Facilitator's Manual

INTRODUCTION TO INTEGRATED PEST MANAGEMENT

Brussels
March 2019
Updated From October 2008

CropLife INTERNATIONAL

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- Part 1

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- Homework assignments

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COURSE OUTLINE

Day 3

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or

Participants Depart

Day 5

Participants depart

INTRODUCTION

REMEMBER THAT GOOD PREPARATION WILL TAKE YOU MORE THAN HALF WAY TO ACHIEVING A SUCCESSFUL COURSE.

This training course on Integrated Pest Management (IPM) has been prepared by CropLife International. It consists of 13 Sessions of approximately two hours each over four days:

Session 1	Introduction to the Course
	Pre-Course Trainee Evaluation
	Basics of IPM – Part 1
Session 2	Basics of IPM – Part 2
Session 3	Basics of IPM – Part 3
Session 4	Basics of IPM – Part 4
Session 5	Basics of IPM – Part 5
Session 6	Pesticide Resistance Management
Session 7	Pesticides and Formulations – Part 1
Session 8	Pesticides and Formulations – Part 2
Session 9	Biocontrol
Session 10	Pesticide Application
Session 11	Health and Safety
Session 12	Environmental Aspects
Session 13	Post-Course Trainee Evaluation
	Certificate Presentation
	Course Closure

Objectives of the Course

The overall objective of this course is to enable participants to understand the underlying concepts and principles of IPM which are relevant to all crops. The course is designed to be used in any area or region. In developing IPM knowledge among the participants, course activities do not use crop or IPM examples from specific areas, but rather call on participants (and the Trainers) to select their own crops and situations as a basis for the activity. To help the Trainers, some examples are given as background and as supporting material.

The main target groups of the course are pesticide retailers and agricultural extension officers, although farmers could also be included.

There will be different levels of knowledge among the participants. However, it is assumed that many will have only a vague idea of what IPM actually is and how it is implemented. Because practical and effective IPM can have many interacting factors, the course is designed to take participants slowly through the explanations of IPM principles and concepts. For this reason, several interacting topics may be introduced in a basic way in one session, and then further developed as individual topics in later sessions.

This is particularly so in Sessions 1 and 2. Trainers **must** bear this in mind, and not allow discussions to become too detailed or technical on the first introduction of a topic.

The objective is **not** to give participants an excess of technical details - these should come later in training courses, such as IPM in specific crops, or sprayer maintenance, repair, and use. After attending this course, participants should be better prepared for later courses they may attend on crop production, and better able to understand the reasons behind the IPM practices implemented in those crops. They should also be better prepared to discuss and explain IPM principles and practices to farmers, and to give practical advice relevant to the farmer's situation.

Trainers should always keep these course objectives in mind during the training sessions, and ensure that all topics are adequately covered.

Course Duration, Location, and Sponsorship

The full course takes 4 days. Some participants, particularly pesticide retailers, may find it difficult to attend for this length of time. In this case, the course can be spread over a longer period of time, such as one or two sessions in a morning, afternoon or evening over several weeks. This will need to be decided in collaboration with the participants prior to the course. If this schedule is followed, the introductory activity of each session will be important as a reminder of the results and conclusions of the previous session.

A suitable venue should be selected for the course. The facilities available at the venue will partly depend on how the course is to be held in terms of timing of the sessions. More facilities in terms of refreshments, and perhaps accommodation, will be needed if the full course is to be held in one instance.

Local sponsorship may be obtained to help fund or organise the course, or provide the venue. Such sponsorship should be acknowledged during the course, and on the Certificate of Attendance presented to the participants at the end of the course.

The *"Introduction to IPM Handbook"* and the *"Trainers Manual"*

Trainers should read both of these before starting any preparations for a course.

The Handbook contains all the necessary information required about the principles of IPM. The Trainers Manual contains the Session details and activities to be undertaken. However, all the contents of the Handbook and all the necessary IPM information are not fully detailed in the session plans. It is the responsibility of Trainers to ensure that all the information contained in the Handbook is covered during the training course. The Trainers must plan in advance for each session to ensure that all the information contained in the Handbook is covered during the relevant session activities. In particular, they should note the structure of the course and how topics are developed from session to session.

Trainers should also note that topics are not necessarily in the same order in the Handbook and the training sessions. This is because topics are often interlinked, and topics may be re-visited to further develop or place in perspective in the training sessions.

Participants should only be given the Handbook at the end of the course, together with their training certificate.

Training Method

The training method is participatory, and the role of the Trainers / Facilitators is to create the conditions within the sessions that assist this type of learning. For the course to be effective it is essential that the Trainers have the necessary participatory training skills and experience. Two Trainers are required to give the course, as they can divide session responsibilities between them, support each other during sessions, and monitoring, coaching and evaluation of the participants is more effective.

Trainer activities are specified during the procedures of each session. This is deliberate, and does not question the skills or experience of the Trainers. Activities are specified in this way so as to take course participants step-by-step through the principles of IPM. Trainers are free to adjust activities to a certain extent depending on local circumstances, but should not change the structure of the course.

The training room should be laid out either with individual participant chairs, or with 3-4 tables, in a semi-circle around the main flipchart. The room should be large enough for participant groups to work separately and without disturbing each other in group activities, otherwise an additional room will be needed.

Trainer Responsibilities

One person should be designated as overall course leader to be responsible for the coordination, planning and conduct of the course.

The Trainers must have a meeting at which they can discuss the training methods which have been summarized in this manual. They need to agree who will deliver which sessions so that they are able to prepare for their particular sessions and activities. Also where co-training (i.e. as a team) is involved, Trainers should agree on how the procedures will be conducted, e.g., how participants will be divided into groups and monitored.

Pre- and Post-Course Participant Evaluation

Following the introduction to the course in Session 1, participants take a pre-course evaluation to assess their existing knowledge of IPM, pesticides, etc. This consists of a 25 question, multiple choice answer test. Exactly the same test is given at the end of the course to assess how participant knowledge has changed.

Trainers should mark the pre-course as soon as possible. However, the evaluation results and the papers should not be given back to the participants, nor should they be told which questions they got right or wrong, as they will sit the same test at the end of the course.

Participants receive their results and both sets of papers after the Post-Course Evaluation in Session 13 at the end of the course.

In certain countries, public announcement of the results could be sensitive to participants. In these circumstances the trainers should use their local knowledge to decide how best to present the results, if at all (e.g. average % change for the whole group). It is important, however, that individual participants receive their marked pre- and post-course papers so that they can self-evaluate their progress as a result of the course.

Preparation of Training Notes, Visual Aids and Training Equipment

After the Trainers have met together and agreed on "who does what", individual Trainers can begin preparation of their training sessions, referring to the Trainers Manual, the handouts included with each session, and the participant manual.

All session handouts and the participant Handbook should be prepared and duplicated well before the course.

Flipcharts should be prepared of the objectives of each session, to be used in the session introduction, and referred to at the end of the session. Also, where presentations are made it is useful to pre-prepare flipcharts with the main points that can be referred to during the presentation.

Certain sessions require additional training equipment, such as pesticide containers, gloves, or bottles of water. There is a check-list at the end of this Introduction, but Trainers should note where such equipment is needed in the course, and decide what they need to obtain and from where.

A display of IPM booklets and other material, e.g. pest and beneficial insect identification charts may also be made available; these can be browsed by particpants at coffee and lunch break. Material should be chosen that is locally relevant.

The Trainers should have a meeting to make sure preparations are completed on time and that all equipment, stationery, etc., is available before the course starts

Activity Times

The times given for each activity of a session are indicative, and are given to help the Trainers when planning and running the session. However, they are not fixed, and it may be found that with a more knowledgeable group of participants some of the activities may be completed in less than the indicated time. Conversely, on occasion more time must be allowed in order for participants to thoroughly cover the topic.

Trainer Notes

Trainer notes are provided at various places in the Trainers Manual. These are to provide additional assistance and direction for the running of the relevant procedure.

Sample questions are provided in many Session activities. These are suggestions, or indicative questions, only, and are intended to guide the trainer in the type of questions to ask so as to stimulate discussion and ensure that all aspects of the topic are covered and discussed. Other questions may be required to achieve this – the trainer must facilitate the discussion and ask these additional questions.

The provided questions are **not** fixed or the only questions that must be asked of the participants.

Handouts

Session Handouts contain the basic information from each activity. They are numbered, the first number referring to the Session number, the second to the handout number of that session. They are intended both as reminder notes for participants, and for Trainers to use as checklists during an activity to ensure that all the topics are adequately covered.

In the Trainers Manual the terms 'present' and 'distribute' are used with regard to handouts.

- 'Present' means give a short lecture to the participants on the contents of the handout.
- 'Distribute' means pass out copies of the handout to participants.

Sufficient numbers of all Handouts for participants must be printed or photocopied prior to the start of the course.

INTRODUCTION

Participants

Participants should be notified at least four weeks before the start of the course. At this time they should receive detailed joining instructions:

- The course location and venue
- The dates of the course, and the date / time when they should arrive at the venue
- An outline of the course and its objectives
- Information on accommodation, if this is to be provided.
- Any costs they may have to bear.

Participant Details

At the end of Session 1, a Handout is distributed for participants to fill out their contact details. These should be returned to the Trainers as soon as possible. The Trainers should prepare a single list of the information, and make sufficient copies to be distributed to all participants on the last day of the course.

This contact list is intended both for the trainer's record of participant attendance, and for networking between Trainers and participants following the course.

Equipment

Using the checklist of training materials and equipment, note against each item the name of the person / company that has agreed to loan it for the duration of the course.

Fix a day for collection / delivery of all items.

Checklist of Training Materials Required

1. Trainers manual and notes
2. Handbook on the Principles of IPM
3. Flipcharts
4. Marker pens
5. Masking tape
6. Cards
7. Glue sticks
8. Block notes
9. Pens / Pencils
10. File covers
11. Selection of pesticide containers / different types of formulations of each hazard classification
12. Selection of labels of each hazard classification
13. Selection of pesticide data sheets / technical leaflets
14. Rubber gloves and other personal protective equipment (PPE)
15. Soap / water
16. Examples of different types of hand sprayers
17. Examples of different types of nozzles
18. Selection of illustrations of major insect pests, beneficial insects, diseases, weeds
19. Pest management leaflets / booklets / recommendations
20. Any other suitable leaflets / booklets / recommendations available, eg from pesticide companies
21. Scouting booklets, etc

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INTRODUCTION TO THE COURSE

PRE-COURSE TRAINEE EVALUATION

BASICS OF IPM – PART ONE

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www.croplife.org

1 INTRODUCTION TO THE TRAINING COURSE

Overview of the Session

The session begins with introductions between the Trainers and the Participants. Following this, the course objectives and outline are presented, together with the expected involvement of the participants in the different course activities. The trainers then explain the remainder of the activities in the session.

Participants undertake a pre-course evaluation of their existing knowledge through 25 multiple choice questions. Trainers **must not** give the papers back to the participants as they will sit the same test at the end of the course. Sitting the same evaluation test will enable the trainers to assess participants increased knowledge of IPM as a result of the course.

The first full participant group activity is to brainstorm 'What is a Pest?' The final activity is another brainstorming to examine local farmer methods of pest management. This activity is to introduce the concept of non-chemical methods of pest management and will be used as a lead-in to later activities.

The session concludes with two homework assignments, one for participants to prepare for Activity 3 in Session 2, and one to complete a Handout of contact details.

Session Objectives

By the end of the session, participants will be able to:

- Describe the overall goals of the training course, including what will be expected of them in completing the course.
- Define what is a pest.
- State the different headings under which pest management methods are categorised.

TOTAL TIME: 2 hours

1 INTRODUCTION TO THE TRAINING COURSE

Procedures

1. Introduction to the Training Program

15 minutes

Objective of the Procedure:

- To establish a friendly atmosphere between the participants, and between the participants and the trainers.

Welcome participants to the first session of the training program. Introduce yourself. Allow the participants a few minutes for each person to introduce him / herself as follows:

- Name and position
- Place and description of work
- Number of years working in this position / place
- Their expectations from the course

2. Overall Training Program Goals and Schedule

15 minutes

Objectives of the procedure:

- To ensure that participants are aware of the objectives of the course, the structure, the schedule, the training methods to be used, and the commitments required from participants.

Refer participants to the overall programme goals (bullet 3 below).

Say that:

- The course will explain the concepts and principles of Integrated Pest Management relevant to all crops.
- It will NOT be a technical course
- After the course, participants will:
  - Understand the underlying principles and concepts of IPM.
  - Be better prepared should they attend other courses on production of specific crops, and be better able to understand the IPM practices implemented in these crops.
  - Be able to discuss and explain IPM principles and practices with farmers, and to give practical advice relevant to a farmer's situation.

Distribute the course timetable.

There will also be some “homework” assignments for the participants to do between sessions. These are intended to build on the session contents, or to prepare material to be used in the next session. Point out that the assignments are part of the learning and self-evaluation process. Emphasise also that it does not matter if a participant is unable to complete the assignment because of a possible lack of knowledge; it is part of the self-evaluation and they will be given the necessary knowledge during the course. No-one will be marked or assessed on the homework assignments.

3. Introduction to Remainder of Session 1

5 minutes

Explain that in the remainder of this session we will be examining some of the underlying aspects of IPM. At this stage this is simply introductory, and there will be more detailed discussions in later sessions.

4. Pre-Course Evaluation

30 minutes

Objective of the procedure:

- To evaluate participant's knowledge of IPM prior to the start of the course.

Explain that before we start the main part of the course, an evaluation of participant knowledge of pest management is useful, both for the trainers to help them conduct the course, and also for the participants to be able to assess their development as a result of the course.

Explain also that they will complete a similar evaluation at the end of the course. The papers and results will be returned then.

Distribute Handout 1.1, *Pre-Course Evaluation*.

The evaluation consists of 25 multiple choice questions. Ask the participants to put a tick or cross in the box next to what they think is the correct answer to the question.

Allow 20 minutes for the participants to complete the evaluation, then collect the papers. Make sure that the participants have written their names on the papers.

Mark the papers as soon as you have some free time. Enter the participant names and test results into the table, ready for the post-course evaluation in

TRAINER NOTE: DO NOT give the evaluation results, give the papers back, or tell participants which questions they got right or wrong, as they will sit the same test at the end of the course.

Participants will receive their results and both sets of papers after the Post-Course Evaluation in Session 11 at the end of the course.

Session 11.

5. Brainstorming – What is a Pest?

15 minutes

Objective of the procedure:

- To introduce participants to the participatory nature of the course.
- To introduce basic concepts on which the course is based.
- For participants to be able to define what is actually meant by a pest, and what are the different types of pest organisms.

Say:

- Before we start the course we need to have a common understanding of how we define and describe pests. These are the definitions that will form the basis of our next sessions.

Ask participants to brainstorm all the pests that affect humans, animals or crops in their part of the country. Record their responses on the flipchart.

TRAINER NOTE: To simplify reviewing the responses, list them in the various pest categories of Handout 1.2, although without using a heading. Eg put all the insect pests into one column, weeds into another, etc as the responses come from participants. Then put in the headings afterwards, when reviewing the responses.

Say:

- We now can step back and review this list. Insert and explain the categorisation of the participant answers on the flipchart according to Handout 1.2, *Pests: Insects, Diseases, Weeds and Others*. Correct, delete or add categories and examples as appropriate.

Ask:

- Given such a categoristion of pests, how can we define a pest in a very simple and broad way?

  List participant answers on the flipchart. When there are no more responses, give the broad definition of a pest from Handout 1.2, *Pests: Insects, Diseases, Weeds and Others*.

Ask if the participants have any questions.

Distribute Handout 1.2, *Pests: Insects, Diseases, Weeds and Others*.

6. Brainstorming – Local Farmer Pest Management Practices

15 minutes

Objective of the procedure:

- For participants to exchange experiences and knowledge of alternative, non-pesticide pest management practices.
- To structure this knowledge into the different types of non-pesticide control methods.
- To provide a lead into subsequent activities.

Say:

- Now that we have defined a pest, we need to look at ways in which they are controlled or their effects are minimised.

Ask:

- How do local farmers control pests or minimise their effects in the major crops?
- What methods do they use?
- Do they use any methods which do not involve pesticides?

List participant answers on the flipchart.

TRAINER NOTE: To simplify reviewing the responses, list them in the various categories given in Handout 1.3, Methods of Pest Management, although without using a heading. Eg put all the mechanical methods into one column, cultural into another, etc as the responses come from participants. Then insert the headings when reviewing the responses at the end of the activity.

Use Handout 1.3, *Methods of Pest Management* as a checklist. When there are no further responses from participants, from your own knowledge of local practices ask leading questions regarding any omissions in the categories.

For example:

- What plant density do farmers use? Is it too low, too high or correct? What effect could this have on pest levels? (Cultural)
- How do farmers prepare the land for planting? How could this affect pest levels? (Mechanical)
- Are there any uncultivated areas of vegetation of near the farmers' fields? Will these have any effect on pest levels? (Biological)
- What sort of seed do farmers use, where does it come from? How could seed affect pest levels? (Sanitation)

1 INTRODUCTION TO THE TRAINING COURSE

TRAINER NOTE: Do not get involved in details or technical discussions in this activity. The objective is to introduce the basic concept that there is a range of methods that farmers can use to manage pests.

Ask:

- Do individual methods vary between crops or locations?
- Which of these methods are easy for a farmer to apply?
- Why?

Ask:

- What are the results of these methods?
- Are there both positive and negative results?
- If so, what are these effects?

List participant answers on another flipchart.

When there are no more responses, review on the flipcharts the answers to both sets of questions.

Emphasise:

- ✔ It is the farmer who is responsible for implementing these methods - it is his crop and his livelihood.
- ✔ There is a range of methods that a farmer can use to manage pests - mechanical, cultural, biological, etc.
- ✔ The farmer needs to consider the economics of each method - does it provide a benefit to him?
- ✔ The alternative, non-chemical pest management methods.
- ✔ IPM incorporates all these ideas.
- ✔ That there are potential negative effects with some methods.
- ✔ IPM also attempts to minimise these negative effects.

Distribute Handout 1.3, *Methods of Pest Management.*

Say:

- During the course we will explore the different types of methods to see how these methods can be used in an IPM programme, and see how IPM can help to minimize possible adverse effects.

TRAINER NOTE: Leave the flipcharts up as they will be referred to in the first group activity of Session 2.

7. Conclusions

5 minutes

Summarize briefly the highlights of the session.

Include as main messages:
- Understanding and definition of a pest.
- A range of methods are available to farmers to manage pest levels.
- It is the farmer who must implement these methods.
- Some methods may have potential negative effects.
- IPM is a strategy for incorporating all possible pest management methods into an overall programme.

Review the session objectives and ask if they were met.

Ask:
- What is the one conclusion or insight of the session that for you is most significant? Why?

TRAINER NOTE: The intention of this question is not to get drawn back into a technical discussion. It is intended to help participants generalise what they have learned in the session. The trainer should paraphrase participant responses, take additional responses, and briefly summarise at the end the key participant conclusions. It is also preferable that these conclusions be recorded on the flipchart to assure greater retention.

THESE SESSION CONCLUSIONS ARE OFTEN THE MOST POWERFUL MESSAGES IN INFLUENCING PARTICIPANT VALUES AND ATTITUDES, BECAUSE THEY COME FROM THEIR PEERS.

8. Homework Assignments

5 minutes

There are two homework assignments:
- The first is for participants to reflect about IPM, the responses from which will be used in the next session.
- The second is for participants to fill out a contact form, both for records of attendance, and for networking between participants and trainers.

Objective of homework assignment #1:
- For participants to reflect on why they need to know about pest management and IPM.
- To emphasise that IPM is an integral part of overall crop production.
- To emphasise that providing practical and effective advice on pest management will not only benefit farmers, but also increase trust between themselves and farmers.

1 INTRODUCTION TO THE TRAINING COURSE

Give the following homework assignment to complete during the break. Their results will be used in Activity 3 of the next session.

Write down as many reasons as possible why you think:

- You should know about the concepts and principles (not technical details) of pest management and IPM, and
- How this will be of practical benefit to you in your work or business.

Objective of homework assignment #2:

- For trainers to have a record of participant attendance, with full contact details.
- To provide a list of names and contact details to all participants at the end of the course that they and the trainers can use to keep in touch and to network.

Distribute Handout 1.4, Participant Details. Ask participants to fill it out as soon as possible and return it to you.

1 PRE-COURSE EVALUATION

Handout 1.1

Participant Name _____

1 A weed is defined as a plant which:

- [ ] a) Injures humans, domestic animals, useful plants, structures or possessions.
- [ ] b) Annoys humans or animals.
- [ ] c) Is growing where it is not wanted.

2 Cultural control includes, among others, the following method:

- [ ] a) Time of planting
- [ ] b) Chemical pest control
- [ ] c) Release of natural enemies of pests

3 Crop rotation is a form of:

- [ ] a) Cultural control
- [ ] b) Mechanical control
- [ ] c) Sanitation

4 One of the foundations of a successful IPM programme is:

- [ ] a) Breeding and releasing natural enemies of pests.
- [ ] b) Using resistant varieties.
- [ ] c) Good crop management to produce a healthy crop with a high yield potential

5 Excessive rates of fertiliser applied to a crop can:

- [ ] a) Reduce crop growth.
- [ ] b) Encourage insect pests and diseases.
- [ ] c) Increase the farmer's profits.

6 Repeated cultivation of the same crop on the same field:

- [ ] a) Ensures optimal uptake by the plant of the fertilisers applied
- [ ] b) Increases the risk of the build-up of soil pests, weeds and diseases
- [ ] c) Promotes higher yields

7 Cultivating resistant varieties means:

- [ ] a) Pesticide use has to be increased
- [ ] b) Less chemical control measures may be necessary
- [ ] c) The risk of pest attack is higher.

1 PRE-COURSE EVALUATION

8 Natural enemies of pests are:

- [ ] a) More common in fields which have not been sprayed with pesticides
- [ ] b) Favoured by increased pesticide use
- [ ] c) Reduced by high rates of fertiliser

9 Integrated pest management:

- [ ] a) Is a corrective technique which relies on pesticides.
- [ ] b) Uses all available techniques in an overall crop / pest management programme.
- [ ] c) Prohibits the use of pesticides in crop production.

10 Which of the following practices would be part of an IPM programme.

- [ ] a) Repeated cultivation of the same crop in the same field.
- [ ] b) Applying as much irrigation water as possible during the season.
- [ ] c) Planting a resistant crop variety

11 The place of pesticides in integrated pest management is:

- [ ] a) Pesticides should not be used in an integrated pest management programme.
- [ ] b) One of the available tools in an overall crop and pest management programme.
- [ ] c) To provide a quick solution to a pest problem.

12 What does pesticide resistance mean

- [ ] a) The inherited ability of a pest to tolerate the toxic effects of a pesticide.
- [ ] b) The extended effect of a pesticide against a pest after application.
- [ ] c) The inherited ability of a plant to withstand the effects of pest infestation.

13 What is the first thing you should do when you see a pest infestation in a crop.

- [ ] a) Select the correct pesticide for the pest.
- [ ] b) Identify the pest so that you know exactly what the problem is.
- [ ] c) Determine if the pest level is high enough to need spraying.

14 The use of a pesticide dose lower than that recommended for a specific pest:

- [ ] a) Saves the farmer money
- [ ] b) Protects beneficial insects
- [ ] c) Fails to control the target pest

15 **One of the most common causes of the failure of a pesticide application is:**

- [ ] a) Using out-of-date pesticide.
- [ ] b) Using the wrong pesticide.
- [ ] c) The pests have developed resistance to the pesticide.

16 **A systemic pesticide is most suitable for the control of:**

- [ ] a) Pests which suck the juices of plants.
- [ ] b) Pests which live in the soil and feed on roots.
- [ ] c) Pests which eat the leaves of plants.

17 **The crops, pests and dose rate information given on the label:**

- [ ] a) Are only some examples of possible uses of the product.
- [ ] b) Restricts the use of the product to the specified crops, pests and dose rates.
- [ ] c) Indicates the most common uses of the product.

18 **Gloves should be worn when mixing pesticides:**

- [ ] a) To avoid getting dirty hands
- [ ] b) To avoid contamination from pesticides which can be absorbed through the skin
- [ ] c) To be able to eat after the operation without washing the hands

19 **The hazard of a pesticide is:**

- [ ] a) The inherent property of the pesticide to cause adverse effects.
- [ ] b) A measure of how poisonous the pesticide is.
- [ ] c) The amount of time a person is in contact with the pesticide.

20 **The most common way in which pesticides enter the body is:**

- [ ] a) Through the mouth
- [ ] b) Through the lungs.
- [ ] c) Through the skin

21 **The pesticide formulations which are absorbed most readily are:**

- [ ] a) Emulsifiable concentrates
- [ ] b) Wettable powders
- [ ] c) Granules

22 The minimum amount of protective clothing to wear for a specific pesticide formulation and activity is:

- [ ] a) Overalls.
- [ ] b) Overalls and rubber gloves.
- [ ] c) Given on the label of the pesticide container.

23 During application, pesticide contamination of the environment can be minimised by:

- [ ] a) Using a low dose rate of the pesticide.
- [ ] b) Avoiding excess application and run-off from the plants.
- [ ] c) Placing warning signs around the treated area.

24 The environment is:

- [ ] a) Air, soil, water.
- [ ] b) Air, soil, water, plants, animals, houses.
- [ ] c) Everything around us.

25 A pre-harvest interval between the last pesticide application and harvest is to:

- [ ] a) Allow time for the pesticide to degrade.
- [ ] b) Allow time for the pesticide to kill all pests.
- [ ] c) Allow time for the crop to fully ripen.

Pre- and Post-Course Evaluation Results

(This table is for the Trainers use only and not for distribution)

	Name	Pre-Course	Post-Course	Difference
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

PESTICIDES AND FORMULATIONS – PART TWO

2

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Pests: Insects, Disease, Weeds and Others

A pest is any organism that:

- Competes with humans, domestic animals or desirable plants for food or water.
- Injures humans, animals, desirable plants, structures or possessions.
- Spreads disease to humans, animals or plants.
- Annoys humans or animals.

