economic and social sustainability for on-farm processes
- 2 Virus vector
- 6 Classifies insecticides by MoA
- 7 Classifies CPAs by acute toxicity
- 8 Synonym for "pesticide"
- 10 Third pillar of GAP
- 14 Time which should be left between CPA application and harvest
- 15 Active ingredient of neem
- 17 Amount of active ingredient needed per hectare
- 18 $(\text{pests}/\text{m}^2) = C \div (V \times D)$
- 20 Absorbed into the plant tissues from where they land, they are then moved about in the plant
- 23 _____ rinse

DOWN

- 1 Shares many symptoms with CPA poisoning
- 2 CPA is aimed at this
- 3 Put this on whenever handling CPAs
- 4 Only apply CPAs when this has been reached
- 5 CPA formulations contain _____ and inert ingredients
- 9 Combination of methods for pest management
- 11 Reflex, flat fan and hollow cone are examples
- 12 Effect that develops slowly, due to a long and continuous exposure to low concentrations of a CPA
- 13 Once infected, CPAs cannot eliminate this pest
- 16 Hazard X likelihood
- 19 CPA stores should be kept _____
- 21 Abominable Snowman
- 22 Being above this is a sign that PHI has not been observed



GAME: IPM Charades

One player picks a piece of paper with a key step in the process of IPM / appropriate CPA management from the “hat” and then they attempt to perform it.

The rest of the group will have 60 seconds to guess what the player is acting out.

Clues can be steps for IPM and appropriate pesticide management, e.g.:

- Prevent pests
- Monitor for pests [or scouting]
- Use threshold
- Read label
- Check weather
- Wear PPE
- Mix the CPA / fill the sprayer
- Triple rinse
- Apply the CPA
- Fill record of CPA application

Clues should be drawn at random. Once all of the clues have been acted out, the participants can put the steps in the proper order, from prevention through to CPA record keeping and container disposal.



7. Activity index

The full list of activities in each section is given below.

3.1 Understanding IPM

- Awareness-raising of farmers of their current implementation of IPM
- Explore the benefits of applying IPM
- Identification, evaluation and control of hazards
- Insect zoo 1 – insect pest or natural enemy?
- Insect zoo 2 – Predators in action
- Insect zoo 3 – Disease symptom development
- Plant doctor simulator
- Subjective threshold development
- Using economic thresholds as a basis for deciding to apply CPAs
- Decision steps for deciding to apply a pesticide

3.2 General information about CPAs

- Interactive discussion on what pesticides are and the types of pesticides
- Pest and pesticide matching
- Interactive discussion on “What’s in a pesticide?”
- Advantages and disadvantages of different pesticide formulations
- Game to group together by active ingredient and formulation type
- Bioassay for specificity testing
- Interactive discussion to delve deeper into insecticides, fungicides and herbicides
- Game to group together by insecticides, fungicide, and herbicides
- Exercise on understanding regulations for CPA life cycle management

3.3 Selecting CPAs

- Interactive discussion on CPA label interpretation
- The pesticide label says... (Game for label interpretation)
- Demonstration of the importance of reading the label
- Interactive discussion and group work on ‘What can be used and why’
- Group work to analyse and select the appropriate CPA
- Debate on the pros and cons of biopesticides
- Buyer beware – interactive discussion and demonstration on the hazards of CPAs of questionable quality
- Shopping challenge (Game for considering all criteria for CPA selection)
- Pesticide resistance role-play
- Group work on pesticide resistance management – what can you do?

3.4 Personal safety and contamination

- Group work ranking CPAs according to hazard as perceived by participants
- Group work to identify where CPAs can contaminate the environment
- Group work for recognising risks of contamination and routes of entry with CPAs
- Interactive discussion on symptoms of CPA poisoning
- Role play to demonstrate first aid for CPA poisoning
- Interactive discussion on personal hygiene

- Demonstration and interactive discussion on PPE
- Spot the problem with the CPA use (Game)
- Personal Protection Equipment (PPE) and its use (Dye exercise)
- Practical exercise to make PPE
- Interactive discussion on PPE maintenance

3.5 CPA handling and application

- Interactive discussion on how to safely transport pesticides
- Practical exercise to learn how to calibrate sprayers
- Interactive discussion on calculating dosage
- Dosage calculation exercise
- Interactive discussion and demonstration on mixing pesticides, particularly when there is more than one product
- Practical exercise to properly triple rinse – the 3 minute shake
- Demonstration of how to mix the pesticide, filling the sprayer and rinsing empty pesticide containers
- Interactive discussion on general precautions when measuring and mixing
- Interactive discussion on how to deal with spillages
- Demonstration of the mixing process - homogenization of the solution
- Demonstration of physical and chemical incompatibility of agrochemical products
- The story of Farmer A and Farmer B (role playing activity / sketch to illustrate consequences of not following labels)
- Interactive discussion and nozzle demonstration
- Nozzles (parts 1-4)
- Interactive discussion on methods of CPA application
- Are we doing the right things? Role play on issues to consider when both preparing and applying pesticides
- Evidence of the influence of the wind during application
- Interactive discussion on special risk areas to be aware of when spraying
- “And then...” (A story game to review the steps involved in appropriate CPA use)
- Brainstorming and group work on records to keep on pesticide applications – why, what and how
- Can you use it? Yes or No (Game)