A pest can be broadly defined as: Any organism which adversely affects man, his crops, his livestock, or anything he considers to be of value

The types of pests include:

- Insects: aphids, beetles, caterpillars, ants, mosquitoes, cockroaches, etc
- Insect-like organisms: mites, spiders, ticks, etc.
- Weeds: any plant growing where it is not wanted.
- Micro-organisms that cause disease: bacteria, fungi, viruses, etc.
- Parasitic weeds: eg Orobanche (broomrape), Striga (witchweed), Cuscuta (dodder), etc
- Molluscs: slugs, snails,etc
- Rodents: rats, mice, etc
- Nematodes: root-knot nematode, etc

Methods of Pest Management

Mechanical

Land preparation and cultivation; rat traps; sticky traps; hand weeding; hand collection of diseased fruits, etc.

Cultural

Optimal crop growing conditions; unfavourable conditions for pests; irrigation; fertilisation; plant density; crop rotation; time of planting; pruning; thinning; trap crops, etc. Resistant crop varieties having repellent chemicals, vigour or tolerance, physical characteristics.

Prevention, Sanitation and Exclusion

Often included under Mechanical and Cultural headings.

Clean, certified seed; burying or composting of crop residues; rodent proof grain stores; removal of sources of food; cleanliness in the store, house or kitchen; nets, screens, etc.

Biological

Natural enemies of pests, including diseases (micro-organisms); preserve natural habitats; rearing and release of natural enemies; pheromones and insect growth regulators (these are sometimes included under chemical control).

Chemical

Synthetic pesticides; natural pesticides; pheromones and insect growth regulators (these are sometimes included under biological control).

Participants Details

Family Name:	
Given Names:	
Employer / Place of Work:	
Location of Place of Work:	
Position:	
Field of Specialisation:	
Work Telephone No:	
Mobile No:	
E-Mail Address:	
Home Address:	
Home Telephone No:	

2 BASICS OF PEST MANAGEMENT AND IPM – PART TWO

Overview of the Session

Following the broad examination of pest management methods in Session 1, this session introduces the overall concepts of IPM and begins an investigation of the crop management components of IPM – mechanical, cultural and sanitation practices.

The session begins with a continuation of basic definitions, including pest control, pest management and Integrated Pest Management, and how IPM is implemented. This is followed by brainstorming the homework activity from Session 1 on why participants need to know about IPM for their work, and the benefits that knowledge of IPM can offer to them.

The IPM Circle, an illustrative 'road-map' is then distributed to participants. This will provide an IPM referral point that can be re-visited during activities and sessions to ensure that participants are aware of how the current activity topic fits into the overall picture.

The trainers then give a short presentation on IPM, yield potential, and crop management, followed by a brainstorming activity on the main agronomic factors required to produce a healthy crop. This provides the basis for participants to break into working groups to list general examples of how these crop management practices can affect pests. The working groups report their results at the beginning of Session 3.

Session Objectives

By the end of the session, participants will be able to:

- Distinguish between pest control, pest management and integrated pest management.
- Define the concepts and benefits of IPM.
- Explain why they need to know about pest management and IPM, and how this knowledge will be of benefit to them.
- State the main agronomic factors required to produce a healthy crop with a high yield potential.

TOTAL TIME: 2 hours

2 BASICS OF PEST MANAGEMENT AND IPM – PART TWO

Procedures

1. Introduction to the Training Program

5 minutes

Welcome participants to Session 2. Briefly review the topics covered in the previous session.

Present the session objectives, and give a brief overview of the procedures.

2. Presentation – What is IPM?

15 minutes

Objective of the procedure:

- For participants to be able to explain the various components of the definition of IPM.
- For participants to understand that IPM is a concept and not a fixed package of recommendations.

- Say that in the last session we defined what we mean by a pest, and explored the different methods that farmers can use to manage pest levels. As the next step we need to understand and define what we mean by Integrated Pest Management or IPM.

Present the explanations of Pest Control, Pest Management and Integrated Pest Management from Handout 2.1, *What is IPM?*

Explain that pest management is a development beyond pest control, and that integrated pest management is a development beyond pest management.

Explain each of the concepts of IPM, referring back to the flipchart results and emphasised points from the last group activity in Session 1.

After the presentation, allow participants to ask questions as necessary about the definition and concepts of IPM.

Also ask:

- At present, do most farmers practice pest control, pest management or integrated pest management?

Distribute Handout 2.1 to participants.

3. Presentation – The Benefits of IPM and How IPM is Implemented

15 minutes

Present Handout 2.2, T*he Benefits of IPM and How IPM is Implemented.*

Emphasise:

✔ The simple definition of IPM

✔ The adoption of IPM by farmers is essential for sustainable agriculture and the reduction in risk to humans, food, wildlife, and the environment.

✔ Farmers used IPM principles and practices to manage pests long before synthetic pesticides were available.

Say:

- At present this may not seem to be of much practical help in implementing IPM, but we now have our foundation of basic definitions and concepts which will be explored and expanded during the course activities.

Ask if the participants have any further questions regarding these basic definitions and concepts.

Distribute Handout 2.2 to participants.

4. Presentation – IPM Circle

5 minutes

Objective of the procedure:

- To provide participants with a 'road-map' to illustrate the components and links of IPM, which will be referred to throughout the course.

Distribute and present Handout 2.3, *Components of IPM - The IPM Circle.*

Refer to the flipcharts from Session 1 on local farmer pest management methods and to the distributed Handouts.

Say:

- The IPM Circle will help participants visualise the components of IPM, how they are linked, and where we are in the course.

- We have already identified some of the components of IPM, while the others will be introduced as the course proceeds.

- In the process, each component will be investigated in more detail.

- Participants can use this graphic as their own checklist of components as we proceed through the course.

TRAINER NOTE: The IPM circle will be referred to throughout the course. A flipchart should be prepared of this representation to put up on the wall of the training room. It will be a constant reminder to participants, and will be referred to as each component is begun and completed, or to illustrate the linkages between components (eg chemical control methods and application, and that all pest management components affect economics and decision making.

5. Brainstorming – Why Participants Need to Know About Pest Management and IPM

5 minutes

Objective of the procedure:

- For participants to reflect on why they need to know about pest management and IPM.
- To emphasise that IPM is an integral part of overall crop production.
- To ensure participants understand that providing practical and effective advice on pest management will not only benefit farmers, but also benefit themselves.

Remind participants that the homework assignment from the last session was to:

Write down as many reasons as possible why you think:

- You should know about the concepts and principles (not technical details) of pest management and IPM, and

- How this will be of practical benefit to you in your work or business.

Ask participants to give their reasons. List these on the flipchart, and then summarise the results compared against Handout 2.4, *Why Participants Need to Know About Pest Management and IPM.*

Emphasise:

✔ The benefits of knowing about IPM to the particular group of participants, eg extension staff or dealers / retailers.

Distribute Handout 2.4 to participants.

6. Presentation – Introduction to IPM, Yield Potential, and Crop Management

5 minutes

Objective of the procedure:

- To provide understanding of the underlying factors of crop management that maximise yield.
- To identify the contribution of pest management to this process.

Present the contents of Handout 2.5, Introduction to IPM, Yield Potential and Crop Management, and then distribute the handout to participants.

Emphasise:

✔ One of the fundamentals of IPM is to use good crop management to grow a strong healthy crop with a maximum yield potential, and which is also more able to withstand pest attack and damage.

Ask if participants have any questions on these aspects.

7. Brainstorming – Agronomic Factors for a Healthy Crop

Objective of the procedure:

- For participants to reflect on how crop management can affect pest levels in the crop and pest management itself.

Explain:

✔ That we will now examine the factors of crop management that are required to grow a strong, healthy crop.

✔ In addition, there are also external factors that can affect pest development and pest management. These external factors are largely outside the control of the farmer and will be discussed in the next session.

Ask the participants:

- What are the main agronomic factors of crop management required to produce a healthy crop?

List the answers on the flipchart (use Handout 2.6, *Main Agronomic Factors for a Healthy Crop*, as a checklist of all the components).

TRAINER NOTE: These should be the main factor headings, not specific examples from within a component. The final list on the flipchart should be the components given at the beginning of Handout 2.6, such as quality of the site, crop rotation, etc.

Distribute Handout 2.6, Main Agronomic Factors for a Healthy Crop. Participants will use this Handout as a checklist during the next activity.

8. Working Groups – Factors of Good Crop Management

45 minutes

Ask the participants to get up and move to different tables so as to form new groups, then give the following working group tasks:

Working Group Tasks

1) Under each of the headings of the main factors of crop management on Handout 2.6, list on flip chart paper how each of these could affect pest levels in the crop or pest management practices.

2) Give broad examples for each (not specific or technical examples for particular crops or pests).

3) Select one person to report to the full group.

Say that groups should be ready to present their results immediately after lunch.

TRAINER NOTE: Walk around the groups and observe their activities. Ensure that the examples they are providing are not specific or technical. Refer to Handout 3.1 for the types of examples.

End of Session 2

What is IPM?

Pest Control: Corrective measure, pesticides or other methods used when pests are already or a likely to become a problem, often attempts to reduce pests to lowest possible level.

Pest Management: Includes preventative methods as well; manages pests so that they are below damaging levels.

✔ **Integrated Pest Management:** Uses all available techniques in an overall crop / pest management strategy that minimises the adverse effects of a pest or pests.

It includes the concepts that IPM:

- is farmer based,
- is not a "package" but is location specific (even down to the field level or crop growth stage),
- is a combination of all suitable techniques that minimise pest levels,
- must be considered as an integral part of crop production together with all agronomic techniques (ie integrated crop management - ICM),
- considers the economics of pest management, and
- minimises pesticide use for the protection of health and the environment - "as little as possible, as much as necessary."

✔ Taking these together, IPM is defined as:

An approach which "means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimise risks to human health and the environment. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms".

(International Code of Conduct on the Distribution and Use of Pesticides, FAO, November 2002)

IPM IS NOT A FIXED PACKAGE OF PRACTICES OR RECOMMENDATIONS – IT IS A CONCEPT.

Benefits of IPM and How IPM is Implemented

Benefits of IPM

- ✔ Use of inputs is optimised
- ✔ Unnecessary pesticide use is avoided
- ✔ Pest management costs are reduced
- ✔ Crop losses are reduced
- ✔ Profits from crop production are maximised
- ✔ Pest resistance to pesticides is avoided
- ✔ Crop production is sustainable
- ✔ The risk of human, animal, food, wildlife and environmental contamination is reduced.

How is IPM Implemented?

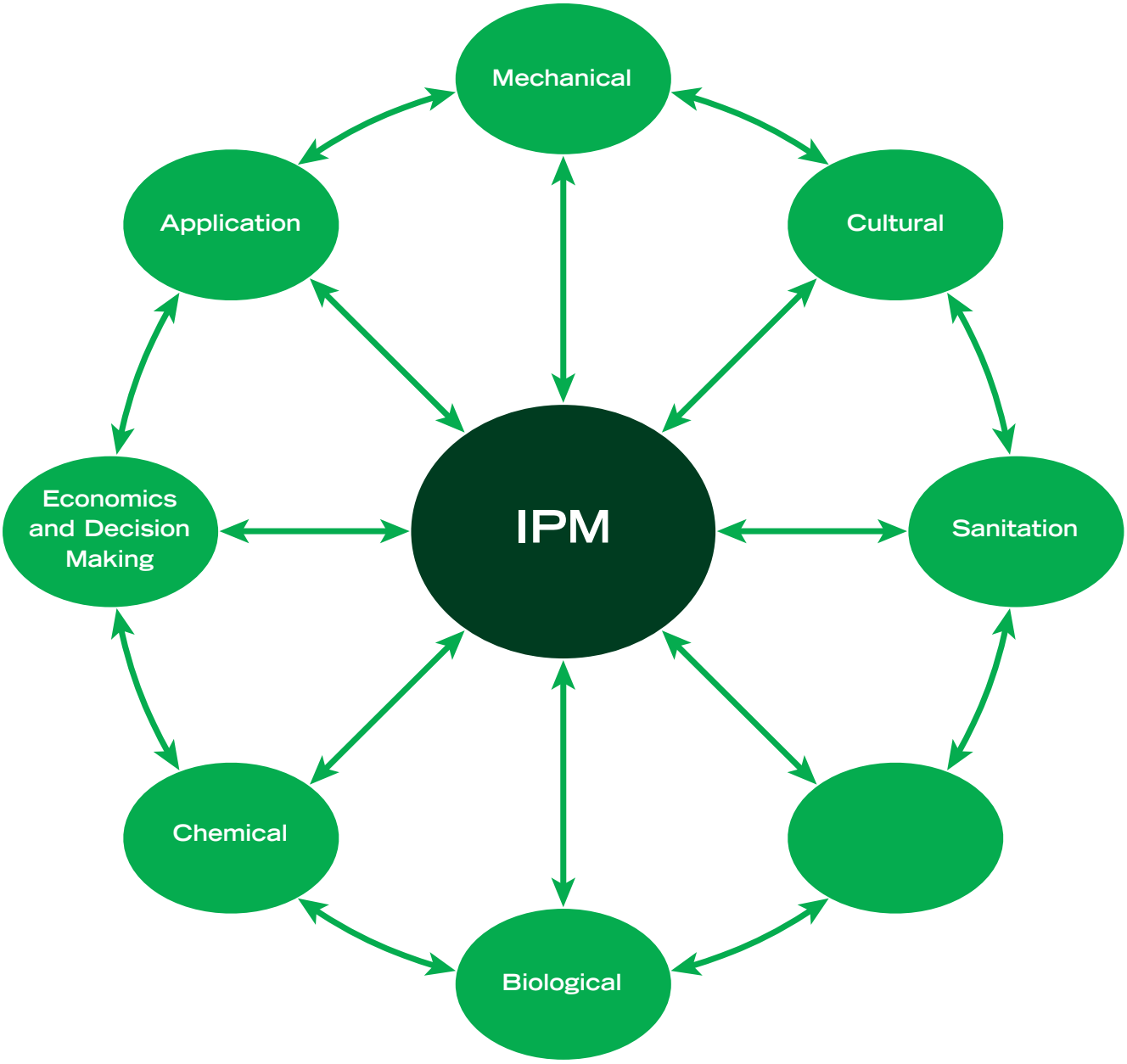
- There are many different types of practices which can be implemented in an IPM programme.
- Those which are actually used will depend on the crop and pest situation, and also to a certain extent on the farmer's resources.
- Pesticides are one of many available methods.
- Put simply:

> IPM is the combination of all appropriate practices into a single plan for crop and pest management that optimises input use to reduce pests and damage to an acceptable level, maximise yield, and minimise negative effects.

- Remember also:

> IPM principles and practices were used by farmers to manage pests long before synthetic pesticides were available

The Components of IPM – The IPM Circle



Why Participants Need to Know about Pest Management and IPM

- ✔ Crop production includes pest management. Neither can be considered in isolation.
- ✔ Crop production practices affect pest levels and pest management practices.
- ✔ These relationships need to be considered when giving farmers advice about crop production and pest management.
- ✔ Pesticides were once seen as the answer to most pest problems. Now, due to increasing concerns about the environment, the development of pest resistance, and the increasing costs of farming inputs, pesticides are considered as just one of a range of control methods available.
- ✔ Farmers can reduce costs and increase profits by the use of all suitable crop and pest management practices.
- ✔ Advisory staff can increase farmers trust in them by providing practical, effective, and simple advice.
- ✔ Input suppliers and retailers can increase customer numbers through providing better levels of service and advice than their competitors, not just for pesticides but also for seed, fertiliser, and other inputs.

Introduction to IPM, Yield Potential and Crop Management

- The overall concepts and principles of IPM are the same for all crops or pests, but different crops or pests may require different IPM practices to be implemented.

- Pest management is only one aspect of crop production. It cannot be considered on its own as crop management affects pest management and vice versa.

- The genetic makeup of the seed, together with crop management, determines the potential yield of a crop. Pest management, good or bad, has no effect on this potential.

Pest management does not increase the yield potential of a crop,

It only protects the crop against loss or damage.

- The primary objective of crop production is to use good seed and good crop management to grow a healthy crop with maximum yield potential, and which is also more able to withstand the effects of pest attack.

- Understanding how a crop grows and develops, and its place in the cropping system, is thus essential for successful pest management.

Main Agronomic Factors for a Healthy crop

Growing a strong, healthy crop is affected by:

- ✔ Quality of site and soil texture
- ✔ Crop rotation
- ✔ Land preparation
- ✔ Seed quality
- ✔ Time of planting
- ✔ Plant spacing and density
- ✔ Weeding
- ✔ Timing and amount of fertiliser
- ✔ Timing and amount of irrigation

3

BASICS OF IPM – PART THREE

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3 BASICS OF PEST MANAGEMENT AND IPM – PART THREE

Overview of the Session

Session 3 begins with workgroup reports on the Factors of Good Crop Management prepared in Session 2. Participants then again break up into working groups which are assigned one local crop each and asked to identify particular alternative, non-chemical techniques a farmer could include in an overall IPM strategy for that crop.

To complete the relationship between crop management and pest management, there is then a full group brainstorming activity on the external factors that can affect crop growth. At the end of the session, participants are given a homework assignment that will prepare them for a 'What If?' activity in Session 4.

Session Objectives

By the end of the session, participants will be able to:

- Understand the links between crop and pest management practices, and their effects on yield and pest levels.
- Describe alternative non-chemical pest management practices that could be used in certain local crops as part of an overall crop/pest management programme.
- Describe the external factors that may affect crop growth, pest development, and pest management.

TOTAL TIME: 2 hours 10 minutes

Procedures

1. Introduction to the Session

5 minutes

Welcome participants to Session 3. Briefly review the topics covered in the previous session.

Present the session objectives, and give a brief overview of the procedures.

2. Working Groups – Factors of Good Crop Management – Working Group Reports

40 minutes

Each group reporter should present the group results. Allow all groups to present before allowing any discussion or making any comments.

After all groups have reported, ask if participants have any comments or other factors to add. Use Handout 3.1, *Crop Management and Pest Management*, to ensure that all the components are adequately covered.

Emphasise:

- ✔ One of the most common problems of poor crop management is a tall or dense crop (vegetative growth), and explain the double effect of this with regard to pest management.
- ✔ Many of the factors that help to minimise pest levels are also the factors of good crop management which lead to higher yields.
- ✔ Often these can be adjusted by the farmer with little or no extra cost.
- ✔ Refer back to the IPM Circle. These factors all fall under the mechanical, cultural and sanitation methods of pest management.

Distribute Handout 3.1 to participants.

3. Working Group Task – Local Alternative Pest Management Methods

30 minutes

Objective of the procedure:

- To identify alternative, non-chemical control methods for particular local crops
- To illustrate that these methods can be different for different crops.

Say:

- In Session 1 we categorised the different methods of pest management, while is Session 2 and the last activity we investigated the factors of good crop management for high yields and how these can affect pest levels.

- We are now going to take this one step further and investigate for specific crops which crop management and non-chemical techniques a farmer could use in an overall crop IPM strategy.

- Refer to the IPM Circle. This activity will explore the mechanical, cultural and sanitation components in more detail.

Ask participants for examples of the most common local crops (e.g., cotton, tomatoes, citrus). Assign one crop to each table, and give the following table task.

Working Group Task

- For the crop assigned to your group, identify the particular crop management techniques a farmer could use in an overall crop IPM strategy.

- Identify each particular technique as mechanical, cultural, or sanitary.

Allow 25 minutes for the working group activity.

TRAINER NOTE: Typical examples of non-pesticide practices for several crops are given in Handout 3.2, *Examples of Non-Chemical Methods of Pest Management*. Additional examples are given in the Appendix of the Handbook.

Walk around and observe the groups to ensure that they are listing the correct types of techniques and practices

4. Working Group Presentations

30 minutes

After 25 minutes, ask each group to report. Let all groups present their results before allowing discussion and comment by participants.

From the results, emphasise:

✔ The different methods used in different crops.
✔ The same methods used in different crops.
✔ IPM takes all appropriate methods and incorporates them into an overall crop management programme.

Distribute Handout 3.2 to participants.

5. Brainstorming – External Factors

15 minutes

Objective of the procedure:

- Participants are aware that external factors can affect pest development and pest management, and are able to describe these factors.

Refer to the IPM Circle.

Say:

- We have now explored the factors of good crop management which lead to higher yields, how these factors can also minimize pest levels, and how they can be used in an overall crop / pest management programme.

- These factors are under the control of the farmer. However, there are other factors which are not under the farmer's control and which can also affect yield and pest levels. These are known as External Factors.

Ask:

- What are the external factors which can affect crop growth, yield and pest levels?

List participant answers on the flip chart, using Handout 3.3, *External Factors*, as a checklist.

Ask:

- Which of these external factors are difficult to avoid?

- Can any be overcome by crop management or other practices?

Emphasise:

✔ An IPM programme needs to take these factors into consideration.

Distribute Handout 3.3, *External Factors*, to participants

6. Conclusions

15 minutes

Summarize briefly the highlights of the session.

Include as main messages:

- Differences between pest control, pest management and integrated pest management.
- Definition of IPM.
- Why participants need to know about IPM.
- Factors of good crop management and how these can affect pest levels.
- Incorporation of these factors into an overall crop / pest management programme.
- External factors can both directly affect plant growth and encourage pest infestations.

Refer participants to the IPM circle to show how we are moving round the circle exploring each of the IPM components in turn, and showing the linkages between each. We will continue this process as the course proceeds.

Review the session objectives and ask if they were met.

Ask:

- What is the one conclusion or insight of the session that for you is most significant? Why? How will it help you in your work?

7. Homework Assignments

5 minutes

Homework Assignment 1

- Ask three of the participants to prepare a 10 minute summary of the day's activities, results, and conclusions to present to the full group at the beginning of the next session as a reminder of today's activities.

Homework Assignment 2

Objective of the homework assignment:

- For participants to be better prepared for the "What If" activities in Session 3.

Give the following homework assignment to complete before the next session:

- If a farmer came to you with a pest problem, how would you go about giving him practical, effective and economic advice?

TRAINER NOTE: Do NOT tell the participants about the "What If" activities in Session 4. The homework is only for them to think about how they would give such advice, not for them to actually prepare for the activity.

Crop Management And Pest Management

Quality of site and soil texture

Stony sites, areas with shallow soils or poor soil texture should be avoided, as these are often associated with a hard pan, which restricts root development. Soils with poor drainage should also be avoided.

Crop rotation

Crop rotations and the previous crop(s) can affect the growth of the current crop. Crop rotations help to minimise the build-up of soil pests and pathogens, such as nematodes, weeds (eg Orobanche), diseases (eg Fusarium, and root rots such as Phytopthora and Pythium).

Land Preparation

Appropriate preparation of a good seedbed is important to assist seeds to germinate and seedlings to grow quickly. Good land preparation also breaks any hard pans and opens up the soil, allowing roots to penetrate fully to obtain water and nutrients. Improved soil tilth and drainage can reduce nematode levels. Tillage can destroy the pupae and overwintering stages of many insect pests. However, the advantages of tillage should be weighed against other advantages gained through no-till agriculture (build-up of organic matter, water retention, soil conservation, lower labour etc).

Seed / Root Stock Quality

The seed / root stock is the basis of the crop. Good seed produces healthy plants with high yield potential and high produce quality. Clean, certified seed or root stock is free of both diseases and weed seeds.

Time of planting

Planting at the correct time promotes healthy plant growth and avoids periods of attack by major pests. For example late planting of Faba bean to avoid infestation by aphid from other legumes, and early planting of cotton to avoid late season bollworm attack.

Plant spacing and density

Plants sown too close together are weaker and more susceptible to pest attack. Too close spacing also provides suitable micro-climate conditions within the crop for the build-up of pests and diseases, such as aphids and whitefly in cotton, blight in tomatoes, downy mildew in cucumbers, and aphids, mites, blight, mildew, and scab in apple.

Weeding

Weeds compete with the crop for sunlight, water and nutrients. Slow growing seedlings, such as cotton, compete poorly with weeds, and the plants are weak and stunted. Weed seeds can contaminate the crop produce, as in wheat. Weeds can attract pests, such as fruitworm in tomato. Tall weeds in orchards can attract rodents, but a low cover of grass or weeds between trees avoids the dusty conditions which promotes red spider mite.

Timing and amount of fertiliser

Ideally an integrated soil fertility management (ISFM) should be adopted, which aims to replenish soil nutrient pools, maximize on-farm recycling of nutrients, and reduce nutrient losses to the environment. Wrongly timed or excess fertiliser can promote vegetative and dense plant growth which encourages insect pests such as aphids and whitefly, and diseases such as mildews and blights.

Timing and amount of irrigation

Similarly to fertiliser, wrongly timed or excess irrigation can promote vegetative plant growth which encourages pests and diseases such as aphids and whitefly in cotton, blight and Orobanche in tomatoes, root rot in Faba beans, and spider mite, aphids, and blight in apple.

Other Factors

Transplanting

Ensure seed beds are disease, insect pest, and nematode free to avoid transferring these pests to the field.

Thinning of seedlings

When seedlings are not thinned or thinned too late, the plants are weaker and more susceptible to pest attack.

Pruning of tree and vine crops

Allows more air and light, and lowers humidity so that diseases (eg blight, mildew, scab) and insect pests (eg aphid) are discouraged.

Removal of Infested Plants / Branches

Infested plants and branches provide sources of disease infestation. Remove and burn all such plants and branches to control the spread of diseases. Plants infested with Orobanche or other parasitic weeds can also be treated in this way in low infestations.

Post Harvest Sanitation

Plough-in, or remove and burn or bury crop residues, fallen fruit, etc. Crop residues left in the field can provide food and shelter for over-wintering pests (eg pink bollworm, cotton stainer, codling moth) and diseases (eg blight, mildew).

3 BASICS OF PEST MANAGEMENT AND IPM – PART THREE

General

From the above it can be seen that the main direct problems caused to pest management by poor crop management are vegetative, tall, or dense growth.

A vegetative or dense crop has a climate inside it which promotes the development of pests such as aphid, jassid and whitefly, and diseases such as blight and mildews. In addition, spraying is less effective as spray penetration and coverage of all the plant surfaces is poor, and it is difficult for the spray operator to walk through the crop.

There is thus the double effect of encouraging pests while reducing the effectiveness of pesticide control measures. Pests are much more difficult to control effectively in a dense crop.

Examples of Non-Pesticide Methods of Pest Management

All Crops	Implement optimum crop management practices to produce healthy and strong plants, which are more resistant / tolerant to insects, diseases and weeds.
Tomatoes	
✔ Tolerant varieties	Against virus diseases and fungal diseases.
✔ Crop rotation	Against soil born diseases (Fusarium), nematodes, Orobanche
✔ Spacing	Plants growing too close together give an environment which encourages diseases such as blight.
✔ Irrigation	Excess irrigation promotes diseases such as blight.
✔ Fertiliser	Excess N makes plants more susceptible to diseases (blight, powdery mildew etc) and insects (aphids, whiteflies which transmit virus diseases). Correct rate of K increases tolerance to diseases.
Faba Beans	
✔ Tolerant varieties	Against Orobanche.
✔ Crop rotation	Against root rots, Orabanche
✔ Late planting	Avoids infestation by aphids (and Necrotic Yellows) from other legumes.
✔ Irrigation	Avoid excess humidity in the soil and in the plant's direct environment to reduce risk of disease such as root rot.
✔ Fertiliser	Excess Nitrogen makes plants more susceptible to diseases (Chocolate Spot) and insects (aphids = indirectly virus diseases). Correct rate of K increases tolerance to diseases.
✔ Roguing	Reduces number of virus infected plants, and so spread of virus. Can also be applied to Orobanche if infestation is low.
✔ Weeding	Removes potential hosts of aphids and virus.
Vegetables general	
✔ Crop rotation	At least one cereal crop before cultivating the same vegetable crop, or fallow for several months.
✔ Fertiliser	Ensure balanced application
✔ Irrigation	Ensure balanced application
✔ Tunnels	Ventilate where vegetables grown in tunnels or

	under plastic sheets to reduce humidity and incidence of disease.
✔ Seedlings	Produce in greenhouse or tunnel to avoid insect infestations.
Mango	
✔ Pruning	After harvest. Enhances aeration within the tree, reducing risk and spread of disease.
✔ Removal of malformed flowers	Reduces spread of flower malformation.
✔ Others	As for Citrus.
Citrus	
✔ Certified planting material	Avoids introduction into the orchard of virus and disease.
✔ Circling trunk with soil	Avoids infection and spread of Phytophthora.
✔ Fertiliser	Balanced fertiliser application. In particular, reduction in amount of N, and increase of P and K.
✔ Irrigation	Avoid excess irrigation.
✔ Pruning	Enhances aeration within the tree, reducing risk and spread of disease. Navels and mandarins should be pruned immediately after harvest in January to induce early spring flush that avoids leaf miner attack.
✔ Dropped fruit	Collect and bury dropped fruits to reduce Mediterranean Fruit Fly.
Cotton	
✔ Crop rotation	Against soil born diseases (Fusarium etc)
✔ Land preparation	Kills and exposes pests such as cutworm. Fine seedbed allows plants to germinate and grow strongly, increasing tolerance to pest attack.
✔ Early planting	Plants mature earlier and avoid late season bollworm attack
✔ Plant spacing	Avoid too close spacing, which makes the plants weak, and gives an environment around the plants which encourages aphids and whitefly.
✔ Fertiliser	Avoid excess Nitrogen, which makes plants susceptible to aphid, jassid, whitefly.
✔ Irrigation	Avoid excess irrigation, which gives an environment around the plants which encourages aphids and whitefly.
✔ Thinning	Early thinning allows plants to grow strongly, increasing tolerance to pest attack.

BASICS OF IPM – PART FOUR

4

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4 BASICS OF PEST MANAGEMENT AND IPM – PART FOUR

Overview of the Session

This session continues the focus on Integrated Pest Management. It begins with a full group brainstorming on biological control and how to encourage natural enemies.

This is followed by a series of interactive discussions and presentations on the place of pesticides in IPM, the economic principles of pest management, threshold levels and pest scouting, and the pest management decision making cycle.

These topics are then further explored with a series of practical "what if" situations with participants aimed at increasing their awareness of the economic principles of pest management. The purpose of these interactive activities is to ensure that participants leave the session having put their theoretical knowledge into practice, while reinforcing a structured and logical approach to problem solving, and are able to give farmers practical and effective advice.

Session Objectives

By the end of the session, participants will be able to:

- Explain the importance of biological control and how natural enemies can be encouraged.
- State the place of pesticides in an IPM programme.
- Describe the economic principles of pest management.
- Define the concepts of threshold levels and pest scouting.
- Identify the steps of the pest management decision-making process.

TOTAL TIME: 2 hours

4 BASICS OF PEST MANAGEMENT AND IPM – PART FOUR

1. Introduction to the Session

10 minutes

Welcome participants to Session 4.

Ask the three volunteers to review the previous day's activities, results and conclusions from the first three sessions of the course.

Present the session objectives, and give a brief overview of the procedures.

2. Brainstorming – Biological Control

20 minutes

Objective of the procedure:

- Participants are aware of the importance of biological control, and how to encourage natural enemies.

Refer to the IPM Circle:

Say:

- In Session1 and 2 we briefly mentioned biological control as one method of pest management. We will now discuss this further to see how biological control and natural enemies can be encouraged in a crop.

Ask:

- How can a farmer encourage and maintain naturally occurring populations of beneficial insects in his crop?

- Are there any ways in which a farmer can artificially introduce natural enemies into the crop?

List participant responses on the flip chart. Once all have been received, summarise the results using Handout 4.1, *Biological Control*, as a checklist.

Distribute Handout 4.1 to participants. More detail will be provided in Session 9.

Refer to the IPM circle.

Say:

- We have now covered the non-chemical pest management methods and will now begin to explore chemical methods.

3. Interactive Discussion - Chemical Control

20 minutes

Objective of the procedure:

- For participants to understand that pesticides are an integral part of most IPM programmes.
- To illustrate the benefits and potential drawbacks of pesticides.

Ask:

- How did we simply define Integrated Pest Management in Session 2?

Take a couple responses from participants. Conclude by restating the simple definition of IPM from Handout 4.2, Chemical Control.

Ask:

- Where would pesticides fit into such a plan?
- What would be the benefits of using pesticides?
- Would there be any drawbacks?

Facilitate the discussion by using the key points from Handout 4.2, and then summarize the discussion by reviewing the contents of Handout 4.2.

Distribute Handout 4.2, *Chemical Control*, to participants.

4. Presentation and Discussion: The Economic Principles of Chemical Control

15 minutes

Objective of the procedure:

- To ensure that participants understand the underlying principles of the economics of pest management.

Refer to the IPM Circle:

Say:

- One of the drawbacks of pesticides we have just identified is their potential cost. Farmers thus need to make the most efficient, effective, and economic use of pesticides.
- We will thus now explore the economic principles of pest management and decision making.

Present and discuss the contents of Handout 4.3, Economic Principles of Chemical Control.

Ask:

- What are examples when you thought farmers were wasting their money (and reducing their profit) with inefficient or unnecessary pesticide application?

5. Interactive Discussion – Introduction to Treatment Thresholds and Pest Scouting

15 minutes

Objective of the procedure:

To ensure that participants understand the underlying principles of:

- Economic / Treatment thresholds.
- Pest scouting.

Say:

- The last two activities have raised the topics of economic or treatment thresholds and pest scouting. We will now explore these topics further.

Ask:

- What do you think are the factors that are taken into consideration when setting threshold levels?

- How do you think threshold levels are determined in practice?

Take several responses, and then present Threshold Levels from Handout 4.4, *Threshold Levels and Pest Scouting*.

Ask:

- How would a farmer know when the threshold level has been exceeded by a pest?

Again take several responses, and then present Pest Scouting from Handout 4.4, *Threshold Levels and Pest Scouting*.

Emphasise:

✔ Pest scouting, crop monitoring and threshold levels are one of the fundamental aspects of IPM and the effective and economic use of pesticides.

Ask if participants have any further questions on these topics.

Distribute Handout 4.4.

6. Presentation and Discussion: The Pest Management Decision Making Cycle

20 minutes

Objective of the procedure:

To ensure that participants understand the underlying principles of:

- The pest management decision making process
- How participants can help farmers in the decision making process and in minimizing the costs of pest management.

Say:

- The activities in this session have given us sufficient understanding of the factors involved to develop a logical decision making process for pesticide application as part of an IPM programme.

Present and discuss the contents of Handout 4.5, the Six Step *Pest Management Decision Making Cycle*.

Ask:

- In the decision making process, with which steps can the participants most help and support the farmer? Why?

Distribute Handouts 4.5 to participants.

7. "What if" Situations – Diagnosing Pest Problems

20 minutes

Objective of the procedure:

- To re-enforce the contents of previous sessions and activities.
- To introduce the concept of diagnosing a farmer's problem by asking simple questions in a logical, structured manner.
- To practice asking such questions in a "live" situation.
- To practice dealing with farmers in a friendly, helpful manner.

TRAINER NOTE:

- The situations given below are not intended for participants to show their detailed technical knowledge but to illustrate the principles of problem solving and providing advice.

- The situations are somewhat artificial, but are intended to enforce the principles of diagnosing problems in a logical manner, in dealing with farmers, and for participants to put these principles into practice.

- The situations also progress from a very general to a more specific situation.

It may be necessary to think of other "What If" situations if the following do not suit local crops and conditions. If this is necessary, then the new situations should concentrate on illustrating principles rather than technical details.

Say:

- This activity is the reason for the homework assignment from yesterday, and we will now put their thoughts and ideas into practice.

Present the following "What if" Situation:

"What if" Situation

It is very early in the tomato season. What if a farmer comes and asks you how to control pests in tomatoes.

✔ *What questions would you ask the farmer?*
✔ *What advice would you give the farmer?*

Give participants 2-3 minutes to think of the questions they would ask and the advice they might give the farmer.

TRAINER NOTE: This "What If" is in two separate parts. Firstly, participants should give the questions they would ask the farmer. Only after this part is completed should participants provide the advice. Suitable advice can only be given after questions have been asked to determine the actual situation.

- Ask different participants what questions they would ask the farmer.

- Then ask what the appropriate advice might be to the farmer. Take a response from one participant, then ask if anyone would approach the problem differently, or give different advice.

TRAINER NOTE: In this situation, appropriate questions and advice would include:

- HAS THE TOMATO CROP ALREADY BEEN PLANTED?
- If no:

✔ Give advice on seed variety, land preparation, plant spacing, fertilizer, irrigation, etc., and what pests to expect and suitable methods of control.

- If yes:

✔ What is the growth stage of the tomatoes? Are they in seedbeds, have they been transplanted, have they been field planted?

✔ What pest(s) are present? (If the farmer doesn't know the name, ask for a description of the pest.) Has he brought a sample of the pest or disease?

✔ How many of each type of pest has the farmer seen, or how much of the field is infested?

✔ What is the growth stage of the pest(s)?

✔ What damage does the farmer see the pest(s) inflicting?

✔ What, if any, steps has the farmer already taken?

Then present a second "What if" situation.

"What if" Situation

What if a farmer asks you to come to see his cotton field, which is infested with aphids. You go to the field:

✔ *What will you look for?*

✔ *On the basis of what you find, what advice would you give the farmer?*

Take responses from several people, allowing some debate for each question. Then give your own advice.

TRAINER NOTE: In the above situation it is best that you:

LOOK FOR:

- ✔ Confirm that the problem is aphids.
- ✔ The level of aphid infestation, and how much of the field is affected.
- ✔ Damage to the plants.

Give advice to farmer:

- ✔ If aphid numbers are low, and beneficial insects are present, then watch and wait for 3-4 days to see if the beneficial insects reduce the aphid numbers.
- ✔ This should still be the case where there is plant damage, but the affected area is small.
- ✔ If the farmer wants to treat the aphids, then he should use mineral oil or detergent, not a pesticide.

- ✔ If aphid numbers are high, and there is plant damage to a wider area, then a pesticide spray may be needed.
- ✔ If only small areas are infested, then spot spraying is better than a whole field spray.
- ✔ A pesticide spray should be applied to include the area around the plants showing damage, as these other plants will still have aphids on them even though they are not yet showing signs of damage.

Repeat for the final "what if" situation.

"What if" Situation

What if a farmer comes to ask for help with his mango orchard. He has brought leaves from one tree to show you.

✔ *What would you do?*

Take a response from one participant, then ask if anyone would approach the problem differently, or give different advice.

TRAINER NOTE: In the above situation the steps would include:

- ✔ Determine whether insects, mites or disease have damaged the leaves.
- ✔ Ask if the fruits are close to harvesting.
- ✔ Ask if only 1 or 2 trees have been affected, or most trees in the orchard.
- ✔ Ask if the infestation is over the whole tree or if only parts of the tree are affected.
- ✔ If only 1 or 2 trees are affected, advise the farmer to spot spray the affected trees with a suitable pesticide, not the whole orchard.

Ask:

- What lessons have we learnt from this activity regarding the economics of pest management?

Emphasise:

✔ Practical, effective and economic pest management requires the use of all available techniques, and that pesticides are not used on a "Spray a pest on sight" basis.

8. Conclusions

5 minutes

Summarize briefly the highlights of the session.

Include as main messages:

- Biological control is extremely important, and natural enemies should be encouraged.
- Chemical control methods are an integral part of IPM.
- All inputs, including pesticides, must be used effectively and economically.
- Thresholds and pest scouting are essential foundations to successful IPM.
- The importance of diagnosing problems in a logical, structured manner.

Refer participants to the IPM Circle to show that we are moving closer to completing the circle. Emphasise the importance of the economic aspects we have covered in this session, both with regard to links to other IPM components, and to the farmer's final profits.

Ask:

- What insights will you especially want to remember when giving advice to farmers about pesticides?

Biological Control

- Natural enemies can be very common in unsprayed fields. When certain pesticides are applied, natural enemies may be killed, removing their control effect on the pest.

- Most commonly seen are predators (ladybirds, spiders, lacewings), but parasites (parasitic wasps and flies) often have the greatest control effect.

- Natural enemies can be encouraged by:
  - Using pesticides only when necessary, particularly early in the season.
  - Using a seed dressing rather than a foliar spray if an early season pesticide is regularly needed.
  - Intercropping, border planting, and relay cropping of suitable plants.
  - Leaving refuge habitats in and around the field where natural enemies can shelter and find food.

- Biological control can be enhanced by the mass rearing and release of natural enemies.

- Pests also suffer from diseases caused by viruses, bacteria, fungi and nematodes. These diseases may be commercially formulated for application as pesticides, such as Bt (*Bacillus thuringiensis)*.

- Pests can be biologically changed by the use of insect growth regulators or their behaviour modified by pheromones. These are sometimes included under chemical control.

- Pests can be controlled by using some plant extracts (botanicals) or chemicals derived from living organisms e.g. by fermentation

Chemical Control

- IPM is the combination of all appropriate practices into a single plan for crop and pest management that reduces pests and damage to an acceptable level.

- Pesticides more often than not are an integral component of this plan.

- Benefits of Pesticides
  - Provide effective and quick reduction in pest populations.
  - Can control several pests at the same time.
  - Easy to use.

- Drawbacks of Pesticides
  - Beneficial insects can be eliminated, causing pest resurgence and secondary pest outbreaks.
  - Development of pest resistance
  - Cost
  - Damage to honey bees and pollinators
  - Environmental hazards
  - Risk of residues in food
  - Potential risk to users and others

- Pesticides in IPM
  - Use pest scouting and treatment thresholds to treat only when necessary
  - Use pest scouting and treatment thresholds to time applications at most vulnerable pest stage.
  - Do not attempt to eradicate pest. It is almost impossible, not necessary to prevent economic damage, and need small numbers of pests to maintain beneficial insects.
  - Use selective, low persistence, low toxicity pesticides if possible.
  - Use only when other practices have not been able to keep pests at a low level.
  - Pesticides can be required in preventative situations, such as in nurseries to produce healthy pest and disease free seedlings, in seed dressing, and for certain diseases, particularly in vegetables.

Economic Principles of Chemical Control

- Crop production inputs cost the farmer money. The more he spends on inputs, the less profit he makes.

  Profit = Value of harvested crop – Production costs – Transport / marketing costs

- All inputs, including pesticides, thus need to be used efficiently, effectively and economically.

- For pesticides, it is the cost over the season that must be considered, not the cost per litre. A pesticide that is cheap per litre may be more expensive over the season as a higher mixing rate may have to be used, or it may be less effective and so require more applications, than a pesticide that is more expensive per litre.

- If pests are at a high level, and the value of the crop that will be lost will be greater than the cost of the pesticide application:

  *Pests are **above** the treatment threshold*

  The use of a pesticide in this case will give a RETURN on the farmer's investment in applying a pesticide.

- If pests are at a low level, and the value of the crop that will be lost will be less than the cost of the pesticide application:

  *Pests are **below** the treatment threshold*

  The use of a pesticide in this case will mean that the farmer LOSES money by applying a pesticide.

Threshold Levels and Pest Scouting

Threshold Levels

- A threshold level is the pest level at which pesticide control is needed to prevent economic loss or damage.

- Usually set at the level where, if the pest population continued at that level or increases, the economic losses would be greater than the cost of control.

- The **economic** threshold will vary during the season depending on a range of factors, including the expected price for the produce, the expected yield and factors influencing the yield (eg weather), and the anticipated cost of future control. An economic threshold is thus difficult to apply in practice.

- A **treatment** or **spray** threshold is largely used instead. This is derived from research trials over several seasons, and is the pest level at which a pesticide treatment will give a return to the farmer in most seasons.

- Treatment thresholds may vary during the season depending on such factors as crop growth stage, the damage the pest can do at that stage, and the numbers of beneficial insects present. These variations are also set as a result of several research trials.

- The same pest in the same crop can have different treatment thresholds in different areas, depending on local conditions.

- With most thresholds a pest population is allowed to exist in the crop, as the cost of control would be greater than the value of the crop protected or saved from loss or damage.

- In some cases the threshold is fairly high.
  - Aphids in cotton.
  - Stem borer in maize.

- In other cases the threshold is zero or very low.
  - Crop virus-transmitting insects where the virus is a major problem.
  - Preventative sprays for late blight in potatoes, downy mildew in cucumbers grown in glasshouses.
  - Rats in bakeries.

Threshold Levels and Pest Scouting

- Pest scouting is regular monitoring of the area to be protected.
  - Gives information on levels of pests and beneficial insects present - the numbers, the growth stage of the pests.
  - Gives information on whether pest levels are above or below the treatment threshold, and so if intervention is needed or not.
  - Gives information on whether previous control actions have been successful.
  - Different crops and pests have different methods and techniques of pest scouting. Also the same crop and pests may have different methods in different countries.
  - Different methods of scouting will also have different treatment thresholds.

Pest scouting, crop monitoring and threshold levels are one of the fundamental aspects of economic and effective use of pesticides, and of IPM.

BASICS OF IPM – PART FIVE

5

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5 BASICS OF PEST MANAGEMENT AND IPM – PART FIVE

Overview of the Session

This session is a close continuation of Session 4 to complete the basics of pest management and IPM. Its first focus is on pesticide selection and dose rates, followed by a working group activity to identify the causes of failure of pesticide applications. The trainer then gives a short presentation on the causes of pest resistance and ways of avoiding the development of resistance.

Finally, role plays are again used in an interactive activity to identify the causes of a pesticide failure. The purpose of these interactive activities is to ensure that participants leave the session having put their theoretical knowledge into practice, while reinforcing a structured approach to problem solving, and participants are able to give farmers practical and effective advice.

Session Objectives

By the end of the session, participants will be able to:

- Identify the factors to be taken into consideration when selecting a pesticide, and using the correct dose rate.
- Define the common reasons for the failure of a pesticide application.
- Explain the causes of pesticide resistance in pests, and ways to avoid the development of resistance.
- Apply a structured and logical approach to solving pest management problems.

TOTAL TIME: 2 hours 5 minutes

5 BASICS OF PEST MANAGEMENT AND IPM – PART FIVE

1. Introduction to the Session

5 minutes

Welcome participants to Session 5. Briefly review the topics covered in the previous session.

Present the session objectives, and give a brief overview of the procedures.

2. Presentation – Pesticide Selection and Dose Rates

10 minutes

Objective of the procedure:

- To ensure that participants understand that for effective pest management it is essential to use the correct pesticide for a pest, and at the correct dose rate.

Refer to the IPM Circle:

Say:

- In the last session we looked at chemical control in IPM, the economic aspects of pest management, and the decision making cycle for control interventions.

- A pesticide application costs the farmer money, and so must give the best possible return to the farmer's investment.

- This requires that a pesticide used for chemical control must be selected and used correctly. We will now take the first steps to see how this can be best achieved, and will further develop these aspects in later activities.

Present the contents of Handout 5.1, *Pesticide Selection and Dose Rates*.

Allow a short time for questions and discussion.

Emphasise:

✔ That selection of quality pesticide products is essential.

✔ The dose rates given on the label must be followed.

Distribute Handout 5.1 to participants.

Say:

- This was just an introduction on pesticide selection and we will re-visit this topic for further exploration in the sessions on pesticides and pesticide application.

- Before that we need to examine the possible reasons why a pesticide application could fail to work properly.

3. Working Group Task – Causes of Failure of Pesticide Applications

30 minutes

Objective of the procedure:

- Using practical examples, for participants to work out the four most common causes of the failure of a pesticide application.

Say:

- Farmers often complain that a pesticide did not work, and blames the pesticide in some way.

- We will now examine the reasons why a pesticide application may fail.

Assign one crop / pest to each table.

Working Group Task

For the Crop and Pest assigned to your table, agree as a group on the following:

- What is the correct pesticide(s) to use?
- When is the best timing for application?
- What is the correct dose?
- How should it be applied?
- What could cause the pesticide to fail?

Allow 25 minutes for the task.

TRAINER NOTE: Depending on where the training session is being held and the local crops and major pests, examples could be:

- Cotton / Aphid
- Tomato / Whitefly
- Potato / Blight
- Cabbage / Diamond back moth
- Cucumber / Mildew
- Apple / Codling moth
- Citrus / Leaf miner

TRAINER NOTE: Avoid extended technical discussions in this procedure. The questions regarding the correct pesticide, timing, dose rate are simply to provide the lead-in to the final question, t*he answers to which are the objective of the activity*. The emphasis should be on determining what could cause a pesticide application to fail, not what are the detailed recommendations for the control of a particular pest.

4. Working Group Reports

30 minutes

After 25 minutes, ask the table groups to report for the crop / pest assigned to their table. All groups should report before any comment or discussion.

TRAINER NOTE: The emphasis here is to bring out the causes of failure, so do not get too involved in technical discussions, for example on what is the correct pesticide for a particular pest.

Summarize the causes of failures from the table group reports, adding where necessary from the points on Handout 5.2, *Causes of Failure of Pesticide Applications*.

Distribute Handout 5.2 to participants.

TRAINER NOTE: Keep the working group flipcharts from this activity. They will be referred to in Session 9, Application, Procedure 1.

30 minutes

5. Role Plays – Identifying the Causes of Pesticide Failure

Objective of the procedure:

- To ensure that participants understand the possible causes for the failure of a pesticide application.
- To reinforce the principles, introduced earlier in Procedure 3, of diagnosing and solving a farmers problem by asking simple questions in a logical, structured manner.
- To practice asking such questions in a "live" situation.
- To practice dealing with farmers in a friendly, helpful manner.

Ask participants as individuals to jot down responses to the following situation and questions:

- If a farmer comes to you and complains that a pesticide did not work:
  - What questions should you ask the farmer?
  - What approach would you take with the farmer to assure that you keep his trust?

After 4-5 minutes, say that in fact this farmer is coming to the classroom now, so they will be able to try out some questions.

Role Play Set-Up

Ask one participant to play the farmer. Remind the group and the "farmer" that the purpose for the role plays is to practice question-asking and advice-giving, so everyone should be reasonable.

Take the volunteer “farmer” outside the classroom, remind him that he is not an unreasonable or difficult farmer, but has a genuine complaint to make. Ask him or her to prepare their complaint - what crop, what pesticide, what happened.

Ask participants if any of them are ready to play the "extension worker" or “retailer” and try out his or her questions and approach. Select one participant to start. (There is time for 3-4 participants to try out their approach.)

Conducting the Role Plays

These 3-4 role plays are meant to be quick and spontaneous, with opportunities to debrief after each role play ends, and before the next one begins. Follow these steps:

1) Ask the participant who volunteered to be the “extension worker” or “retailer” to stand or sit at the front of the room so that they can try out their approach to the “farmer”.

2) Set the stage by explaining that a farmer is about to come with a complaint. Ask participants to take notes about what they like in the "extension worker's" approach and what they might do differently.

3) Tell the "farmer" to come in to begin.

4) Allow the role play to run for 4-5 minutes, at least until the extension worker has had a chance to ask some questions.

5) Then stop the action, but keep the two role players in front of the group.

Role Play #1 Debrief

a) First ask participants what they liked about the Extension Worker's approach.

b) Then ask the "farmer" what the Extension Worker did that was helpful? Not helpful?

c) Then ask the Extension Worker what he or she was trying to do, and how was it working.

d) Then ask the participants what they would do differently?

Role Play #2

Ask one of the participants who is assertive about what he or she would do differently to try it out. Invite the participant to the front of the room, and ask the "farmer" to continue where the last role play ended.

Allow 4-5 minutes for "Extension Worker #2" to give the farmer advice.

Debrief as before. Invite another participant to try his or her approach.