3.6 Post-spraying activities

- Interactive discussion on re-entry intervals
- Practical activity to wash, dismantle and reassemble a knapsack sprayer
- Interactive discussion and demonstration of empty container disposal
- Group work on planning empty container disposal
- Interactive discussion and group work on waste CPA disposal
- Practical activity to construct a biobed

3.7 CPA storage

- What's wrong with this picture? (Game to identify problems with CPA storage)
- Practical exercise to organise a CPA storage cabinet
- Practical exercise to organise a large CPA store
- CPA inventory brainstorming – why, what and how



Appendices

Appendix 1. Identification of training needs

Country: _____

For each of the topics listed below, list whether the topic is a high, medium or low priority. Note whether training is needed primarily to **raise awareness** (e.g. of issues or importance of a topic); to introduce **fundamental concepts** and terminology; to **build skills**; or to support **planning** for implementation and application of concepts and skills. Make use of the baseline data, GAP data, etc. as a reference.

Training topic		Field technicians	Farmers
1	Understanding IPM		
	Minimising pesticide use through IPM Introduction to IPM as a strategic approach Relationship to GAP, GAP requirements, etc.		
	Identification of pests and beneficial organisms		
	Monitoring and decision support tools		
2	General information about CPAs		
	What is a pesticide?		
	What's in a CPA		
	Advantages and disadvantages of common pesticide formulations		
	How do CPAs work?		
	Legislation, key regulations and contractual obligations related to CPA life cycle management		
3	Selecting CPAs		
	Label interpretation		
	Selecting appropriate CPAs		
	Purchasing CPAs		
	CPA resistance management		
4	Personal Safety and Contamination		
	Problems associated with CPAs		
	Routes of CPA exposure		
	Symptoms of CPA poisoning		
	Treatment of CPA poisoning		
	Personal hygiene and general precautions		
	Personal Protection Equipment (PPE)		
	PPE maintenance		
5	Handling and application		
	Transporting pesticides		
	Calibration of spray machinery		
	Calculating dosage		
	Correct preparation of mixtures		
	How to deal with spillages		
	Mixing products – homogenization of the solution		

	Mixing products – physical and chemical incompatibility		
	Following recommendations for application		
	Nozzle selection and maintenance		
	CPA application methodology		
	General precautions while spraying		
	The influence of weather conditions on effective CPA application		
	Environmental and wildlife considerations while spraying		
	Records that must be kept after each CPA application		
	Understanding residue problems and how to avoid them		
6	Post-spraying activities		
	Re-entry intervals and safeguarding areas after spraying		
	Sprayer decontamination and maintenance		
	Disposal of containers		
	Disposal of waste CPAs		
7	Pesticide storage		
	CPA storage characteristics, optimal environmental conditions, organisation and safety		
	Maintaining a CPA inventory		

Responsible person	Venue / location	Target group / no.	Expected outputs	Year											
				Q1			Q2			Q3			Q4		
Training activity															
Actions required															
Preparation of training material															
Translation of material															
Preparation and confirmation of training budget for activity															
Confirmation of training date(s)															
Identification and organisation of trainers															
Identification and organisation of trainees (farmers/technicians)															
Identification/organisation of venue															
Collation of equipment (if necessary)															
Organisation of refreshment/meals															
Organisation of transport for trainees															
Organisation of transport for trainers															
Other															

Appendix 3. Checklist for adaptation of training material to local situation

Country: _____

Below list is a guide to potential areas for consideration when adapting/preparing training material to the local context.

Training topic	Check
Training material	
Select topics required and associated training exercises	
Does the text need adapting to local literacy level for technicians/farmers?	
Is background information adequate for informing target GROUP?	
Is technical information, e.g. labelling, CPAs fitting with local situation?	
Are alternative/additional images required for illustration?	
Organise translation into local language, if necessary	
Prepare handouts	
Are complimentary information materials available e.g. videos	
Equipment / training props	
What equipment is required for training activity?	
Organise collation of equipment for training activity	
Training venue	
What size group will be trained?	
Is sufficient material available for training activity?	
What will be location for training?	
Is location/venue organised?	
Are facilities appropriate for training or does additional equipment, e.g. flipcharts, need to be organised?	
Is there a need to organise refreshments/meals?	
If so, organise refreshments/meals.	

Additional needs identified/to be considered

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