TRAINER NOTE: The extension worker should find out if:

- **The pest was correctly identified by the farmer.**
- **The correct pesticide was used.**
- **The stage of the pest life cycle when the pesticide was applied. (eg older caterpillar larvae are very difficult to kill with the recommended doses).**
- **The correct dose rate was applied.**
- **The pesticide was applied correctly.**

Then the extension worker should advise the farmer to correct any mistakes that were found as a result of the questioning. If no mistakes were apparent, then the farmer should try a pesticide of a different group, and come back to tell the extension agent the results.

(Is the extension worker sure that the farmer has not made a mistake? Wrong identification of the pest and use of the wrong pesticide are very common mistakes.)

Repeat for a fourth role play if there is time.

5 minutes

6. Conclusions

Summarize briefly the highlights of the session.

Include as main messages:

- After deciding to use a pesticide, the correct one must be selected and used at the correct dose.
- The four most common causes of pesticide failure are incorrect pesticide, dose rate, timing, or application.
- The main factors promoting pesticide resistance are using the same pesticide too often, and using too high a dose rate.
- The importance of diagnosing problems in a logical, structured manner.

5 BASICS OF PEST MANAGEMENT AND IPM – PART FIVE

Ask:

- What insights will you especially want to remember when giving advice to farmers about pesticides?

Refer participants to the IPM Circle.

Say:

- We have now looked at all but one of the components of IPM, as we still have to explore application.

- However, before looking at application, we will continue our exploration of chemical control by looking in more detail about pesticides in the next two sessions. Knowledge of the properties and characteristics of pesticides helps us to use them to best effect in an IPM programme.

5 minutes

Pesticide Selection and Dose Rates

Pesticide Selection

✔ A pesticide only controls a certain range of pests, so one which is effective against the pest to be controlled must be used.

✔ If there is more than one suitable pesticide:
- Select one with a limited range of activity, as this has the least effect on beneficial insects and helps to reduce the risk of pesticide resistance in other pests.

- Select one which poses the least risk to humans, animals, and the environment under the conditions in which it will be used.

✔ The same pesticide should not be used repeatedly against the same pest during the season as this increases the risk of pesticide resistance.

✔ Use only pesticides from reputable manufacturers and dealers, in unopened containers with a complete label. Beware of counterfeit products.

Pesticide Dose Rates

✔ Dose rates are given on the container label.

✔ Too low a dose rate and not all pests are killed. The pesticide is not effective, crop losses are not prevented, and costs are increased.

✔ Too high a dose rate and the excess is wasted. More pests are not killed, and costs are increased. The risk of pest resistance is also increased, as is the risk of phytotoxicity to treated plants.

Causes of Failure of Pesticide Applications

The five most common causes of the failure of a pesticide application are:

Incorrect Pesticide Used

- Pest identified correctly, but wrong pesticide selected.
- Pest not identified correctly, correct pesticide selected for mis-identified pest (has no effect on actual pest present).

Incorrect Timing

- Pest population not at a susceptible stage.

Incorrect Amount

- Dose rate too low to kill pests.
- Poor application.

Incorrect Application

- Pesticide not applied to the right place (eg poor underleaf cover for aphid or downy mildew control)
- Not applied evenly (areas of over- and under-dosing)
- Application equipment poorly calibrated
- Badly maintained application equipment
- Application in adverse weather conditions (eg too hot or windy, or rain after application)

Resistance to Pesticide

- Pest develops resistance to the pesticide used - this is covered in Session 6.

The following may also cause a pesticide application to fail, but are less common:

Sub-Standard Pesticide (this may be common in certain regions)

- Poor quality formulation
- Adulterated product
- Counterfeit product
- Expired

Pest Resistance to Pesticide

Plants Under Stress

- Systemic pesticides not translocated

PESTICIDE RESISTANCE MANAGEMENT

6

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6 PESTICIDE RESISTANCE MANAGEMENT

Lesson Plan

Materials needed.

- ✔ Flipchart stands.
- ✔ Flipchart paper.
- ✔ Markers (4 colours).
- ✔ Notebooks, pens, and file covers for participants who have forgotten to bring them.
- ✔ Coloured cards.
- ✔ Glue stick or blue tack.
- ✔ Masking tape.

TOTAL TIME: 100 minutes

Intended audience:
Farmers and crop protection product dealers (resellers)

Preparation:

- ✔ Flipchart with the session title "Pesticide Resistance Management" and the Session Objectives.
- ✔ Flipchart with definitions of Pesticide Resistance.
- ✔ Sufficient copies of "How Resistance Develops in a Population" for all participants.
- ✔ Three blank flipcharts with a vertical dividing line down the middle.
- ✔ Print off sufficient Attendance Record sheets.
- ✔ Print off sufficient Assessment question sheets.
- ✔ Print off sufficient Fact Sheets for participants.
- ✔ Organise venue and seating arrangements

Attendance Record

As participants arrive, ask them to enter their name and other information on the Attendance Record. There is also a column on the form to enter their marks from the Assessment Questions at the end of the training session.

6 PESTICIDE RESISTANCE MANAGEMENT

Attention:

Welcome the participants to the session.

Say:

- Puppies are one of the most common pets in the world

They are all nice and soft and playful, but will inevitably grow and show inherited characteristics of their parents – hair color, size, strength, aptitudes – which can be desirable or not in the pet owner's eyes.

Ask:

- Why should this be?

Take several responses.

Inherited traits in puppies, like in any other living organism, such as hair color and size, pass from generation to generation with minimal external pressure or interventions. In the same way, resistance traits in pests are inherited, and could be passed on the offspring of resistant individuals.

Title:

Refer to the Title Flipchart and tell participants that this training session will cover *Pesticide Resistance Management*.

Credibility:

Say that pesticide resistance has caused major problems to farmers in all parts of the world. This has meant that certain pesticides can no longer be used against the pest.

In some instances, this effect has been so severe that production of a crop has had to be abandoned, and farmers have lost a major part, or all, of their livelihood.

Objectives:

Refer to the Title Flipchart with the Lesson Objectives.

By the end of the session, participants will be able to:

- State clearly what is pesticide resistance, and how it develops in a pest population.
- Outline the different types of pesticide resistance mechanisms.
- Describe the factors which promote pesticide resistance.
- Explain the practices which can be used to avoid or manage pesticide resistance.

Benefits:

Knowing the factors which promote pesticide resistance, and the practices which can avoid the development of resistance, ensures that development of pesticide resistance is prevented, a full range of pesticides remains available to manage pests, and farmers can continue to economically produce crops.

6 PESTICIDE RESISTANCE MANAGEMENT

Direction:

- The session starts with an interactive discussion exploring what is meant by pesticide resistance.
- The Facilitator then gives a presentation on how resistance develops in a population, together with brief presentations on resistance mechanisms and cross resistance.
- The remainder of the session is taken up with a work group activity looking at the factors which promote the development of resistance, and the corresponding practices which can prevent or avoid the development of resistance.

Delivery

1. Interactive Discussion – What Is Meant By Pesticide Resistance

5 minutes

Say that in the introduction we noted that people from tropical areas of the world have darker coloured skin than people from temperate areas, as this gives them protection from skin cancer and so they have an advantage in the strong sunlight over people with lighter coloured skin. Even so, in both populations there are people who are born with no skin or hair colouration at all due to genetic variation.

Ask:

- How can we apply this concept of genetic variation and genetic advantage to the use of pesticides?

Guide the discussion, and **write** participant comments on the flipchart when these are appropriate to the definition of Pesticide Resistance below.

Put up the "*Definition of Pesticide Resistance*" flipchart, and explain the definitions, **referring** to the responses on the participant comments flipchart.

The definition of pesticide practical resistance used by FAO and IRAC (the Insecticide Action Committee) is:

"A heritable change in the sensitivity of a pest population that is reflected in the repeated failure (*more than one instance*) of a product to achieve the expected level of control when used according to the label recommendation for that pest species *and where problems of product storage, application and unusual climatic or environmental conditions can be eliminated as causes of the failure*." (Text in italics is additional in the FAO definition)

Put simply, a pest population is resistant to a pesticide when:

"There is repeated failure of the pesticide to achieve the expected level of control when used according to the label recommendation."

2. Presentation – How Resistance Develops in a Pest Population, the Different Resistance Mechanisms, and Cross Resistance

15 minutes

Distribute the "How Pesticide Resistance Develops in a Population" diagram.

Explain how resistance develops with repeated use of the same pesticide.

- Every population has a low number of naturally resistant individuals.
- When a pesticide is applied, these resistant individuals survive, together with some susceptible individuals.
- The proportion of resistant individuals in the remaining population is higher than before the pesticide was applied.
- When the survivors reproduce, there is more chance of resistant individuals mating with another resistant individual, so the next generation has a higher proportion of resistant individuals than the previous population.
- This process is repeated each time the same pesticide is used.

This effect is also described as "natural selection" or "survival of the fittest".

Point out that for example purposes the diagram shows only three generations, but that resistance is unlikely to develop this quickly.

Emphasise that resistance can develop in **any** pest organism – insects, mites, weeds, diseases, etc.

Say now that we understand what resistance actually is, we now need to understand what are the different resistance mechanisms – how an individual is able to prevent being killed by a pesticide.

Explain that we will not go into these different methods in detail, but it is important to be aware of them as this knowledge can be useful in the prevention or avoidance of pesticide resistance.

Briefly present "*Resistance Mechanisms*" and "*Cross Resistance*" from the Fact Sheet.

3. Work Groups – Factors Which Promote the Development of Pesticide Resistance, and Practices to Prevent / Avoid the Development of Resistance

30 minutes

Distribute participants into three groups. Give each group a flipchart with a vertical dividing line down the middle.

Say that now we understand what is meant by pesticide resistance and the different resistance mechanisms, we need to look at the factors which promote the development of pesticide resistance in a pest population.

Work Group Task:

- Agree amongst yourselves the different factors which could promote the development of pesticide resistance. Write these on the left of the flipchart (right in Arabic speaking countries).
- Against each of the factors which promote the development of resistance, write the corresponding practices which would prevent / avoid the development of pesticide resistance.

Say that participants have 25 minutes for the activity.

3. Work Group Reports – Factors Which Promote the Development of Pesticide Resistance and Practices to Prevent / Avoid the Development of Resistance

60 minutes

Ask each group to put their flipchart up on the wall.

Participants should get up, look at the flipcharts from the other two groups, and **make** notes of any comments they may have or points they would disagree with.

Allow 10 minutes for the walk round, and then participant should take their seats again.

Ask participants if they have any comments to make regarding the other group's flipcharts, or disagree with any of the points.

Review the flipcharts, **using** "*Factors Which Promote the Development of Pesticide Resistance*" and "*Practices Which Prevent or Avoid the Development of Pesticide Resistance*" as a checklist to ensure that all points are covered, **adding** where points are not included on the group flipcharts.

Point out that the prevention or avoidance of pesticide resistance is largely concerned with avoiding the practices which promote resistance.

6 PESTICIDE RESISTANCE MANAGEMENT

Describe Resistance Management Strategies and Mode/Site of Action in detail, including rotation of MoA. Discuss how to find out MoA. If relevant describe resistance management for biotech crops. Concentrate on Bt-crops – point out this is a similar approach to #6 for chemical pesticides (preservation of susceptible insects).

Summary

1 minute

Include as major messages:

- The definition of pesticide resistance, particularly the simple definition
- How pesticide resistance develops in a population
- That pesticide resistance can occur in any pest population – insects, mites, weeds, diseases, etc.
- Factors which promote the development of pesticide resistance, and the consequent corresponding practices to prevent or avoid resistance.
- Resistance management strategies

Questions

1 minute

Ask if everyone understands or if there are any additional questions. Answer these provided they are relevant.

Ask if the session objectives were met.

Evaluation

12 minutes

Hand out the Assessment Sheet and ask participants to complete two of the questions.

Collect the Assessment Sheet for later marking and entering the marks on the Attendance Record.

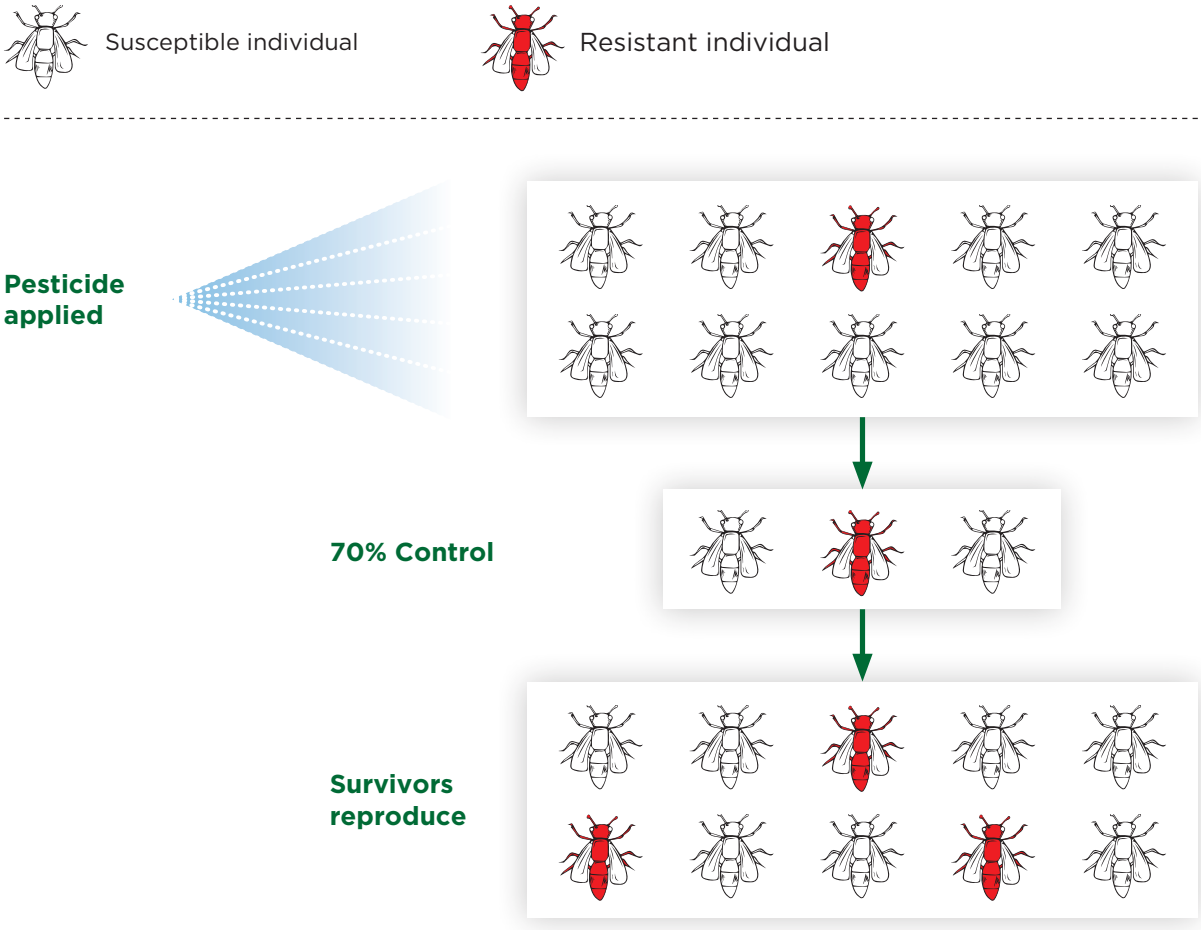
Next Step

1 minute

Say participants are now able to provide appropriate advice about pesticide resistance to farmers and other pesticide users, which will help to prevent or avoid the development of resistance, and so protect their livelihoods.

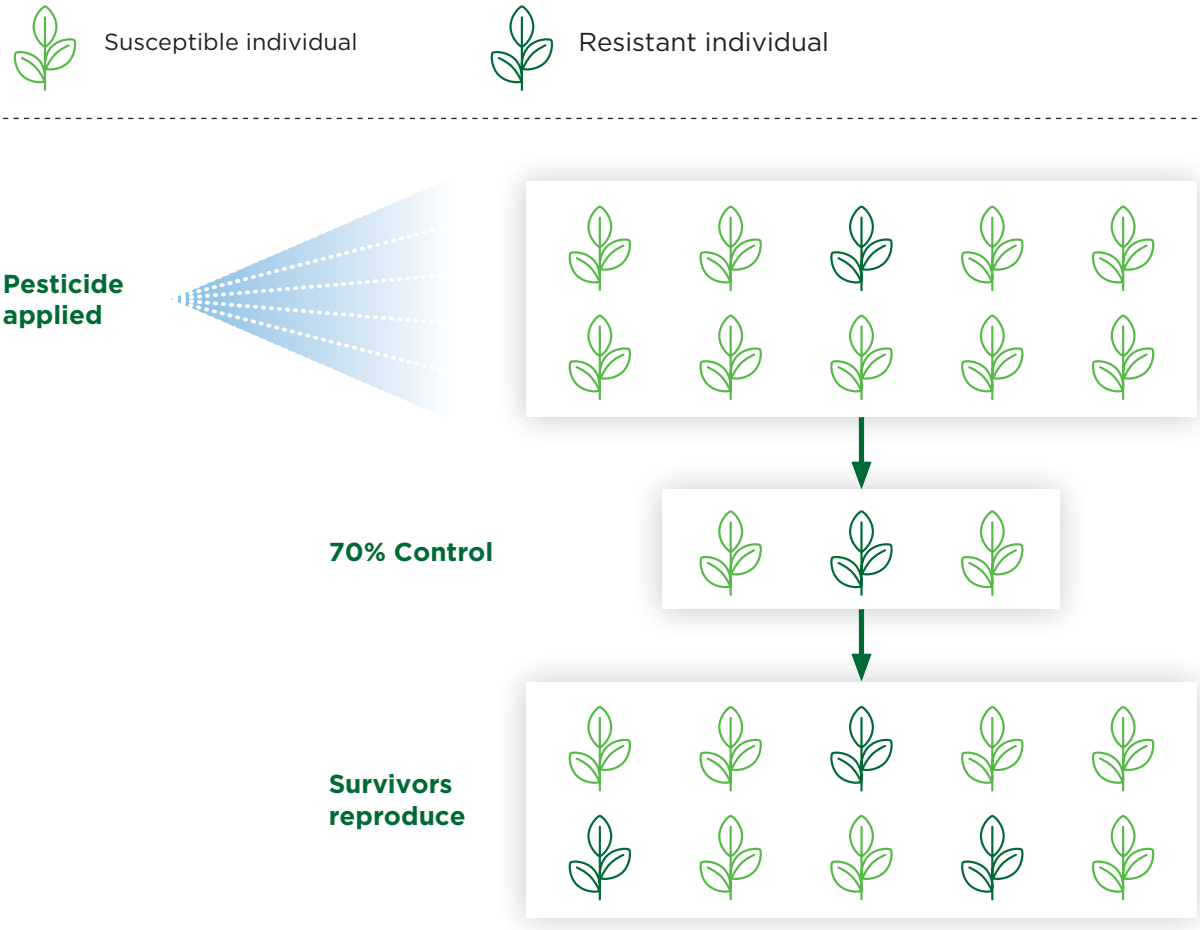
Hand out the Fact Sheet to participants.

How Insecticide Resistance Develops in a Population



How Fungicide Resistance Develops in a Population

How Herbicide Resistance Develops in a Population



FACT SHEETS[1]

Definition of Pesticide Resistance

Both FAO and IRAC (Insecticide Resistance Action Committee) use the following definition:

"A heritable change in the sensitivity of a pest population that is reflected in the repeated failure (*more than one instance*) of a product to achieve the expected level of control when used according to the label recommendation for that pest species *and where problems of product storage, application and unusual climatic or environmental conditions can be eliminated as causes of the failure.*" (Text in italics is additional in the FAO definition)

Put simply, a pest population is resistant to a pesticide when:

"There is repeated failure of the pesticide to achieve the expected level of control when used according to the label recommendation."

Resistance Mechanisms

Metabolic / Detoxification

- Most commonly found in insects, less common in diseases, becoming more common in weeds.
- Based on systems insects have developed to detoxify natural occurring toxins in their host plants or other food sources.
- Resistant individuals can detoxify the pesticide at a faster rate than susceptible individuals, and before the pesticide can kill the individual.
- Level of resistance can range from low to high, and from pesticide to pesticide.

Reduced Target Site Sensitivity

- The binding site of the pesticide in the organism is changed so that the pesticide cannot bind to the site, reducing the effectiveness of the pesticide.
- The most common known mechanism in weeds and fungi, and is also common in insects.

Reduced Penetration

- Slows the penetration of the pesticide through the cuticle of resistant insects.
- On its own, this mechanism only produces low levels of resistance, but can greatly increase the effect of other resistance mechanisms when combined with these.

[1] Some or all of these can be used as handouts to participants depending on requirements

Sequestration (separation or isolation)

- In plants the pesticide is removed from sensitive parts to a tolerant site, such as a vacuole.

Behavioural Resistance

- Occurs only in insects, mites, and rodents.
- Individuals change their behaviour so that they do not come into contact with the pesticide.
- Insects may stop feeding if they come across the pesticide, or leave the sprayed area (for example move to the underside of a leaf, move deeper into the crop canopy, or fly out of the sprayed area).

Cross Resistance

Cross resistance is when resistance to one pesticide also results in resistance to another pesticide, even when the pest has not been exposed to the second pesticide. It occurs when the different pesticides have the same resistance mechanism in the organism.

Cross resistance most commonly develops with pesticides that have the same mode or site of action, and are usually, but not always, from the same chemical group.

Some resistance mechanisms can affect pesticides from different chemical groups. This usually occurs when resistance is caused by metabolism.

Factors Which Promote the Development of Pesticide Resistance	Practices Which Prevent or Avoid the Development of Pesticide Resistance
Reliance on pesticides as the main tool of pest management, and ignoring non-pesticide management methods.	Use non-pesticide crop and pest management practices for all types of pests – insects, mites, weeds, diseases, etc.: • Optimal crop management practices. • Cultural pest management. • Mechanical pest management. • Biological pest management. • Only use pesticides when necessary (weeds with high fecundity rates might require preventive applications also) • Scout the crop to determine pest and beneficial levels before applying a pesticide. • Crop rotation and soil cultivation practices are often particularly important strategies for weed control.
Continual and frequent use of the same pesticide on a pest population, particularly populations with short generation times.	Avoid repeated use of the same pesticide, or pesticides with the same mode of action. Rotate pesticides with different mode/site of action.
Treatment of both larval and adult stages at the same time with a single pesticide.	Pesticide applications should target early pest developmental stages, or the most susceptible stages.
Use of broad spectrum pesticides. These are likely to be used more in an area as they control more pest species, and so the selection pressure on all pest species is increased.	Use selective pesticides, avoid broad spectrum pesticides. This is not necessary true for weeds.
The use of application rates which are below or above those recommended on the label	Apply pesticides according to the dose rates on the label.

continued overleaf

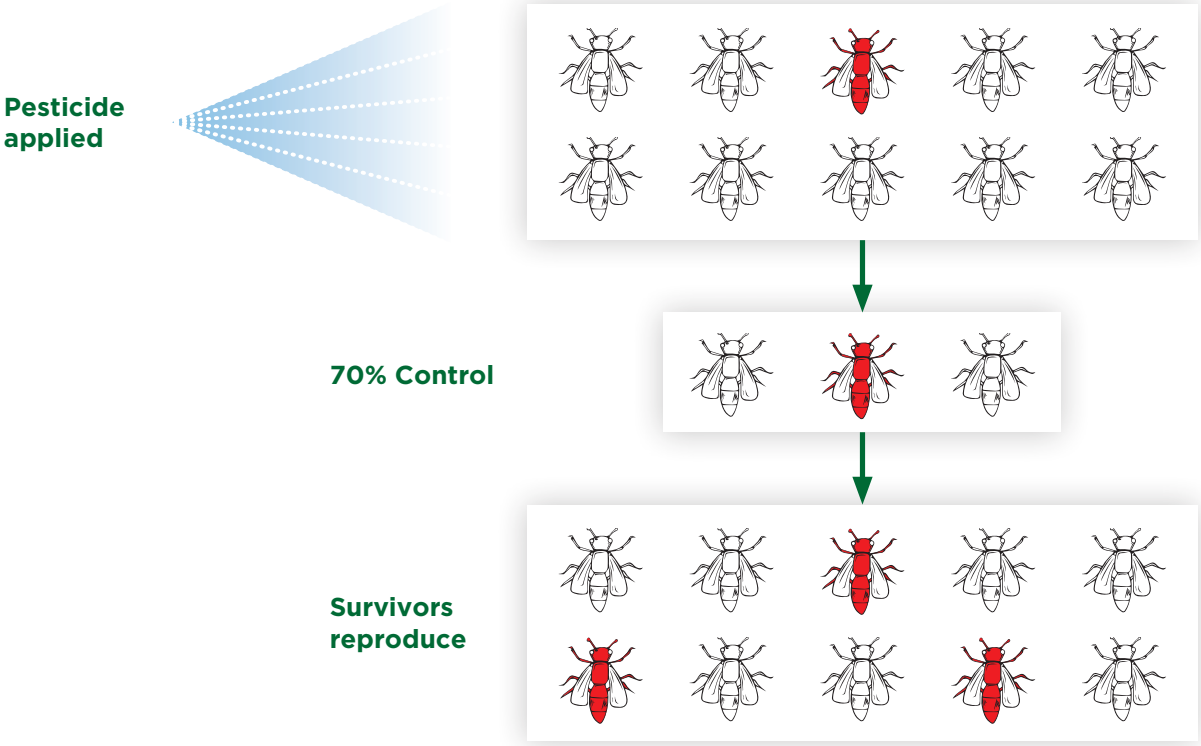
6 PESTICIDE RESISTANCE MANAGEMENT

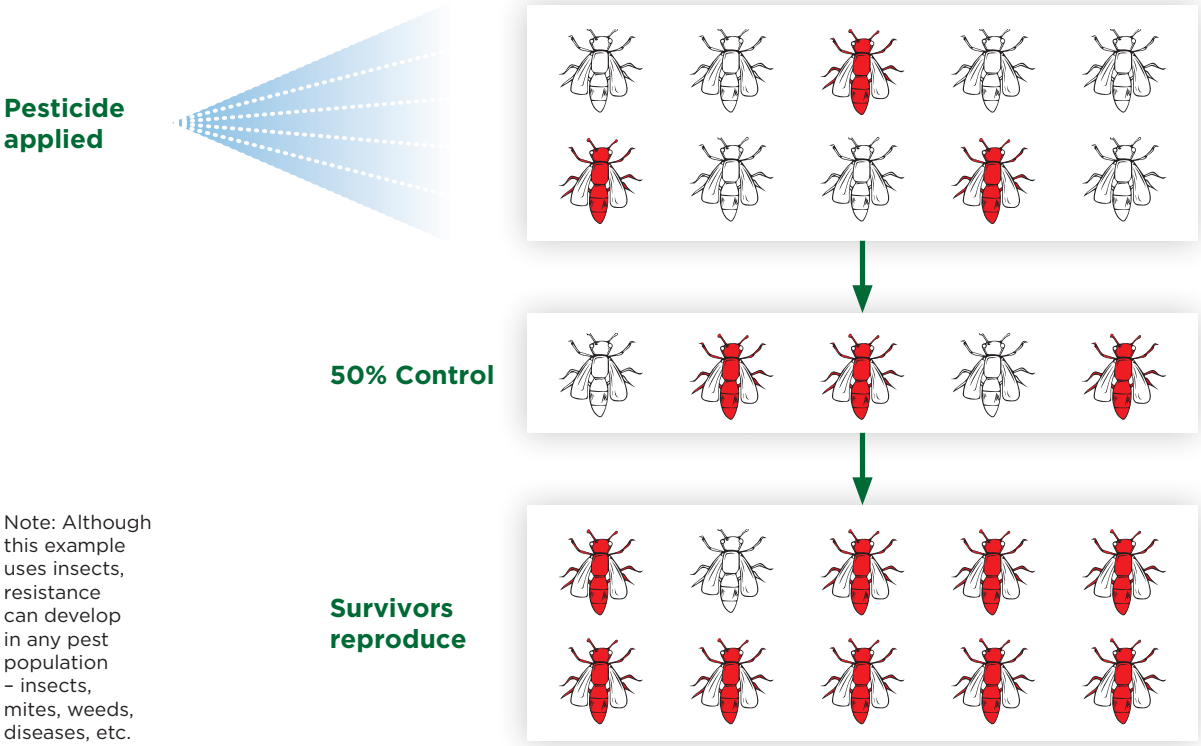
Factors Which Promote the Development of Pesticide Resistance	Practices Which Prevent or Avoid the Development of Pesticide Resistance
Poor coverage of the area being treated. This includes both cover of the whole target area (eg a field), and also within the target area (eg poor underleaf coverage, or crop penetration). It also includes areas of over- and/or under-dosing in the target area.	Ensure even and adequate coverage of the target area.
Use of counterfeit/illegal pesticides that may have unknown active ingredient and/or unknown concentration	Use of genuine products.
Areas where there is little or no immigration of susceptible individuals from outside.	If pesticide mixtures are used (tank or pre-mixtures), the following **must** be considered: • The individual insecticides must be highly effective, and applied at the individually recommended rates. • Mixtures of pesticides with the same mode of action should not be used. • Known or potential cross resistance problems between the individual pesticides. • The individual pesticides should have similar persistence periods. This is not necessary true for herbicides.
Adoption of IPM is a major way to manage resistance development	

How Resistance Develops in a Population

Susceptible individual

Resistant individual





Note: Although this example uses insects, resistance can develop in any pest population – insects, mites, weeds, diseases, etc.

Managing Resistance

Resistance development can be delayed by adopting a number of different practices that rely on pest management and pesticide use strategies:

1. Integrated Pest Management (IPM):

Adoption of IPM, which includes cultural practices such as crop rotation, possible use of pest-resistant varieties and maintenance of naturally-occurring predators and parasites and other beneficial organisms, help keep pests populations low and therefore avoids the need to use control measures. If pest control is needed a range of practices can be used including mechanical control e.g. hand-picking of diseased leaves, biological pesticides, chemical deterrents and chemical pesticides. The net result is chemical pesticides are only used when necessary and not continuously. **Chemical pesticide should always be used within an IPM strategy.**

2. Using the correct pesticide dose:

Using less than the recommendation dose results in greater survival of the pest and promotes the build-up of resistance. High doses select for the most resistant individuals and also can be damaging to the environment and unsafe. **Always use the dose recommended on the pesticide label.**

3. Calibrate and maintain the application equipment:

Poorly calibrated and maintained equipment results in leakage and uneven coverage of the crop and/or target with resulting under- or over-dosing. **Always calibrate application equipment before use and keep it properly maintained.**

4. Good application practices:

A pesticide needs to be applied effectively to the target – this is achieved by directing to the target location e.g. undersurface of leaves, by ensuring the right droplet size (with liquid sprays) etc., correct volume of water (to avoid run-off), do not spray in windy conditions and, in hot climates, during the hottest time of the day. Incorrect application results in under- or overdosing. **Always used recommended application techniques e.g. direct spray to target, correct nozzles (droplet size), correct volume of water etc.**

5. Double-hit strategy:

If the pest survives the pesticide application, consider the option of applying a different pesticide or a different control technique to kill survivors. This is a useful strategy for surviving weeds. In small plots single surviving weeds can be removed by hand; this or other control technique should be done before seeding. Avoid resorting to applying increased doses of the original pesticides. **Consider controlling survivors from a pesticide application with a different pesticide or control technique.**

6. Preservation of susceptible insects:

A few programmes preserve susceptible pests through leaving unsprayed areas or promoting attractive habitats with the cropping area that facilitate immigration of the pest so that susceptible and resistant individual mix and mate , diluting the resistant individuals. This is exclusively done with insect pests.

7. Use good quality, genuine pesticides:

Use of illegal or counterfeit pesticides can result in applications of unknown amounts of the active ingredient (or a different active ingredient), which results in under-, over, or incorrect dosing and undermines resistance strategies. **Never use illegal or counterfeit pesticides.**

8. Mode/Site of Action (MoA) rotation:

There are hundreds of active pesticide substances, many of which act in different ways – referred to as a different mode or site of action (MoA). A key element of effective resistance management is the use of rotations (alternations, sequences) of different insecticide MoA classes. Users should avoid by repeated use within the crop cycle, or year after year, of the same insecticide or related products in the same MoA class. MoA classes can be determined by labelling on the pesticide bottle (in a few countries) or looking up the active ingredient against lists (see hand-out Rotation of Mode of Action). In some cases the result can be obtained through applying mixtures with different MoAs e.g. some fungicides and many herbicides, if recommended (note: if mixtures are used the full dose recommended for each pesticide should be used). Generally, however, mixtures are not recommended for resistance management for insecticides. **If repeated applications of chemical pesticides are necessary, the MoA should be rotated.**

Biotech-derived Crops

1. Herbicide-tolerant:

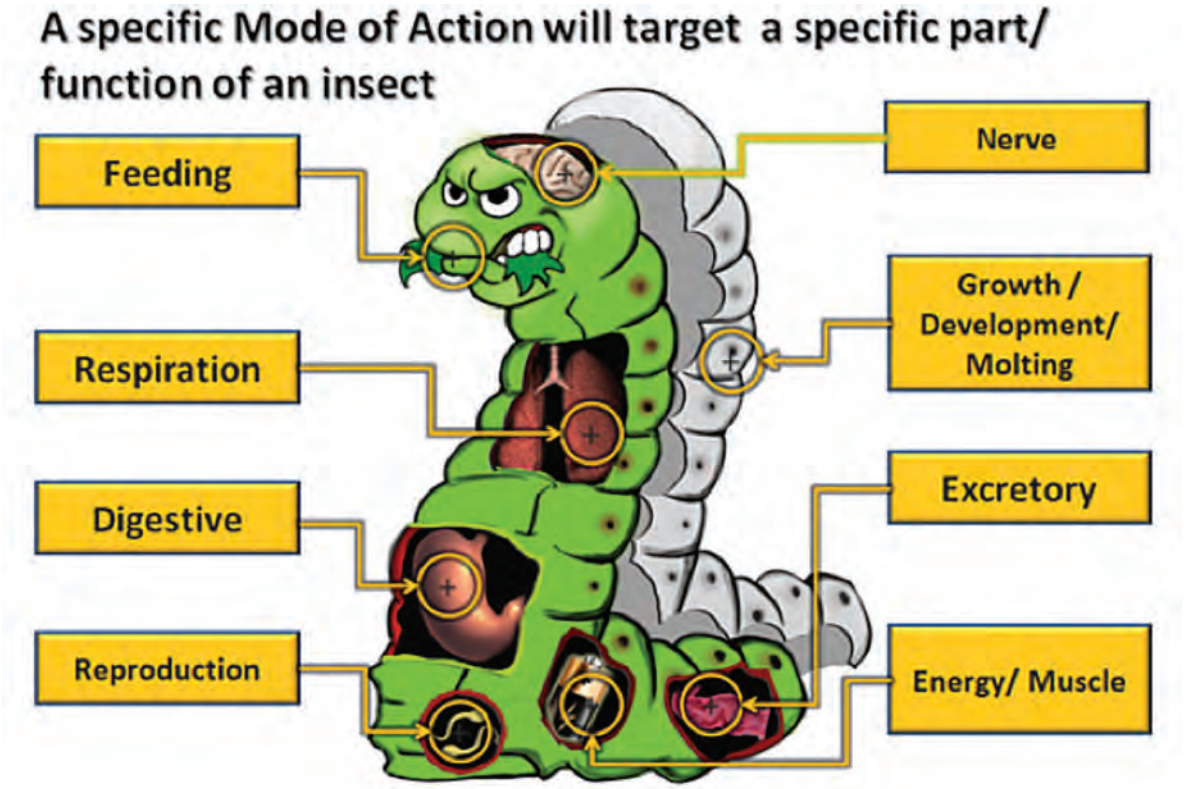
Resistance management in herbicide-tolerant crops follows the same strategy as conventional crops, outlined above.

2. Bt-crops:

Management of resistance in Bt-crops is achieved through planting of a refuge. This is an area or percentage of the crop that is planted to conventional seed or planted to a crop that is equally attractive to the pest insect. Surviving resistant insects from the Bt-crop plants mix and are diluted by susceptible insects from the refuge (see hand-out of resistance management in Bt-crops). The amount (%) of refuge for each product should be stated on the label. Some products consist of a mixture of Bt and conventional seed at the required percentage. Refuge should be employed from initial planting of Bt-crops.

Mode/Site of Action

There are hundreds of active pesticide substances, many of which act in different ways – referred to as a different **mode or site of action (MoA)**. This is illustrated in the picture below that shows where different pesticides may affect and insect.

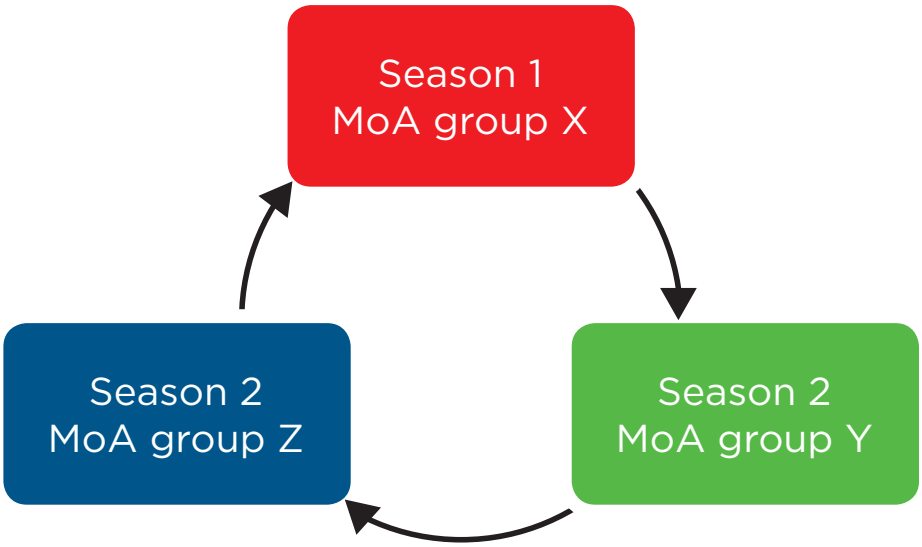


Although the picture illustrates MoA for insects, many different herbicides and fungicides also have different MoA.

Continued use of products with the same MoA will result in development of resistance, normally in the target pest, but this could also be more broadly e.g. several weed species to a broad spectrum herbicide that is repeatedly used.

Mode/Site of Action Rotation

There are hundreds of different pesticides, may which have different modes/sites of action (mechanism or site of activity, MoA). Resistance can to develop to a specific MoA and can be delayed through avoiding using the same MoA all the time by rotating MoA over time. This is illustrated by two examples below:



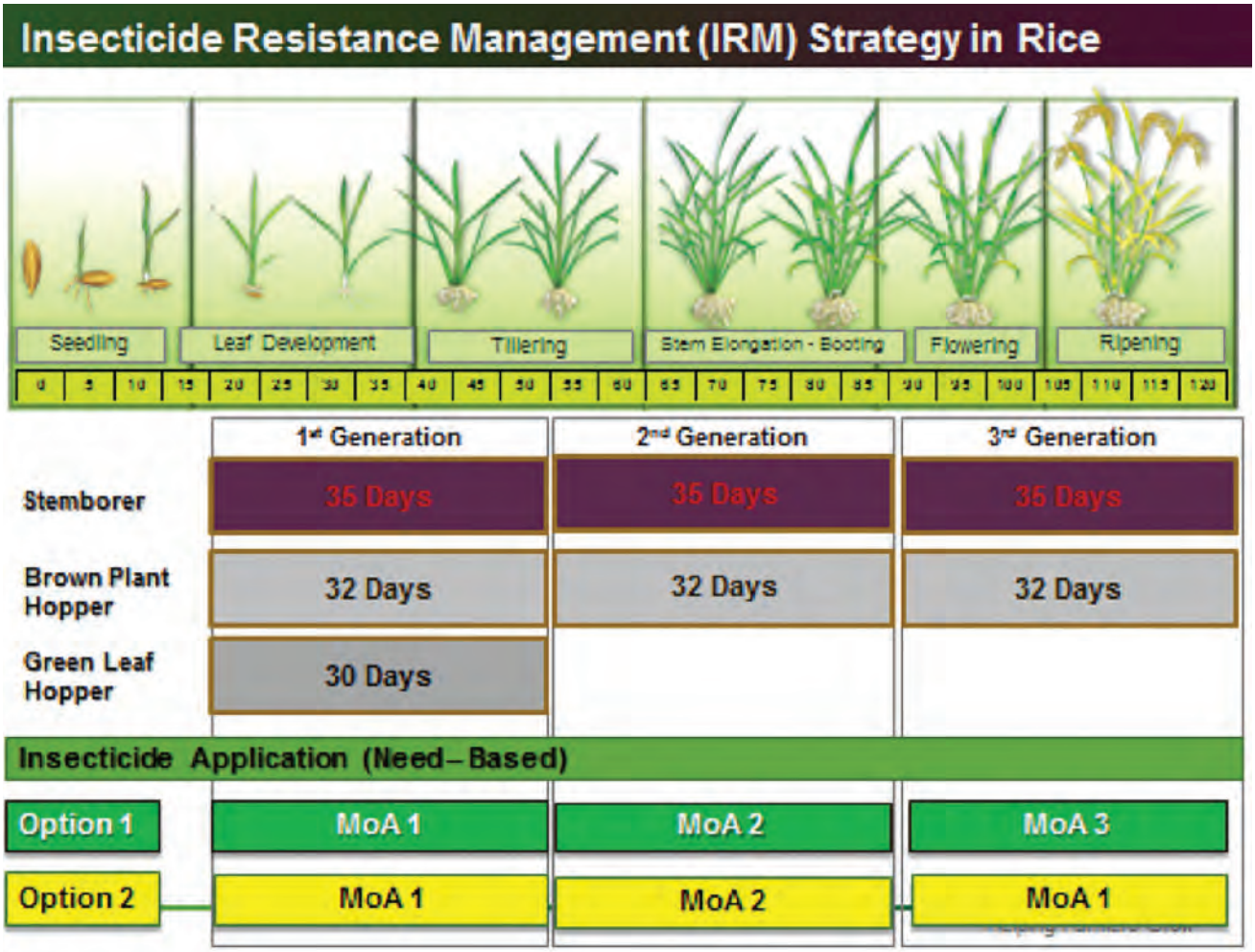
Sequence of insecticides through season

This requires that the MoA of a product is easily known. This is the case where the label of the product has a letter or number code that gives the MoA: each different MoA has a different code, so a user just needs to choose products with different code numbers and rotate as shown above. In the absence of a MoA labelling, the user needs to take note of the active ingredient that is listed on product label and look up the MoA on the lists/posters shown on CropLife International Resistance Action Committees' websites:

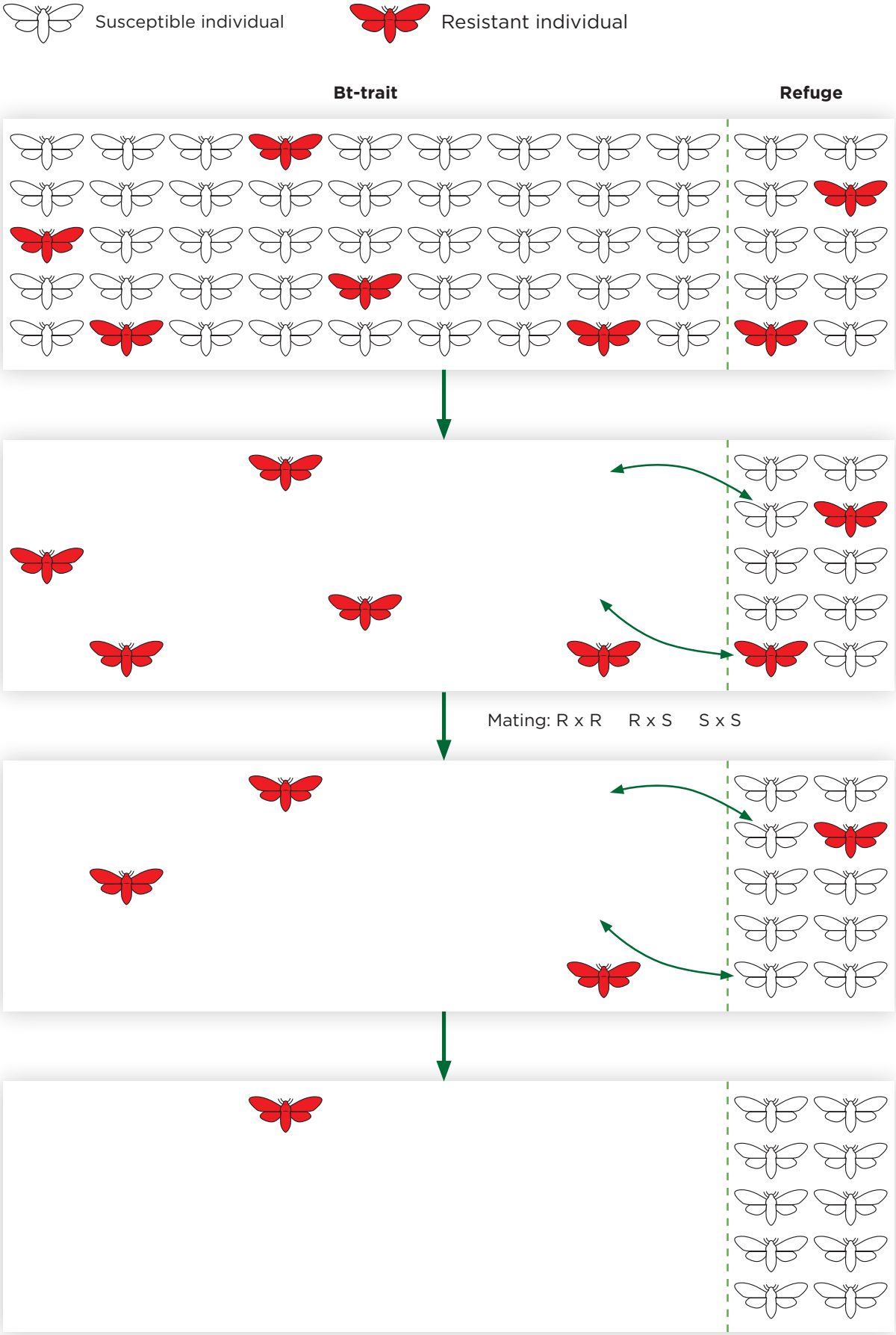
- the Fungicide Resistance Action Committee (FRAC: www.frac.info)
- the Insecticide Resistance Action Committee (IRAC: www.irac-online.org)
- the Herbicide Resistance Action Committee (HRAC: www.hracglobal.com)
- the Rodenticide Resistance Action Committee (RRAC: www.rrac.info)

A good retailer should have access to the lists/posters and keep up-to-date. Local pesticide company representatives should be able to help. If only some products have MoA labelling it may be easier to preferentially choose those.

On the basis of this information MoA rotation can be included as part of an IPM strategy and adapted for specific crops, for example:



Resistance Management in a Bt Crop: Use of Refuge



Homework Assignments

5 minutes

Objective of the procedure

- For participants to reflect on the underlying objectives of using a sprayer.

Give the following questions to participants.

- What is the ultimate objective when we apply a pesticide to a crop? What are we really trying to do?
- What is the target we are trying to reach when we apply a pesticide?
- What basic function does a sprayer perform in helping us to achieve these objectives?

See also:

International Code of Conduct on the Distribution and Use of Pesticides - Guidelines on Prevention and Management of Pesticide Resistance (FAO)
http://www.eppo.int/PPPRODUCTS/resistance/FAO_RMG_Sept_12.pdf

Resistance Management for Sustainable Agriculture and Improved Public Health (IRAC)
http://www.irac-online.org/documents/irac-croplife-irm-booklet/?ext=pdf

Overview of an Insect Resistance Management (IRM) Plan for Plant Protection Insecticides (IRAC)
http://www.irac-online.org/documents/key-components-of-an-irm-plan/?ext=pdf

General Principles of Insecticide Resistance Management from IRAC
http://www.irac-online.org/documents/principles-of-irm/?ext=pdf

Herbicide Resistance Action Committee website
http://www.hracglobal.com/

Fungicide Resistance Action Committee website
http://www.frac.info/

Rodenticide Resistance Action Committee website
http://www.rrac.info/

PESTICIDES AND FORMULATIONS –PART ONE

7

CropLife INTERNATIONAL

www.croplife.org

7 PESTICIDES AND FORMULATIONS – PART ONE

Overview of the Session

Pesticides are one of the tools in an IPM programme. Knowledge of pesticides and their different types, formulations, and toxicity is thus essential for safe, effective and economic use of pesticides.

This is the first of two sessions on pesticides and formulations. The purpose of this session is to enable the participants to understand the different types of names and classification of pesticides, and to be able to use this knowledge to assist in selecting the most suitable pesticide product for a particular pest problem.

To set the background that pesticides are tools which need to be used safely, the first participant activity is a workgroup task on the homework assignment about dangerous items in everyday use and how knowledge of the tool and its potential hazards are essential for safe use. The remainder of the session is concerned with pesticides names and classification, and how knowledge of these topics can assist in the selection of a suitable product. These aspects will continue in the following session.

Before this session, you should assemble a collection of different pesticide containers, labels, and formulations available locally. These samples will provide the focus for the session.

Session Objectives

By the end of the session, participants will be able to:

- State the different types of pesticide names.
- Define key elements and terminology of pesticides, and identify the different ways that pesticides can be classified.
- Explain how an appropriate pesticide can be selected based on different classification criteria.

Equipment and Learning Aids

- Samples of local formulations and labels from each hazard classification.
- Gloves
- Soap / water

TOTAL TIME: 2 hours

Procedures

1. Introduction to the Session

5 minutes

Welcome participants to Session 7. Briefly review the topics covered in the previous session.

Refer to the IPM Circle. Remind participants that we will now continue our exploration of chemical control with a deeper look at pesticides.

Present the session objectives, and give a brief overview of the procedures.

Ask the three volunteers to review the previous day's activities, results and conclusions from sessions 4 to 6.

2. Working Group Task – Review of Homework Assignment on Dangerous Things in Everyday Use

20 minutes

Objective of the Homework Assignment:

- For participants to think about the hazards associated with everyday items, and how these dangers are minimized so as to avoid injury.

Remind participants that their homework assignment was for each participant to make a list of 5 common tools or items from everyday use that are potentially dangerous (examples were a portable gas stove, a knife), and to list the precautions that should be taken to avoid accidents and injury when they are used.

Working Group Task

- Each person should present his list and precautions to the other table members.

- The table should then decide which two of the items cause most accidents or injuries, and why.

Allow 15 minutes for the task.

Move around to the table groups, sitting in and listening to some of the presentations of the lists and the decisions on the two most dangerous items.

3. Working Group Presentations

30 minutes

After about 15 minutes, ask each group to present their results.
Allow all groups to present before asking the following questions.

- All the items presented are in common use and sometimes cause accidents and injury. What are the common factors of use that cause these accidents and injuries?
- Is the greatest risk from the tool itself, from the way in which the tool is being used, or from the person actually using the tool?

TRAINER NOTE: Emphasise the aspects of actual use of the tool, not the aspects that will cause the tool to break down (such as poor maintenance), or solutions to breakdowns.

Examples of such common factors would be misuse, lack of knowledge about the potential dangers, not taking the correct precautions in use, carelessness, etc. Note these common factors on the flipcharts.

Say:

- The common factors which can cause danger with these everyday tools are things such as carelessness, misuse, and lack of knowledge by the user, but if we take the correct precautions then they are safe to use. Pesticides are also a tool, and if the correct precautions are taken the dangers of use can be minimized.

4. Presentation – Pesticide Terminology

10 minutes

Objective of the procedure:

- To ensure that participants understand the different names that are given to an individual pesticide.

Present the contents of Handout 7.1, *Pesticide Terminology*. Allow a short time for questions and discussion.

Distribute Handout 7.1 to the participants.

5. Interactive Discussion – Classification of Pesticides

20 minutes

Objective of the procedure:

- To define what is meant by a "pesticide", and identify the different types of pesticides used against different types of pests.
- For participants to reflect on the most common types of pesticide in the country, based on usage.

Remind participants of the broad definition of "pest" from Session 1:

- A pest can be broadly defined as any organism which adversely affects man, his crops, his livestock, or anything he considers to be of value.

A pesticide is defined as:

- Any substance which is used to prevent or reduce loss or damage caused by pests, either by directly killing the pest, or by inhibiting its growth, or by repelling it.

Ask:

- What are examples of the most common products used by farmers in the country, and what are they used against?

List the examples given on the flipchart, using Handout 7.2, *Pesticide Classification*, as a check list of the types of pests controlled. When all the common products have been listed,

Ask:

- From this list, are the most common pesticides applied against insects, diseases, weeds, or other pest?

Say:

This is one way in which pesticides are classified - according to the type of pest against which they are used, for example insecticides, fungicides, herbicides.

6. Presentation and Discussion – Selection of a Pesticide Based on the Different Types of Classification

25 minutes

Objective of the procedure:

- For participants to understand that knowledge of the different ways in which a pesticide can be classified can help in selecting a suitable product in order to achieve effectiveness and safety.

Ask:

- In what other ways can pesticides be classified?

Use Handout 7.2, *Pesticide Classification*, as a check list.

Present the contents of Handout 7.2, *Pesticide Classification*.

Ask:

- How does knowing about the different types of classification help in handling and using pesticides most effectively?

- Why might you select a particular pesticide for a pest on the basis of one or more of the different types of classification?

TRAINER NOTE: Emphasise during this discussion the principles of pesticide selection based on different types of classification.

Distribute Handout 7.2 to the participants.

7. Conclusions

5 minutes

Summarize briefly the highlights of the session.

Include as main messages:

- Pesticides have more than one name. It is the common name that is important when distinguishing between different pesticides.
- Pesticides can be classified according to different criteria.
- Knowledge of the different criteria can help in selecting the most suitable pesticides for an IPM programme.

Ask:

- What insights will you especially want to remember when giving advice to farmers about pesticides?

Refer participants to the IPM Circle.

Say:

- In the next session we will complete our examination of pesticides.

Review the session objectives and ask if they were met.

Pesticide Terminology

Active ingredient

Only a certain component of a pesticide product has activity against pests. This component is called the active ingredient. There may be more than one active ingredient in a product.

Chemical name.

Each active ingredient has a chemical name that describes the actual chemical composition. This name is often long and complicated. It may appear on the label in brackets.

Common name

Each active ingredient is also given an internationally recognised common name that is much easier to use and remember than the chemical name. A specific common name always refers to the same active ingredient, regardless of the manufacturer of the product. Common names are always given on the label.

Product name.

Manufacturers give their own name to their products containing particular active ingredients. It is the product name which appears in large print on the label.

Pesticide Terminology

Type of Pest Controlled

✔ Insecticides	against	Insects.
✔ Fungicides	against	Fungi.
✔ Herbicides	against	Weeds.
✔ Acaricides	against	Mites.
✔ Rodenticides	against	Rats, mice, and other rodents.
✔ Molluscicides	against	Snails.
✔ Nematicides	against	Nematodes.

Chemical Group

The chemical group to which the pesticide belongs.

Insecticides

- **Inorganic:**
  Do not contain carbon. Commonly based on arsenic, copper, mercury, sulphur, tin or zinc. Many of these compounds are now banned or have severely limited uses.

- **Organic:**
  Contain carbon. Synthetic in that they have been developed by man. The most common pesticides.

- **Botanical:**
  Obtained from plant extracts

- **Biological / Microbial:**
  Contain bacteria, viruses, protozoa, or fungi

Herbicides

Herbicides have many different chemical groups, among the most common of which are the triazines, substituted ureas, and sulfonylureas.

Fungicides

Also have many different chemical groups, among the most common of which are inorganic, dithiocarbamates, and triazoles.

Toxicity

A measure of how poisonous a pesticide is to man. High toxicity to man does not necessarily mean that the pesticide is highly toxic to the pest. Formulations are usually less toxic than the pure active ingredient. The following WHO classification of toxicity is most commonly used, although there are others such as national systems:

- **Class Ia:** "Extremely Hazardous"
- **Class Ib:** "Highly Hazardous"
- **Class II:** "Moderately Hazardous"
- **Class III:** "Slightly Hazardous"
- **[no class]** "Unlikely to Cause Hazard in Normal Use"

The toxicity warning on the pesticide label refers to the formulation, not the active ingredient

Mode of Action

Describes the method by which the pesticide acts on the pest.

- **Contact:** The target pest is only killed when it comes into direct contact with the pesticide. For a given volume of spray, the more drops per square centimeter of surface, the better the effectiveness of the pesticide. Most insecticides are contact pesticides, and are most effective against insect pests which move about a lot.

- **Stomach:** A pesticide that must be eaten by the insect pest to kill it. Most contact pesticides are also stomach poisons for insect pests. These pesticides are more effective against pests which move around a lot.

- **Systemic:** A pesticide that is absorbed and moved within a plant, and kills the pest when it feeds on the plant. Movement is mainly from the upper to lower leaf surface, and upwards within the plant. There is very little movement down the plant, so overall plant coverage is essential for pests in the lower parts of the crop. Absorption of the pesticide by the plant is reduced if the plants are under stress. Systemic insecticides are most effective against insect pests which do not move very much, and suck plant juices. Most herbicides are also systemic.

- **Fumigant:** A pesticide in vapour or gas form in the air which the pest breathes in. These pesticides can only be used in enclosed spaces, such as greenhouses and warehouses.

PESTICIDES AND FORMULATIONS – PART TWO

8

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8 PESTICIDES AND FORMULATIONS – PART TWO

Overview of the Session

This is the second of two sessions on pesticides and formulations. Building on the topics covered in the previous session, a presentation and discussion introduces the components of a formulation, followed by working groups on the advantages and disadvantages of different types of formulations. Finally there is a presentation and interactive discussion on the pesticide label.

Before this session, you should assemble a collection of different pesticide containers, labels, and formulations available locally. These samples will provide a focus for the session.

Session Objectives

By the end of the session, participants will be able to:

- Describe the components that make up a pesticide formulation, and identify the common types of formulations that are used locally.
- Consider the advantages and disadvantages of different types of pesticide formulations and pesticide classifications when selecting a product.
- Identify the areas on the label where the different types of information are presented.
- State why reading the label is important.

Equipment and Learning Aids

- Samples of local formulations and labels from each hazard classification.
- Gloves
- Soap / water

TOTAL TIME: 2 hours 10 minutes

8 PESTICIDES AND FORMULATIONS – PART TWO

Procedures

1. Introduction to the Session

10 minutes

Welcome participants to Session 8.

Refer to the IPM Circle:
Say:

- This session will complete our examination of chemical control and pesticides.

Present the session objectives, and give a brief overview of the procedures.

2. Presentation / Discussion – Components of Formulations

20 minutes

Objective of the procedure:

- For participants to understand the different components which make up a pesticide formulation, and what are the differences between the main types of formulations.

Present the contents of Handout 8.1, Formulations.

Make the following points:

- Commercially available pesticide products are normally a mixture of the active ingredient and other substances. This mixture is known as the formulation and allows the active ingredient to be more conveniently handled and stored, and to be more effective in its action.

- Sometimes it is desirable to improve further the effectiveness of a chemical, in which case additives such as wetters or stickers can be included in the spray mix.

- Review the common types of formulations and their properties.

Use your samples as examples, and describe their nature and explain how the formulation is abbreviated on the product label with a percentage active ingredient, followed by the abbreviation of the formulation, e.g. 3 G = 3% granules.

TRAINER NOTE: Though the session on safety comes later in the training course, it is always important to model safe practices when handling the concentrates. Wear gloves, don't smoke, avoid spillage, and wash after handling containers.

Ask participants if they have any comments or points which need clarification.

Distribute Handout 8.1 to participants

3. Working Group Task – Advantages and Disadvantages of Different Types of Formulations

20 minutes

Objective of the procedure:

- For participants to reflect on the advantages and disadvantages of different types of pesticide formulations.

Assign each table group one formulation from the following common types.

- ✔ Emulsifiable Concentrate
- ✔ Wettable Powder
- ✔ Suspension Concentrate
- ✔ Seed Dressing
- ✔ Granule
- ✔ Bait
- ✔ Fumigant

Table Task

- The type of formulation given to your group has advantages and disadvantages for storage, mixing, application and safety. Agree as a group on all these advantages and disadvantages.

Allow 15 minutes for the task

8 PESTICIDES AND FORMULATIONS – PART TWO

4. Working Group Reports

40 minutes

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 Handout 8.2, Advantages and Disadvantages of Formulation Types, to cover any points missed by the participants.

Ask:

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

Distribute Handout 8.2 to participants.

5. Presentation and Interactive Discussion – The Pesticide Label

30 minutes

Objective of the procedure

- To explain the importance of the label, the different parts of the label, and the information given.

Present the contents of Handout 8.3, The Pesticide Label.

Emphasise:

✔ The label is the primary source of information about a product.

✔ We have covered some of the types of information on the label in previous sessions, such as pesticide names, dose rates, and recommendations for use. Other aspects, such as safety and pre-harvest intervals will be covered in later sessions.

TRAINER NOTE: Have copies of local containers / labels available to illustrate the various components of the label and use as specific examples, eg Active ingredient / product name, registered uses and dose rates, pre-harvest intervals.

If there is a standard label format in the country, it will be useful to prepare a flip chart to outline where the different information groups (uses, safety, etc) are located on the label

Distribute Handout 8.3, *The Pesticide Label*, to participants.

Ask if participants have any further questions.

Distribute Handouts 8.4, *Pictograms*, and 8.5, *Hazard Warnings,* to the participants.

Explain the pictograms and hazard statements on the label, using Handouts 8.4 and 8.5 to illustrate the different types and meanings.

Ask the following questions:

- Why should farmers read the label?
- What should farmers do if they cannot read?
- What is the most important information on the label for the farmer?

TRAINER NOTE: There is no real 'correct' answer to the last question, as all the information on the label is important.

The underlying objective of the question is to ensure that participants are fully aware of all the different types of information presented on the label, and to re-enforce this knowledge from the comments of other participants.

6. Conclusions

5 minutes

Review the major messages of the session.

Include as main messages:

- Pesticide formulations have different characteristics. These can be important when selecting a pesticide for use in an IPM programme.
- The pesticide label is the source of all information about a pesticide. Do not assume you know the contents – READ THE LABEL every time a pesticide is used.

Review the session objectives and ask if they were met.

Ask:

- What were the most important conclusions for you today? Why?

Refer participants to the IPM Circle.

Say:

- We have now completed our examination of the chemical control component of IPM. In the next session we will look at Application to complete the circle.

8 PESTICIDES AND FORMULATIONS – PART TWO

Formulations

✔ A **Formulation** is a combination of various ingredients designed to improve the properties of a pesticide product for effectiveness, safety, handling, storage, and application.

✔ More recent formulations, such as suspension concentrates (SC), water dispersible granules (WG), and microgranules (MG), have improved stability and safety properties.

✔ The properties of a formulation, including effectiveness and safety, depend on the use of high quality ingredients and manufacturing processes.

Components

- **Active ingredient** - the component with activity against pests
- **Inert ingredients** - components which have no activity against pests

For example:

- Solvents — Liquid formulations. The active ingredient is dissolved in the solvent.
- Carriers — Dry formulations. The active ingredient is mixed with or absorbed onto the carrier.
- 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.

Not all formulations will contain all the different types of inert ingredients

Common Types

Emulsifiable Concentrates (EC)

- Liquid formulations where the active ingredient is dissolved in a petroleum solvent, or, more recently, safer alternatives.
- The formulation is diluted with water to form a suspension for application.
- Usually contain 25 to 75 percent of active ingredient.
- ECs are among the most common pesticide formulations.

Wettable Powders (WP)

- Dry formulations of fine, insoluble powders. The active ingredient is combined with an inert carrier such as clay or talc, together with wetting and / or dispersing agents.
- The formulation is diluted with water to form a suspension for application.
- Usually contain more than 50 percent active ingredient.
- WPs are among the most common pesticide formulations.

8 PESTICIDES AND FORMULATIONS – PART TWO

Suspension Concentrate (SC)

- Used for active ingredients that are not soluble in the more common solvents.
- They are mixed on a carrier, such as clay, and formulated with a liquid to form a thick, paste-like suspension.
- The formulation is diluted with water to form a suspension for application.
- Combine the benefits of both ECs and WPs.

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

- Dry or liquid formulations for application to seeds prior to planting.
- Dry formulations usually require no further dilution (SS formulations require dilution with water).
- Liquid formulations usually, but not always, require dilution with water.
- Seed may be available that is already dressed with a pesticide (PS formulations)

Granules (G)

- Dry formulation of relatively large and heavy particles of an inert material.
- The active ingredient may be coated on the outside or absorbed into the particles.
- Applied without any further dilution.
- Usually contain 1 to 15 percent of active ingredient.
- Most commonly used for soil application to control weeds, nematodes and soil living insects.

Baits (B)

- An active ingredient mixed with food or other attractant material.
- The bait may be sold pre-mixed, or the pesticide and bait material mixed by the user.
- Pests are killed by eating the pesticide contained in the bait, either in a single dose, or over time.
- The concentration of active material is low, usually less than 5 percent.
- Commonly used in indoor situations, but may be used in agriculture.

Fumigants (F)

- Pesticides that form poisonous gases.
- May be a liquid under high pressure that changes to a gas when released, or a volatile liquid, or a solid that releases a gas under high humidity.
- Used for structural pest control, food and grain storage, soil sterilization, and greenhouses.

Advantages and Disadvantages of Different Types of Formulations

Emulsifiable Concentrate (EC)

Advantages

- Easy to handle, transport and store
- Easily measured and mixed with water
- Can be used with most types of application equipment
- Little agitation needed in spray tank, does not settle out
- Not abrasive to nozzles and pumps
- Do not block filters or nozzles

Disadvantages

- Usually high concentration in the formulation
- Due to high concentration, easy to make errors when mixing, and in application dose rates
- Mixers need more protective clothing than applicators
- May cause phytotoxicity to crops
- Easily absorbed through the skin
- Solvents may attack rubber, plastic, hoses, gaskets etc
- Flammable

Wettable Powder (WP)

Advantages

- Easy to handle, transport and store
- Can be used with most types of application equipment
- Easily mixed with water
- Usually less phytotoxic than ECs
- Absorbed less readily through the skin than ECs

Disadvantages

- Can cake in storage
- Mixers need more protective clothing than applicators
- More difficult to accurately measure out than ECs (WP weight vs EC volume)
- Risk of inhaling powder during mixing
- Require constant agitation in the spray tank, or they quickly settle out
- Abrasive to nozzles and pumps
- Can clog filters and nozzles
- Inert carriers may leave a deposit on crops, which has to be removed before marketing

8 PESTICIDES AND FORMULATIONS – PART TWO

Suspension Concentrate (SC)

Advantages

- Easy to handle, transport and store
- Can be used with most types of application equipment
- Easily mixed with water
- Usually less phytotoxic than ECs
- Absorbed less readily through the skin than ECs

Disadvantages

- Mixers need more protective clothing than applicators
- Container must be shaken before use to remix formulation
- Require moderate agitation in the spray tank, or they settle out
- May be abrasive to nozzles and pumps
- May clog filters and nozzles
- Inert carriers may leave a deposit on crops, which has to be removed before marketing

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

Advantages

- Depending on formulation, similar to EC, WP and SC formulations.
- Can be applied to seed on-farm with simple equipment.
- Help to avoid early season foliar sprays, and so protect beneficial insects

Disadvantages

- Depending on formulation, similar to EC, WP and SC formulations.
- Bulk treatment of seed requires specialist treatment equipment.
- Treated seed may be eaten by humans, domestic animals or wildlife

Granule (G)

Advantages

- Ready to use, no mixing needed
- Soil application: Do not stick to foliage
- Slow release of pesticide gives extended protection
- Low risk of drift
- Little hazard in use to applicator
- Require only simple application equipment

Disadvantages

- Plant application: Do not stick to foliage
- May need to be incorporated in soil
- Can be difficult to obtain even distribution over the target area
- Slow release of pesticide results in long persistence
- May be hazardous to non-target animals such as chickens and other birds who mistake granules for food grain

8 PESTICIDES AND FORMULATIONS – PART TWO

Bait (B)	
Advantages - May be ready to use - Little pesticide needed - bait applied only where pests are present and pests are attracted to the pesticide	**Disadvantages** - Can be attractive to non-target organisms (domestic animals, children etc) - Pests may prefer other food or crop to the bait - Pests may avoid bait due to association with ill-effects (eg bait shyness of rodents)
Fumigant (F)	
Advantages - Toxic to a wide range of pests. - Can penetrate cracks, wood, soil and grain. - Single treatment will usually kill most pests in the treated area	**Disadvantages** - Target site must be covered and airtight to prevent the gas from escaping. - Most are highly toxic to humans and all other living organisms. - Need specialized protective clothing, including respirators. - Need specialized application equipment - Fumigated premises must be well-aired before access by humans and animals is allowed.

Major Pesticide Formulation Types – Solids

Physical State	How Applied	Formulation Type	Diluent	Problems, Hazards		
Solid	Undiluted	Dust		- Drifts easily - Do not stick to target surfaces - Difficult to obtain even distribution - Risk of inhalation	Dust when handling concentrate	Operator exposed to concentrate
		Granule		- Do not stick to leaves or other non-level target surfaces - May need to be incorporated in soil - Difficult to obtain even distribution - Slow release, long persistence - May be dangerous to non-target organisms		
	Diluted	Wettable Powder	Water	- Mixer needs more protection than operator - Needs constant agitation - Abrasive to nozzles and pumps - Can clog filters and nozzles		
		Bait	Bran, grain	- Can be attractive to non-target organisms (food)		

Major Pesticide Formulation Types – Liquids

Physical State	How Applied	Formulation Type	Diluent	Problems, Hazards		
Liquid	Diluted	Emulsifiable Concentrate	Water	- Mixer needs more protection than applicator - Easy to under- or over-dose - May cause phytotoxicity - Easily absorbed through skin - May attack rubber, plastic, hoses, gaskets - Flammable	Mixer exposed to concentrate	Splashes adhere to clothes and skin
		Flowable		- Container must be shaken before use - Needs moderate agitation in spray tank - May be abrasive to nozzles and pumps - May clog filters and nozzles		

The Pesticide Label

✔ The **FIRST** and most important activity when using a pesticide is to:

READ THE LABEL

✔ The label on the container is the primary source of information about a pesticide.

✔ The label has all the basic information that is needed:

- Product name
- Active ingredient
- Concentration of active ingredient and inert materials
- Crops and pests for which the pesticide is registered
- Dose rates
- Toxicity and hazard warnings
- Safety precautions
- Pre-harvest interval
- Pictograms
- Expiry date
- Registration number
- Name of manufacturer / importer

Pictograms

STORAGE

Keep locked away and out of reach of children

ACTIVITY

Handling liquid concentrate

Handling dry concentrate

Application

ADVICE

Wear gloves

Wear boots

Wear eye protection

Wear face shield

Wear mask

Wear respirator

Wear overalls

Wear apron

Wash after use

WARNING

Dangerous to animals

Dangerous to fish and water

Hazard Statements and Band Colour

✔ Labels should include a hazard statement, a warning symbol, and often a band colour based on the WHO toxicity classification.

WHO Class (1)	Label		
	Hazard statement	Symbol	Band Colour (2)
Ia Extremely Hazardous	Very Toxic		VRed
Ib Highly Hazardous	Toxic		TRed
II Moderately Hazardous	Harmful		HYellow
III Slightly Hazardous	Caution	None	Blue
Products unlikely to present a hazard in normal use	Caution	None	Green

(1) The hazard warning on the label refers to the formulation, not the active ingredient.
(2) This is the most commonly used colour scheme, but it may differ in some countries.

BIOCONTROL

9

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9 BIOCONTROL

Overview of the Session

This session is a detailed continuation of Session 4. It provides detail and examples of how it can be used.

Objectives of the Procedure

- Participants are aware of the role of biocontrol in IPM and how it can be effectively implemented
- To understand the benefits and limitations of biocontrol

Introduction

100 minutes

Refer to IPM circle

Say:

- In earlier sessions, we have seen that Biocontrol is one of the tools that can be used in IPM. We will now discuss in more detail how this can be used.

Ask:

- What is biocontrol?

Discuss:

- What organisms can be used in biocontrol?

List and Discuss. Are participants familiar with these organisms

- How are the different ways organism can be used?

Discuss:

At the end of discussion distribute Handout 9.1 and go through the above questions again.

Biocontrol in action

30 minutes

Ask:

- Are participants aware of any of the organisms or techniques being used in the field?

List and discuss. If there are no examples introduce some of local relevance.

Distribute the appropriate regional handout of examples including pictures.
Give a short overview / explain the following methods:

- Inundative control
- Classical/inoculative biocontrol
- Mass-trapping using a semiochemical.
- Mating disruption using semiochemicals

Working Group Task – Advantages and Disadvantages of Biocontrol

45 minutes

Objectives of the procedure

- Based on the examples given and participants knowledge determine what are the advantages and what are the disadvantages of biocontrol

Assign one type of biocontrol agent to each table (biopesticides inoculation, biopesticides inundation, predators/parasites inoculation, predators/parasites inundation, pheromones/allomones)

Allow 25 minutes for the task and 25 minutes for feedback. Distribute Handout 9.3 and add further advantages/disadvantages from the discussion.

How to Handle and Apply Biocontrol Agents

20 minutes

Say:

- We have seen some examples of biocontrol and also discussed its advantages and disadvantages of biocontrol agents.

Ask:

- What special measures are needed to store, handle and apply biocontrol agents?

List and discuss reason why.

Distribute handout 9.4.

Conclusion

5 minutes

Summarize briefly the session.

Include main messages

- Biocontrol uses living organisms to control pests (parasites, predators and micro-organisms), but also can include semiochemicals that alter the target pest's behavior
- Biocontrol is effectively employed in many IPM programs
- Approaches include inoculation, inundative release, as well as manipulation of the environment to encourage biocontrol agents. Semiochemicals attract or confuse the pest.
- Biocontrol agents have specific properties e.g. safe and specific, living organisms that are sensitive to storage and environmental conditions, slow acting, which determine how they are handled and if and when they can be effectively used.

Thank the participants and ask if there are any questions or comments.

What is Biocontrol?

Biological control or Biocontrol means controlling pests and diseases using living organisms. These are often referred to as natural enemies, but also include organisms that are antagonistic (displace through competition, rather than kill the pest).

What are biocontrol agents?

The most commonly seen and used natural enemies are:

- Predators, such as ladybirds (ladybugs), spiders, lacewings and hoverflies
- Parasites, such as the wasps *Trichogramma* and *Encarsia*, as well as predatory mites
- Microbes, such as bacteria (e.g. Bacillus thuringiensis), fungi (e.g. *Metarhizium*) and viruses (e.g. baculoviruses) as well as protozoa (e.g. *Nosema*). Also often included in this category are insect parasitic nematodes

These should be distinguished from other naturally-occuring crop protection products, such as botanical pesticides (e.g. neem, pyrethrum) or behaviour modifying chemicals – semiochemicals (e.g. insect sex pheromones, allomones from plants), which are also potentially useful tools in an IPM program. However, semiochemicals are included as examples of how other natural crop protection products are used.

How are biocontrol agents used?

Natural enemies should be distinguished from other naturally-occuring crop protection products, such as botanical pesticides (e.g. neem, pyrethrum) or behaviour modifying chemicals – semiochemicals (e.g. insect sex pheromones, allomones from plants), which are also potentially useful tools in an IPM program. However, semiochemicals are included as examples of how other natural crop protection products are used.

Natural enemies are used in three different ways:

1. Encourage natural enemies already present

This is an important element of IPM. A good example of this is the planting of flowering plants around the field, maintaining headlands (strip of land left unploughed at the end of a field) of wild flowers or hedgerows or maintaining breeding sites for beetles within the field ('beetle banks'). In all cases these are not treated with chemical pesticides.

2. Classical or inoculative biocontrol

This involves the release of a relatively small number of organisms that reproduce and gradually suppress the pest population, becoming established in the field.

3. Inundative biocontrol

Large quantities of the organism are released or applied to the crop. This is generally the most common intervention.

Semiochemicals work by affecting the behaviour of the pest (which is normally an insect).

Examples of Biocontrol

Africa

Release of the parasitic wasp, *Epidinocarsis lopezi*, to control the cassava mealybug. The parasitoid, which was introduced from South America, its area of origin, and after mass-rearing at the International Institute of Tropical Agriculture was released into Nigeria in 1981, where it established. It has since been released in several sub-Saharan countries and is now established in at least 26 countries. Cassava mealybug, which had threatened to decimate cassava production across the region and which were showing resistance to chemical pesticides, declined following release and establishment and have since remained low (in areas of poor soil, cultural practices to improve soil fertility was also needed). Between 1979 and 2013 USD34.2 million was invested in the program, with an estimated return (in terms of saved cassava production and livelihoods) of 199:1

This is an example of classical/inoculative biocontrol.

Application of a granulovirus (granulosis virus) to control the false codling moth in South Africa. The granulovirus, which is specific to the false codling moth and thus safe to non-target organisms was registered in 2004 in South Africa, following extensive research on mass production (in the host insect), formulation and field trials. The virus is applied using standard spray application equipment to citrus trees targeted early instars of the pest caterpillar. The caterpillar is infected when it eats the virus from sprayed foliage or fruit. Efficacy is improved by addition of molasses to the spray tank, which encourages feeding, acts as a sticker and also provides some protection against UV breakdown of the virus. As the virus takes some days to kill it is generally less effective against late instars as they can cause unacceptable damage before they die; in such cases a fast-acting chemical pesticide would be employed. Virus-killed insects disintegrate to release more virus, which can infect more larvae. The virus has also been used on avocado and grapes.

This is an example of inundative biocontrol

Control of locusts with the entomopathogenic fungus (a fungus that infects insects), *Metarhizium anisopliae*. The fungus is commercially mass-produced in North and West Africa, as well as South Africa. It is applied through standard application equipment (ground and aerial) as a biopesticide against the young nymphs (hoppers) of the brown and desert locust. Formulation in oil avoids the need for a very high relative humidity for the fungal spores to germinate. The germinating fungus penetrates the insect cuticle and the fungus grows within the insect, killing it within a few days. Sporulation of the fungus can result in further infection, but this is not the primary reason for control.

This is an example of inundative biocontrol

Control of the Pink Bollworm on cotton in Egypt through mating disruption.

The Pink Bollworm was effectively managed through the application of its synthesized sex pheromone (a chemical substance produced by the insect to attract the opposite sex) the cotton crop. The pheromone was applied by hand as a 'twist and tie' tube from which it is slowly released, although microencapsulated (the pheromone is contained in a minute capsule and is slowly released) and other formulations have also been used. Application of the pheromone confuses the male moth, which then cannot locate female to mate. In Egypt three applications of the pheromone was made from mid-season, followed by a final application of a synthetic chemical insecticide. In the mid1990s, 95% of the Egyptian cotton crop was treated in this way, although this has fallen away now. Mating disruption is still used in several countries including Israel.

This is an example of mating disruption using semiochemicals (chemicals that conveys a signal from one organism to another to modify behaviour).

Examples of Biocontrol

Asia-Pacific

Control of the parasitic plant, dodder (*Cuscuta* spp.) with the pathogenic fungus, *Colleotrichum gloeosporioides*, in the Peoples' Republic of China. Dodder is serious pests of oilseed, potato, soybean and peanuts in parts of Chinas. A fungus that is pathogenic to Dodder was isolated in 1963. This has been mass cultured and applied as a mycoherbicide (fungus-based herbicide). Up to 85% control has been reported, with losses in soybean, for example, reduced 30-50%. The same fungus species has also been tested for control of itch grass in Thailand.

This is an example of inundative biocontrol

Control of the rhinoceros beetle in oil and cocoanut palm in Southeast Asia and the Pacific with a Nudivirus (a type of large, rod-shaped virus). This virus, first discovered in Malaysia has been released in several islands in the region, including Fiji, Samoa, the Maldives, Papua New Guinea and Mauritius. Beetles are infected with the virus and released where they return to breeding sites (dead palm trunks). At the breeding sites, other adults and larvae are infected. As few as 10 infected larvae can establish the disease on an island. Population control can last for several years, but breeding sites need to be limited through removal of dead trees (five left standing per hectare).

This is an example of classical/inoculative biocontrol

Application of *Bacillus thuringiensis* (Bt) to control diamond-back moth (DBM) in Malaysia. Commercial formulated Bt products have been registered in Malaysia for control of DBM for more than 20 years. The diluted product is applied to cabbages and other crucifers in the Cameron Highlands and has provided good control of DBM, which had developed resistance to a number of synthetic chemical insecticides. After intensive use of some Bt products, DBM developed resistance to some Bt strains. This highlights that resistance can develop to some biopesticides and that a resistance management strategy, that alternated Bt with synthetic chemical insecticides, and as part of an IPM program, is the most positive way forward. It is worth noting that some of the crystal toxin(s) produced by Bt, which are responsible for its pesticidal activity, are the basis of those produced by genetically-engineered Bt-crops. With Bt-crops resistance is managed through planting areas of the crop with non-Bt crop plants. The equivalent of this with Bt sprays would be to leave some of the crop unsprayed.

The application of Bt is an example of inundative biocontrol

Control of the Brinjal Fruit and Shoot Borer by mass trapping in Bangladesh. The Brinjal Fruit and Shoot Borer has proved to be a difficult pest to control. In this example the insect is attracted to a sticky trap by its synthesized sex pheromone. Several traps per field manages the pest, which is enhanced by natural enemies present in the field. This has resulted in 50% more marketable fruit compared to previous control strategies. It is estimated that approximately 15% of brinjal (aubergine or eggplant) farmers are using this technique.

This is an example of mass-trapping using a semiochemical.

Examples of Biocontrol

Latin America

Control of Mealybug with the predatory beetle, the Mealybug Destroyer.
The Mealybug ladybird (Cryptolaemus montrouzieri) was first described in Papua New Guinea, but it is also endemic in Australia. The adults and larvae eat mealybugs and other scale insects, such as the citrus scale and aphids. It has been used as a biocontrol agent for over 100 years. The beetle is known as the Mealybug destroyer outside Australia and it has been mass reared on a commercial basis and released in several countries in Central and South America, including Costa Rica, for control of the Pink Hibiscus mealybug. The juvenile and adult beetles eat both eggs and young stages of the pest.

This is an example of classical/inoculative biocontrol

ontrol of silver leaf on Japanese plums in Chile with the fungus, *Trichoderma*.
Trichoderma was registered and applied for silver leaf control in Chili in 1987. It has also been used for control of chlorotic vine leaf curl in South America. However, the antagonistic fungus is a ubiquitous soil inhabiting fungi and are of considerable commercial importance due to their ability to suppress many plant pathogenic fungi. Different species of Trichoderma have been widely studied and employed for management of root and seedling diseases, often being applied to the soil as a powder or liquid formulation. It is also used as a seed coating.

This is an example of inundative biocontrol

Control of the velvetbean caterpillar with a nuclear polyhedrosis virus (NPV) in Brazil. NPVs are specific, often species specific, viral pathogens. An NPV infectious to the velvetbean caterpillar, a major pest of soybean was isolated and field tested by EMBRAPA, the Brazil Government research organization. Mass production techniques were developed, which included collection of infected larvae from NPV-sprayed fields. This led to commercialization of wettable powder formulations of the NPV, which were applied to millions of hectares of soybean per year against the young instars of the pest, successfully controlling it. Normally only one spray per season is required.

This is an example of inundative control

Control of cotton boll weevil through lure and kill. Weevils are attracted to a cardboard tube which has been treated with the insect's aggregation and sex pheromone formulated with a persistent, synthetic insecticide. The insect is killed by the insecticide. This technique has been used on hundreds of thousands of hectares in South America during the off-season and between chemical applications. In Argentina and Bolivia it has been used to prevent the boll weevil becoming established.

This is an example of lure and kill using a semiochemical.

Advantages and Disadvantages of Biocontrol

Advantages	Disadvantages
Specific – generally safe to humans, other non-target organisms (including bees) and the environment	Often only effects one pest species, which can be a problem with pest complexes
Leave no toxic residues – can often be used close to crop harvest	Sensitive to environmental conditions, which may result in variable results
Can be self-sustaining providing pest suppression over long periods and thus inexpensive over the longer term	Production batches may be variable, depending on condition, which may lead to variable results
Target pests unable or very slow to develop resistance	Generally slow acting and therefore may not be suitable for situations where rapid control is needed e.g. fruits where no cosmetic damage is acceptable
Generally an effective tool in an IPM strategy	Use may require specialized knowledge
Some locate or attract the pests reducing the need for specific application placement	Many cannot be used with chemical pesticides
	Can be difficult to store

Add others from discussion

Handling Biocontrol Agents

Biocontrol agents a normally living organisms so they need to be carefully handled and stored. This can include:

- Storage and transport under cool conditions e.g. refrigeration
- Separate to chemical pesticides, to which they may be sensitive
- Away from sunlight

Storage survival may be short, so instructions on the label must be strictly adhered to

Application of biocontrol agents also often needs to take into account special considerations, for example:

- Generally, timing of the release or application of a biological control agent is critical to success in order to:
  - Target the correct stage of the pest
  - The organisms remain active long enough to have the desired effect, for example this may be late in the evening to avoid sunlight
- Fungal-based biopesticides may need humidities greater than 95% to work properly
- Mixtures with chemical pesticides or closely timed applications of chemical pesticides should be avoided with many biological control agents – fungicides may kill fungal-based products, insecticides can kill predators and parasites, some chemical pesticides act as insect anti-feedants which can result in insect pathogenic viruses, protozoa and bacteria not being ingested by the target pest. However, mixtures of semiochemicals and chemical pesticides are often used.

Instructions on the label should always be closely followed

Although generally safe, it is recommended that appropriate Personal Protective Equipment (PPE) is worn when handling and applying biocontrol agents. For parasites and predators this may be gloves and a simple particle mask. For biopesticides based on formulated micro-organisms and semiochemicals this normally should be the same as the minimum PPE recommended for chemical pesticides (gloves, sturdy shoes or boots, long sleeve cotton shirt, long cotton trousers and during mixing and loading of sprayers, a visor.

PESTICIDE APPLICATION

10

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10 PESTICIDE APPLICATION

Overview of the Session

The purpose of this session is to enable the participants to understand the principles of pesticide application, and the factors which determine the effectiveness of application

Before this session, you should assemble a collection of different nozzles and sprayers as examples of the different types of equipment.

The session begins with a reminder about the four main reasons for the failure of a pesticide treatment. To put pesticide application into perspective, the homework activity (given at the end of Session 6) of the objectives of applying a pesticide and using a sprayer are then brainstormed. This is followed by presentation and full group discussion activities about plant coverage, droplet size, and the main types of sprayer nozzles. The session concludes with an assessment of the different types of sprayers commonly used by small farmers.

Session Objectives

By the end of the session, participants will be able to:

- State the role of a sprayer in pesticide application.
- Understand the relationship between plant coverage, droplet size and volume of water.
- State the advantages and disadvantages of large and small pesticide droplets.
- Describe the main types of nozzles, their characteristics and uses, and the basics of sprayer calibration and maintenance.
- Be able to compare the advantages and disadvantages of common types of sprayers used by small farmers.

Equipment and Learning Aids

- Examples of the three common types of nozzles
- Examples of different types of pesticide sprayers
- Gloves
- Soap / water

TOTAL TIME: 2 hours

10 PESTICIDE APPLICATION

1. Introduction to the Session

10 minutes

Welcome participants to Session 10. Briefly review the topics covered in the previous session.

Refer participants to the IPM circle.

Say:

- In this session we will complete the circle by exploring pesticide application.

Present the session objectives, and give a brief overview of the procedures.

Refer to the working group results from Session 5, Procedure 4, and to Handout 5.2, *Causes of Failure of Pesticide Applications*.

Emphasise:

✔ That application is involved in two of the four main reasons for the failure of a pesticide treatment. Correct application of a pesticide is thus crucial for it to be effective and provide an economic benefit for the farmer.

2. Brainstorming – Objectives of Using a Sprayer

15 minutes

Objective of the Procedure:

Participants understand:

- What we are actually trying to achieve when using a pesticide.
- The target for the pesticide
- The role of a sprayer in applying a pesticide

Remind participants that their homework assignment was to think about the following questions:

- What is the ultimate objective when we apply a pesticide to a crop? What are we really trying to do?
- What is the target we are trying to reach when we apply a pesticide?
- What basic function does a sprayer perform in helping us to achieve these objectives?

Ask participants in turn for their answer to the first question until there are no more responses. List the responses on the flipchart.

Repeat for the second and third questions.

Review the answers, using Handout 10.1, *Objectives of Using a Sprayer,* as a checklist.

Emphasise:

✔ That pesticides cost the farmer money. They must be applied effectively to give a return on his investment.

Conclude the procedure by emphasising:

✔ The four bullet points under "To be most effective".

Distribute Handout 10.1 to participants.

3. Presentation – Plant Coverage, Droplet Size, and Volume of Water

15 minutes

Objective of the procedure

- Participants understand the relationship between plant coverage, droplet size, and volume of water.

Present the contents of Handout 10.2, P*lant Coverage, Droplet Size, and Volume of Water*.

Ask:

- Is it better to use large or small amounts of water when spraying? Why?
- Are different amounts of water needed for different crops or pests? Why?

Distribute Handout 10.2 to participants

4. Interactive Discussion – Advantages and Disadvantages of Large and Small Droplet Sizes

15 minutes

Objective of the procedure

- To review the overall effects of droplet size on spray application.

Ask the following questions in turn, listing participant responses on the flipchart:

- What are the advantages of large droplets?
- What are the disadvantages of large droplets?
- What are the advantages of small droplets?
- What are the disadvantages of small droplets?

Review the results, using Handout 10.3, Advantages and Disadvantages of Large and Small Droplet Sizes, to fill in any gaps.

TRAINER NOTE: Refer back to Session 6, Procedure 6 and Handout 6.2, *Pesticide Classification*, to link droplet sizes and plant coverage with the Mode of Action of pesticides.

Ask:

- Is it important to use a large or small droplet size for the application of a herbicide? An insecticide? Why?

Distribute Handout 10.3 to participants.

5. Presentation and Discussion – Nozzles, and Sprayer Calibration and Maintenance

25 minutes

Objective of the procedure

Participants are aware of:

- The common types of nozzles, their characteristics, and uses.
- The importance of sprayer calibration and maintenance.

Ask:

- What are the three common types of nozzle?

Present the contents of Handout 10.4, *Nozzles*, using the sample nozzles as examples.

TRAINER NOTE:If no example nozzles are available, Handout 8.4a can be distributed instead.

Ask:

- How often do you see farmers using the wrong type of nozzle?

Present the contents of Handout 10.5, *Sprayer Calibration and Maintenance*.

Ask:

- How often do farmers calibrate their sprayer?

- Would the nozzle replacement interval also depend on the type of formulation being sprayed?

Distribute Handouts 9.4 and 9.5 to participants.

6. Interactive Discussion – Comparison of Different Sprayer Types

30 minutes

Objective of the procedure

- To illustrate the advantages and disadvantages of different sprayer types.

Explain that on the basis of what has been already discussed, we will now look at the different types of hand sprayers commonly used by farmers (by 'hand sprayer' we mean one that is physically carried by the operator).

TRAINER NOTE: This procedure assumes that local farmers are using hand sprayers. However, in certain areas / regions farmers may be using tractor mounted or towed sprayers. In such cases the procedure will need to be adjusted, although the principles and basic questions remain the same, eg tractor mounted boom vs airblast sprayers.

If no example sprayers are available, Handout 9.6a can be distributed instead.

Ask:

- What are the most common types of hand sprayer used by farmers?

List the answers as headings on separate flip charts.

Take the first sprayer type and ask:

- What are the advantages of this type of sprayer?
- What are disadvantages?

List the responses on the flipchart under the relative headings.

Repeat for the other types of sprayer.

Summarise the results, using Handout 10.6, *Advantages and Disadvantages of Different Sprayer Types*, as an example and to fill in any gaps.

Ask:

- What criteria should a farmer use when deciding to buy a sprayer?

Distribute Handout 10.6 to participants.

7. Conclusions

5 minutes

Review the major messages of the session.

Include as main messages:

- One of the four common reasons for the failure of a pesticide is concerned with application.
- Pesticides cost the farmer money. They must be applied effectively for him to obtain a return on his investment.
- Different volumes of water and droplet sizes are needed depending on several variables – crop and growth stage, pest type, and pesticide type.
- Different nozzle types give different droplet sizes and spray patterns – the correct nozzle type must be selected depending on the requirements of the application.
- Different sprayer types have advantages and disadvantages – the use to which they are to be put needs to be considered by the farmer before purchase.
- Regular sprayer calibration, maintenance and nozzle replacement are essential for effective pesticide application.

Refer participants to the IPM Circle

Say:

- We have now completed the IPM circle and explored all components.

Ask:

- What are the most important conclusions for you about IPM? Why?

Objectives of Using a Sprayer

The ultimate objective of using a pesticide is to:

- Protect the crop from economic damage or loss
- To do this in the most effective and economic way

  (Pesticides cost money – they must be used effectively to give the farmer a return on his investment)

The ultimate target of a pesticide is the pests

The intermediate target is usually the surface of the plant

A sprayer is used to break the spray mix up into droplets to be deposited on plant or other target surfaces so as to give adequate and even coverage

To be most effective:

- There must be even coverage of the pesticide droplets over both individual plants and the whole field.
- If the pesticide is not applied evenly, there will be areas of over- and under-dosing, which are ineffective and increase losses and costs.
- Particularly with underleaf pests (aphids, whitefly, some diseases, etc) there must be good coverage of the lower leaf surface for contact pesticides to be effective.
- If the target area is limited, for example aphids only in certain parts of the field or application to young seedlings, then spot- and band-spraying can save pesticide, water and time.

Plant Coverage, Droplet Size, and Volume of Water

The objective of using a sprayer is to get the pesticide to the target pest, not to drown the pests with water.

To achieve even plant and field coverage:

- It is the number of pesticide droplets deposited on the plant which is important, not the volume of water used.

If droplet diameter is halved, eight times as many droplets are formed from the same volume of spray mix.

If large droplets are produced by the sprayer:

- A large volume of water is needed to achieve the required number of droplets on the plant.

If small droplets are produced by the sprayer:

- A small volume of water is needed to achieve the required number of droplets on the plant.

Advantages and Disadvantages of Large and Small Droplets

Bait (B)Large Droplets		Small Droplets	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Less liable to drift			More liable to drift
Less likely to evaporate before hitting plant surface			More likely to evaporate before hitting plan surface
	Poor coverage of lower leaves and under-leaf surfaces	Better coverage of lower leaves and under-leaf surfaces	
	More liable to uneven field coverage	More even field coverage	
	Need larger volumes of water	Need smaller volumes of water	
	Run-off from plant surfaces	No run-off from plant surfaces	

- Large droplets are used for the application of herbicides so as to minimise drift
- Small droplets are used for the application of insecticides, acaricides and fungicides to optimise crop penetration and underleaf coverage

Nozzles

Full Cone / Hollow Cone 	- Produce a cone shaped spray. With cone nozzle, the full area of the cone has spray droplets, with hollow cone nozzle the droplets are only on the outside of the cone. - Full cone nozzles usually fitted only to air-blast sprayers or tractor boom sprayers, hollow cone nozzles used with hand operated equipment. - Droplet size tends to be small, and there is a risk of spray drift. - Used at higher pressures than flat fan or deflector nozzles. - Most commonly used for application of insecticides, acaricides and fungicides.
Flat Fan / Even Spray Flat Fan 	- Produce a fan shaped spray. - Droplet size tends to be large, with a low risk of spray drift. - Flat fan nozzles deposit most spray directly under the nozzle tip, so used on tractor mounted boom sprayers, where several nozzles can overlap, producing an even spray pattern. - "Even spray" flat fan nozzles produce an even deposit of spray across the fan, and are thus suitable for hand operated equipment. - Most commonly used for the application of herbicides. - May reduce the effectiveness of insecticide, acaricide and fungicide application.
Deflector 	- Also known as "flooding" or "anvil" nozzles. - Droplet size tends to be large, with a low risk of spray drift. - Give a relatively even deposit of spray across the fan. - Most commonly used for the application of herbicides. - May reduce the effectiveness of insecticide, acaricide and fungicide application.

Nozzles

Hollow Cone Nozzle

Flat Fan Nozzle

Deflector Nozzle

Sprayer Calibration and Maintenance

Sprayer Calibration

- Accurate calibration of a sprayer is essential to ensure that the correct amount of pesticide is applied to the target area.
- Involves measuring the output of the sprayer, the width of the spray pattern produced, and the speed at which the sprayer is moving over the ground.
- Once these factors are known, the amount of spray mix applied to the target area can be calculated.
- If necessary, adjustments can then be made to one or more of these factors (or to the mixing rate of the pesticide in the water or to the pressure), to ensure that the correct amount of pesticide is applied.

Sprayer Maintenance

- Regular maintenance is essential to ensure that the sprayer is working correctly, and for safety (no leaks).
- Nozzles should be replaced regularly – at least at the beginning of each season, more often if the sprayer is used frequently.
- Seals should be regularly checked for leaks, and replaced as necessary.
- A small toolkit (screwdriver and spanners of suitable sizes) should be available to effect immediate repairs. These are sometimes provided with the sprayer.

Comparison of Sprayer Types

Advantages	Disadvantages
Pressure (Compression) Sprayer Cheap purchase cost.	Pressure rapidly drops, with reduction in output and increase in droplet size.
Can be used for insecticides, fungicides, herbicides.	Requires frequent re-pumping to maintain pressure.
	Very low work rate (ha/day)
Hand operated knapsack Cheap to moderate purchase cost.	Low work rate (ha/day)
Low volume of water	Not suitable for use in orchards unless extension fitted to lance
Good coverage of plants and field	Cheaper versions have a short working life, and are prone to breakdowns and leaks.
Low operating costs	
Can be used for insecticides, fungicides, herbicides.	
Motorized knapsack mistblower Low volume of water	High purchase cost.
Good coverage of small plants and field.	Understanding of drift technique essential to obtain good coverage.
High work rate (ha/day)	Not suitable for use in tall crops and orchards unless additional spray mix pump fitted.
Not suitable for application of herbicides.	High operating costs.
	Liable to breakdown and requires high levels of maintenance.
	Higher risk of spray drift.

10 PESTICIDE APPLICATION

Advantages	Disadvantages
ULV Sprayer Cheap to moderate purchase cost.	Understanding of drift technique essential to obtain good coverage.
No water needed.	Hazards associated with application of concentrated formulations.
Good coverage of plants and field.	Moderate operating cost (needs batteries).
High work rate (ha/day)	Higher risk of spray drift.
Can be used for insecticides, fungicides, herbicides.	Different type of ULV sprayer needed for herbicides
	Not suitable for use in orchards.

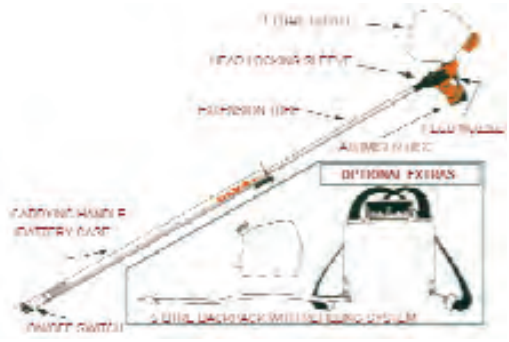
Sprayer Types

Pressure (Compression)

Hand operated knapsack

Motorized knapsack mistblower

ULV



8. Homework Assignments

Homework Assignment 1

- Ask three of the participants to prepare a 10 minute summary of the days activities, results and conclusions to present to the full group at the beginning of the next session as a reminder of today's activities.

Homework Assignment 2

Break the participants up into table groups and give the following homework assignment:

You are walking from one village to the next and come across a farmer behaving strangely. You suspect pesticide poisoning.

- What objects would you look for to help confirm your suspicion of pesticide poisoning?
- What symptoms in the victim would you expect to see?
- What actions would you take?

The groups should prepare their answers on flipcharts, ready for presentation the next day in Session 11.

TRAINER NOTE: Do NOT tell the participants about the first aid Role Play in Session 11.

The role plays are intended to put their group-prepared theoretical knowledge into practice - without warning, as would happen in real life.

If their first aid skills turn out to be in need of improvement, this is part of the self-evaluation and learning process.

TOXICITY, HEALTH AND SAFETY

11

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11 HEALTH AND SAFETY

Overview of the Session

This session introduces the basics of health and safety when using pesticides. It begins with a discussion on the relationship between pesticide hazard, exposure and risk. The next activity brainstorms the routes by which pesticides enter the body, and common causes of exposure. The trainer then gives a short presentation on the possible harmful effects of pesticides.

The workgroup homework assignment from Session 6 was to prepare flipcharts on symptoms of pesticide poisoning and first aid measures. All workgroup flipcharts are put up, but rather than a simple flipchart presentation, the trainer reviews only the symptoms of poisoning. The situation analysis and first aid measures developed by the workgroups are then enacted by volunteers in Role Plays, with the trainers taking the part of 'farmers', one of whom is suffering from pesticide poisoning. Trainers need to prepare for this activity before the session starts.

In the final activity, the trainer presents the essentials of protective clothing, and the full group brainstorms possible alternatives if specially made clothing is not available.

Session Objectives

By the end of the session, participants will be able to:

- Describe the relationship between pesticide hazard, exposure and risk.
- State the routes by which pesticides enter the body, common causes of exposure, and the harmful effects of pesticides.
- Describe the general symptoms of pesticide poisoning and how to give basic first aid to a victim.
- Select the correct protective clothing for a pesticide activity, and advise on possible alternatives if specially made clothing is not available.

Equipment and Learning Aids

- Food and drink (bread, biscuits, tea, water).
- Bottles of water.
- Pesticide container.
- Pesticide measuring / mixing equipment

TOTAL TIME: 2 hours 5 miuntes

1. Introduction to the Session

5 minutes

Welcome participants to Session 11. Briefly review the topics covered in the previous session.

Refer to the IPM Circle:

Say:

- In previous sessions we investigated the various components of IPM and how they are linked together. In this and the following session we will look at the possible risks of using pesticides to humans, animals, and the environment, and how these risks can be minimised.

Present the session objectives, and give a brief overview of the procedures.

2. Presentation / Discussion – Hazard, Exposure and Risk

10 minutes

Objective of the procedure:

- For participants to understand the meanings and the relationship between pesticide hazard, exposure and risk.

Ask:

- Have any participants seen or heard of anyone suffering from pesticide poisoning?

Say:

- We have all heard about farmers and others being poisoned by pesticides. Before we go into more detail of pesticide poisoning, we need to be aware of the principles underlying the risk from using a pesticide.

Present Handout 11.1, *Hazard, Exposure and Risk*.

Ask if participants have any questions.

Distribute Handout 11.1 to participants.

3. Brainstorming / Discussion – Ways in Which Pesticides Enter the Body

15 minutes

Objective of the procedure:

- Participants know the main routes through which pesticides enter the body.
- Participants are aware of common causes of pesticide exposure.

Ask:

- What are the main routes through which pesticides can enter the body?
- What would be common reasons for pesticides to enter the body through these routes?

As participants give their responses to the first question, put the routes on the flipchart as main headings.

As they give responses to the second question, list the reasons under the headings.

When there are no more responses, use Handout 11.2, Routes of Exposure and Common Causes, as a checklist to fill any gaps.

Emphasise:

✔ The most common route of exposure is dermal (through the skin).

✔ The primary safety consideration is to avoid exposure.

Distribute Handout 11.2 to participants.

4. Presentation – Harmful Effects

10 minutes

Objective of the procedure:

- Participants understand the three main types of harmful effects to humans of pesticides.

Present Handout 11.3, *Harmful Effects*.

Ask if participants have any questions.

Distribute Handout 11.3 to participants.

5. Review of Homework Assignment – General Symptoms of Poisoning

15 minutes

Objective of the procedure:

- Participants are able to recognise the general symptoms of pesticide poisoning.

Remind participants that their homework assignment at the end of Session 10 was:

You are walking from one village to the next and come across a farmer behaving strangely. You suspect pesticide poisoning.

- What objects would you look for to help confirm your suspicion of pesticide poisoning?
- What symptoms in the victim would you expect to see?
- What actions would you take?

Ask the workgroups for the homework assignment to put up their posters, but they should not present the results.

Review their responses to the second homework question, 'What symptoms would you expect to see', using Handout 11.4, *General Symptoms of Acute Pesticide Poisoning*, as a checklist of symptoms, correcting and adding as necessary.

6. Role Play – Basic First Aid

40 minutes

Objective of the procedure:

- Participants are able to give basic first aid and take the correct actions.
- This knowledge is tested in a practical situation.

Say:

- We have now covered the general symptoms of pesticide poisoning from your homework assignment. However, the assignment had two additional questions, and we will now cover these, particularly First Aid.

Ask:

- Which group would like to go first?

When one group has volunteered, ask their presenter to step outside the room for a few minutes.

TRAINER NOTE: The trainers need to prepare for these role plays in advance with the necessary materials.

ROLE PLAY #1 – CONTAMINATED FOOD.
You will need some food and drink (eg bread, biscuits, tea), some water in a bottle, and a clean pesticide container.

ROLE PLAY #2 – PESTICIDE SPLASHED IN THE EYE DURING MIXING.
You will need some water in a bottle, some pesticide measuring equipment, and a clean pesticide container.

Explain to the remaining participants that the homework assignment was not just about preparing flipcharts, but to think about first aid procedures and actions. Rather than a simple flipchart presentation, we are going to 'present' practically through a Role Play.

Emphasise:

✔ The role plays are intended to put their group-prepared theoretical knowledge into practice – without warning, as would happen in real life.

✔ If their first aid skills turn out to be in need of improvement, this is part of the self-evaluation and learning process.

Ask who would like to play the roles of a poisoning victim and his friend in the first role play.

Role Play #1:

The two volunteers should set themselves up as 'farmers' having a break from spraying, and eating and drinking. One 'farmer' should pretend to be suffering from poisoning (nausea, dizziness, confused, etc). The other 'farmer' should be ready to answer questions and help the group presenter administer first aid.

Ask the group presenter to come into the training room so that he is immediately presented with the poisoning situation. The unaffected 'farmer' should say to the presenter that there is something wrong with his friend, but he does not know the reason. Ask for the participant's help.

Let the participant then take over and administer first aid to the affected 'farmer'.

Role Play Debrief:

Ask the other participants:

- Did the volunteer analyse the situation correctly?
- Did he take the correct first aid actions?
- Would they have done anything differently?

Ask for another participant to volunteer for Role Play #2, and again ask them to leave the room.

Ask for another two volunteer 'farmers' from the other participants.

Role Play #2:

The volunteers should set themselves up as 'farmers' who are mixing a pesticide ready for spraying. One 'farmer' should pretend to be suffering from pesticide splashed in the eye (burning eye, dizziness, confused, etc). The other 'farmer' should be ready to answer questions and help the participant administer first aid.

Ask the other volunteer to come into the training room so that he is immediately presented with the poisoning situation. The unaffected trainer should say that his friend has splashed pesticide in his eye, and to ask for the volunteer's help.

Let the volunteer take over and administer first aid to the affected 'farmer'.

Role Play Debrief:

Ask the other participants:

- Did the volunteer analyse the situation correctly?
- Did he take the correct first aid actions?
- Would they have done anything differently?

Review Handout 11.5, *Basic First Aid*, pointing out where the volunteers followed the correct first aid actions, and what they and the other participants may have missed.

Distribute Handouts 11.4 and 11.5 to participants.

Emphasise:

✔ This activity, Handout 11.5, and the Handbook cover basic first aid only.

✔ Encourage participants to learn about additional first aid measures after the course, such as artificial respiration, when and how to induce vomiting if necessary, or how to treat an unconscious person.

TRAINER NOTE: Handout 9.5 contains some sources of information and advice on the treatment of pesticide poisoning.

It would be useful to look up local telephone numbers for poison control centres, doctors and hospitals prior to the start of the course, so that these can be given to participants together with Handout 10.5.

Also, encourage participants to establish contacts with local doctors and hospitals and for them to provide these with the sources of information on the specific treatment of individual pesticides.

7. Presentation / Brainstorming – Protective Clothing

20 minutes

Objective of the procedure:

- Participants understand the importance of protective clothing.
- Participants are aware of alternatives to purchased protective clothing.

Present Handout 11.6, *Protective Clothing*.

Ask:

- Farmers very often do not use protective clothing because none is available or it is expensive. What alternatives could they use to protect themselves from exposure to pesticides?

Write participant responses on the flipchart, using Handout 11.7, *Alternatives to Specially Made Protective Clothing*, as a checklist.

Distribute Handouts 11.6 and 11.7 to participants

8. Conclusions

5 minutes

Review the major messages of the session.

Include as main messages:

- The primary consideration to reduce risk when handling or using a pesticide is to avoid exposure.
- The most common route of exposure is through the skin.
- Many of the symptoms of pesticide poisoning are similar to illnesses – anyone who has been handling pesticides and develops symptoms should see a doctor.
- Participants should familiarise themselves with local emergency numbers and establish contacts with doctors and hospitals.
- Protective clothing only protects if it is undamaged and clean.

Refer participants to the IPM circle.

Ask:

- Can the knowledge of IPM we have gained in previous sessions help with health and safety aspects?
- How?

Review the session objectives and ask if they were met.

Hazard, Exposure and Risk

Hazard is the inherent property of substance to cause adverse effects.

Exposure is the amount of time a person is in contact with the substance, or how much they get on their body.

Risk is the probability of adverse effects from using the substance, and is the combination of Hazard and Exposure.

RISK = HAZARD X EXPOSURE

Every time a pesticide is used, there is an associated **Risk**:

Risk depends on the hazard of the pesticide combined with exposure during the conditions under which the pesticide is handled or used.

A pesticide formulation has an inherent hazard. To reduce the risk:

RISK REDUCTION = EXPOSURE REDUCTION

Routes of Exposure and Common Causes

Dermal through the skin, or the eyes.

Inhalation breathing into the lungs through the nose or mouth.

Oral swallowing through the mouth.

Common Causes of Pesticide Exposure

Dermal	Eyes	Inhalation	Oral
Not washing hands after handling pesticides or containers	Rubbing eyes or forehead with contaminated gloves or hands	Handling pesticides in confined or poorly ventilated areas	Not washing hands before eating, drinking or smoking
Splashing or spilling pesticide on the skin	Splashing pesticide in the eyes	Handling dusts or powders	Splashing pesticide into the mouth
Wearing contaminated clothing	Pouring dry formulations without wearing goggles	Using an inadequate or poorly fitting respirator	Storing pesticide in drink bottles
Being exposed to pesticide drift	Being exposed to pesticide drift	Being exposed to pesticide drift	Accidentally applying pesticide to food
Applying pesticides in windy weather	Applying pesticides in windy weather	Applying pesticides in windy weather	
Leaking sprayers			
Touching treated plants, livestock or soil			

✔ The primary safety consideration is to AVOID exposure

See also CropLife International Guidelines for the safe and effective use of crop protection products: www.croplife.org

Harmful Effects

Acute	Occur immediately after exposure, within minutes or hours.	- Poisoning symptoms (see Handout 10.4). - Physical effects: - Mouth, throat, stomach burnt. - Lungs burnt. - Eyes burnt. - Skin blistered, cracked.
Delayed	Take time to appear, may be years after exposure. Usually caused by repeated exposure, but may be due to single exposure.	- Cancer. - Damage to internal organs.
Allergic	Affect some people, but not all. Usually require repeated exposure before they appear.	- Asthma (difficulty in breathing). - Skin irritation (rashes, blisters, sores). - Eye irritation (itching, watering) - Nose irritation (sneezing)

- Possible effects are intensely studied prior to product registration, particularly the first two (allergic effects often depend on an individual person's reaction to exposure). High doses are used with test animals to determine what possible short and long term effects might occur.
- These risks are accounted for when a product is registered.
- Provided the label recommendations for the handling and use of the product are followed, the potential effects are not expected to occur.

General Symptoms of Acute Pesticide Poisoning

General Symptoms

Many of the symptoms of acute pesticide poisoning are similar to illnesses, such as flu or food poisoning.

Anyone who has been handling pesticides and develops suspicious symptoms should see a doctor, taking the pesticide container with them.

Depending on the pesticide and amount of exposure, only some of the symptoms may appear, and individual symptoms may appear at different times after the exposure.

Initial Symptoms:	Nausea, vomiting
	Headache, dizziness
	General weakness or tiredness
	Tightness in the chest
Later Symptoms:	Excessive sweating, salivation
	Vomiting, diarrhea
	Stomach cramps
	Muscle twitches, cramps, aches
	Blurred vision
	Confusion
	Fits or unconsciousness

Basic First Aid

First Aid is the initial treatment of an affected person, before seeking proper medical attention.

Follow the product label instructions on first aid if available

The **First Action** is to remove the person from the source of exposure by removing pesticide from the skin, removing contaminated clothing, or getting the person to fresh air. While doing this, be careful not to contaminate yourself.

Pesticide on the Skin (follow label instructions if available)

- Drench skin and clothing with plenty of water.
- Remove contaminated clothing.
- Wash hair and skin with soap and water. If available, a shower is the best way to thoroughly wash and rinse the whole body.
- Dry the victim, and wrap in a blanket or any clean clothing. Do not allow the victim to become chilled or overheated.
- If the skin is burned, or otherwise injured, cover immediately with a loose, clean, dry, soft cloth or bandage.
- Do not apply ointments, greases or powders to burns or injured skin.

Pesticide in the Eye (follow label instructions if available)

- Wash the eye(s) quickly but gently.
- Hold the eyelid open and wash with a gentle drip of water flowing across the eye rather than directly onto it. If a tap is not available, a tea pot, or similar, can be used.
- Rinse for 10 minutes or more.
- Do not use chemicals in the rinse water.

Pesticide Inhaled (follow label instructions if available)

- Get the victim to fresh air immediately.
- Warn other people in the area of the danger.
- Loosen tight clothing that would restrict breathing.

Pesticide Swallowed (follow label instructions if available)

- Repeatedly rinse mouth with plenty of water.
- Do not induce vomiting if you can get the victim to a doctor within one hour.
- Never induce vomiting if the victim is unconscious or having convulsions
- Never induce vomiting if the victim has swallowed a corrosive poison, as it will burn the throat and mouth as severely coming up as it did going down. It may also get into the lungs and cause burning there. Similarly, never induce vomiting if an emulsifiable or oil solution has been swallowed, as these can cause death if inhaled during vomiting.

Take the affected person to a doctor as quickly as possible, taking the pesticide container or label.

Sources of information / advice on pesticide poisoning:

- **The pesticide label**
- The pesticide manufacturing / importing company (information on the label)
- Local emergency phone numbers – doctors, hospitals, etc
- Local poison control centres. Worldwide poison centre locations can be found at the WHO website: http://www.who.int/ipcs/poisons/centre/directory/en/index.html
- Pesticide poisoning diagnostic tool (to identify pesticide from poisoning symptoms): http://www.pesticideinfo.org/Search_Poisoning.jsp#Identify
- WHO training manuals on pesticide poisoning (intended for medical staff): http://www.who.int/ipcs/poisons/training_manual/en/index.html
- US EPA Recognition and management of pesticide poisonings: http://www.epa.govv?opp00001/healthcare/handbook/handbook.htm
- Specific medical treatment for individual pesticides: http://www.intox.org/databank/pages/chemical.html http://www.inchem.org/pages/pims.html

Protective Clothing

✔ Protective Clothing is clothing and other devices worn to keep pesticides away from the body and minimise exposure.

✔ The minimum amount to wear for an activity is given on the label.

✔ Protective clothing only protects if the pesticide remains on the outside.

✔ Torn, damaged, or broken protective clothing must not be worn, as pesticide can enter and be trapped next to the skin.

✔ Body Protection
- Overalls, collar fastened.
- Cotton or canvas hat, preferably with wide brim.

✔ Hand and Foot Protection
- Rubber gloves and boots when handling concentrates.
- Gloves and boots should be unlined. Fabric lining can trap pesticide and is impossible to clean.
- Trousers outside boots, not tucked inside.

✔ Eye and Face Protection
- Safety glasses or goggles when there is a risk of dusts or mists, such as mixing dry formulations and spraying.
- Face shields when there is a risk of splashing, such as mixing liquid formulations.

✔ Inhalation Protection
- Dust or mist masks that cover the nose and mouth when there is a risk of dusts or mists.
- Must be disposed after use.
- Respirators (face piece with filter canisters attached) usually only needed for specialised operations, or when mixing and applying more toxic products.

See alsoCropLife International Guidelines for personal protection when using crop protection products in hot climates: www. croplife.org

All protective clothing must be washed or cleaned after use.

Alternatives to Specially Made Protective Clothing

Specially made protective clothing is not always available, or is expensive. Other approaches which have been used include:

✔ Body Protection
- Long sleeved shirt and trousers.
- Shirt collar fastened, sleeves down, cuffs buttoned.
- Baseball hat.

✔ Hand and Foot Protection
- Strong plastic bag on each hand.
- For spraying operations only, canvas shoes.

✔ Eye and Face Protection
- Sunglasses or glasses (only give minimal protection).

✔ Inhalation Protection
- For spraying operations only, a cloth tied over the nose and mouth.

All protective clothing must be washed or cleaned after use.

ENVIRONMENTAL ASPECTS

CropLife INTERNATIONAL

www.croplife.org

12

12 THE ENVIRONMENT AND CONSUMER PROTECTION

Overview of the Session

The purpose of this session is for the participants to understand what is meant by the environment, how pesticides can get into the environment, and the adverse effects of pesticides in the environment.

The session begins with a full group interactive discussion about the homework assignment, which was that participants write down what they think is the environment, what it includes, and why we should protect the environment. This discussion among peers sets the tone for Session 12.

The next table group task in the session asks participants to rate the "degree of problem" of farmer practices that cause or potentially cause environmental contamination. The participant outputs of this activity are further explored in the form of "what if" situations to enable participants to practice correct advice that should be given to farmers so as to avoid environmental contamination. Finally, participants explore means by which any adverse effects of pesticides on food and on consumers can be minimised and how IPM can assist in this.

Session Objectives

By the end of the session, participants will be able to:

- Define the meaning of the word “environment.”
- Identify potential sources of pesticide contamination into the environment based on current knowledge of farmer practices, and how pesticides can move in the environment.
- Describe sensitive areas in the environment.
- Explain the concept of residues on food crops and pre-harvest intervals.
- Give advice on the appropriate practices for preventing pesticide contamination of food.

TOTAL TIME: 2 hours 5 miuntes

12 THE ENVIRONMENT AND CONSUMER PROTECTION

1. Introduction to the Session

10 minutes

Welcome participants to Session 12 and the last day of the course.

Ask the three volunteers to review the previous day's activities, results and conclusions from sessions 9 to 11.

Refer to the IPM Circle:

Say:

- In our sessions on chemical control we identified that a risk is involved with pesticide use. In this session we will look at the possible risks to the environment and consumers, and how these risks can be minimised or avoided.

Present the session objectives, give a brief overview of the procedures, and explain that all handlers and users of pesticides have a responsibility to protect the environment and consumers.

2. Working Groups – Sources of Contamination

15 minutes

Objective of the procedure:

- To reflect on common sources of pesticide contamination.

Say

- Good advice is based on good observation and understanding of farmer practices. Say that we want to explore what they currently know about farmer practices with pesticides that could be contaminating the environment.

Working Group Task

1) Consider the potential sources of contamination we identified in the last activity:
   (a) Storage and mixing sites
   (b) Excess spray application leading to run-off
   (c) Spray drift
   (d) Washing water – personal, equipment, clothing
   (e) Spills
   (f) Improper disposal of containers
   (g) Left-over pesticide mix

2) Using a 1-5 scale, with "1" being "No Problem" and 5" being "Major Problem," agree as a group on a rating of farmer practices for potential sources of contamination.

3) Include examples where you have actually seen farmer practices which have contaminated the environment and which determined your group's ratings.

3. Working Group Reports

20 minutes

Ask each group to present their ratings for each potential source of contamination.

If there are any big differences in ratings between the groups, ask why.

Summarise the most common / highest ratings. Say that we will come back to these practices and examples later in the session.

4. Interactive Discussion – Pesticide Movement in the Environment, and Sensitive Areas

10 minutes

Objective of the procedure:

- To identify the possible ways that pesticides can move through the environment.
- To identify areas particularly sensitive to pesticide contamination.

Ask:

- What are the possible ways that pesticides can move from the source of contamination into the environment?

Add to participant responses by referring to the contents of Handout 12.2, *Pesticide Movement in the Environment*.

Ask:

- What are especially sensitive areas in the environment where we would not want to see pesticide contamination?

Add to participant responses by referring to the contents of Handout 12.3, *Sensitive Areas*.

5. Interactive Discussion – Pesticide Residues and Pre-Harvest Intervals

10 minutes

Objective of the procedure:

- To understand the concepts of pesticide residues on food, and the factors which affect the length of the pre-harvest interval.

Continue the discussion from Procedure 6 and explain the concept of residues on food crops from Handout 12.3, *Residues on Food Crops*.

Remind participants that pre-harvest intervals are specified on the pesticide container label, as discussed in Session 9, Procedure 5.

Ask:

- Assuming the pesticide had been applied correctly, following all the recommendations, what would be the factors which would determine the length of the pre-harvest interval?

After some discussion of these questions, summarize by emphasizing the key points from the contents of Handout 12.3, *Pre-Harvest and Re-Entry Intervals*.

Distribute Handouts 12.2 and 12.3 to participants.

6. "What if" Situations from Examples of Farmer Practices – Advice on Correct Practices

20 minutes

Objective of the procedure:

- To consolidate the knowledge gained in the above procedures;
- To further refine participant skills in dealing with farmers.

Refer to the flipchart results from Activity 4 where examples of farmer practices that participants had seen as sources of contamination were recorded.

Take one example and say:

- What if you observed a farmer... (e.g., emptying a sprayer in, or close to, a canal). What advice would you give the farmer on the potential effects of his actions, and how to minimise environmental contamination?

Take a response from one participant, and ask if anyone would give different advice.

Repeat for two or three more examples from the flipchart.

7. Interactive Discussion – Consumer Protection

15 minutes

Objective of the procedure:

- To reflect on how consumers can be protected from any adverse affects of pesticides, using the knowledge gained throughout the course.

Explain that, using the knowledge gained throughout the course about pesticides and pesticide use, we will now reflect on how the effects of pesticides on the food we eat and on consumers can be minimized.

Ask:

- How can farmers best avoid any adverse effects of pesticide residues on food?

List participant answers on the flipchart.

Summarise the results, using Handout 12.4, *Consumer Protection, as a checklist*.

Emphasise:

✔ Residues on food crops can be minimised or avoided, and consumers protected, by following IPM principles.

Distribute Handout 12.4 to participants.

8. Conclusions

5 minutes

Review the major messages of the session.

Include as main messages:

- The environment is everything around us and we are dependent on it for our survival.
- Since we bring pesticides into the community, we have a responsibility to ensure they are used correctly to protect the environment for our children, families and animals.
- We can best protect the environment and consumers of our produce by following the principles and practices of IPM.

Ask:

- What information about pesticides and the environment was most meaningful for you today?

The Environment

Includes everything around us

- "Natural" elements – soil, water, air
- Plants, animals, indoors / outdoors, houses, gardens, offices, etc,

We are dependent on the environment for our survival

Sources of Environmental Contamination

- Storage and mixing sites
- Excess spray application leading to run-off
- Spray drift
- Washing water – personal, equipment, clothing
- Spills
- Improper disposal of containers
- Left-over pesticide mix

Pesticide Movement in the Environment

Volatilisation from treated surfaces

Drift during application

Washing from treated surfaces to the ground / soil

- Rain
- Dew
- Overhead irrigation

Incorporated into the soil with crop residues

Removal from field as residues on crop surfaces

- Vegetables
- Fodder
- Fuel

Removal from the field on contaminated equipment

- Spraying and mixing equipment
- Clothing
- Containers

Carried across the field in irrigation water

Leaching through the soil into ground water

Sensitive Areas

Indoors

- All areas where people – especially children, pregnant women, elderly, sick – live, work or are cared for.
- Places where food is processed, stored, prepared or eaten.
- Places where domestic animals are kept, live and eat.

Outdoors

- Areas near open / surface water
- Where ground water is near the surface
- Near schools, playgrounds, hospitals
- Where honey-bees are active
- Near non-target gardens, food or fodder crops

Residues on Food Crops

- Pesticides are applied to food crops to protect them from loss and damage
- These pesticides leave a residue which could be hazardous if the crop is eaten

Pre-Harvest and Re-Entry Intervals

- The Pre-Harvest Interval is the period in days between the pesticide application and harvest so as to allow time for the pesticide to degrade
- Length of pre-harvest interval depends on the toxicity of the pesticide and its rate of degradation or persistence
- Intervals are longer for pesticides of high toxicity and with slow rates of degradation
- With any crop, the Re-Entry Interval specified on the pesticide label should be observed before entering a treated crop – put up signs, warn people that the field has been treated

Consumer Protection

Farmers

- ✔ Read the product label for any particular precautions to take
- ✔ Use all appropriate practices to manage pests
- ✔ Use pest scouting and treatment spray thresholds for pesticide applications
- ✔ Use only the recommended pesticides at the correct dose for the crop / pest
- ✔ Apply pesticides effectively and efficiently
- ✔ Avoid pesticide drift when spraying so as to avoid contaminating other crops
- ✔ Dispose of empty pesticide containers and left-over spray mix safely so as to avoid contaminating other crops
- ✔ Observe the pre-harvest interval

IN OTHER WORDS:
FOLLOW THE PRINCIPLES AND PRACTICES OF IPM!

Course Participants

- ✔ With the knowledge of IPM obtained from this course, be prepared to explain to consumers in the community that pesticides are an integral part of crop production and offer no risk when they have been handled and applied correctly.

POST-COURSE TRAINEE EVALUATION

CERTIFICATE PRESENTATION

COURSE CLOSURE

CropLife INTERNATIONAL

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13

13 POST-COURSE EVALUATION

Overview of the Session

During Session 1 the participants sat a pre-course evaluation to assess their level of IPM knowledge prior to attending the course. The first participant activity of this session is to sit the same test again so as to evaluate their change in knowledge as a result of the course. It was for this reason that participants did not receive their pre-course test papers back following the pre-course evaluation in Session 1.

Participants then complete a course evaluation questionnaire while the trainers mark the papers, after which the pre- and post-course marks are given to the participants and they receive both sets of answer papers.

Certificates are then presented to the participants showing their attendance at the course. The presentation could be by the trainers, or perhaps by an invited local Ministry of Agriculture, Health or Environment official, or a representative of a private sector pesticide, agrochemical, or farmer association.

Following the presentation of Certificates, the course is officially closed.

Session Objectives

By the end of the session, **Participants** will be able to:

- Evaluated their changes in knowledge of IPM.
- Received a Certificate of Attendance and a copy of the Handbook.
- Established networking contacts with other participants if these did not previously exist.

By the end of the session, **Trainers** will have:

- Evaluated individual participant changes in knowledge of IPM.
- Received feedback from participants on the structure and contents of the course, and any suggestions they have for improvement.
- Established networking contacts with the participants if these did not previously exist.

TOTAL TIME: 2 hours 10 miuntes

13 POST-COURSE EVALUATION

1. Introduction to the Session

5 minutes

Welcome participants to the final Session of the course.

Present the session objectives, and give a brief overview of the procedures.

2. Course Summary

10 minutes

Objective of the procedure:

- To summarise the main course messages for participants.

Say:

- The formal part of this IPM course is now completed.
- You hope that the participants have increased their understanding and knowledge of IPM – and enjoyed themselves in the process.
- Thank all the participants for their enthusiasm, contributions, and involvement.

Refer participants to the IPM Circle for a summary of the final course messages:

Say:

- We have completed the IPM circle and explored all components.
- We have discovered that IPM involves using all appropriate crop and pest management practices to reduce pests and damage to an acceptable level.
- IPM is farmer based, it takes economics into consideration, it optimises input use, maximises yield, and minimises negative effects.
- IPM starts with growing a healthy crop.
- IPM is not a fixed package of recommendations, but must be flexible with the methods utilised depending on the local situation and farmer resources.
- We have also looked at safety, environment, and consumer protection, which are all enhanced by following IPM principles.
- IPM avoids or minimises the possible risks associated with chemical control.
- IPM provides for sustainable farming systems, and protects the environment on which we depend for our survival.
- We have also discovered that providing farmers with practical, effective, simple and beneficial advice on IPM principles can be of benefit to us in our work by developing increased trust.

Review the Overall Goals of the training course from Session 1.

Ask the participants:

- Have these Overall Goals of the training course been met?

3. Post-Course Evaluation

30 minutes

Objective of the procedure:

- To evaluate participant's changes in knowledge of IPM after attending the course.

Distribute Handout 13.1, *Post-Course Evaluation*.

This is a same multiple choice evaluation with 25 questions as given in Session 1, Procedure 4. Ask the participants to put a tick or cross in the box next to what they think is the correct answer to the question.

Allow 20 minutes for the participants to complete the test, then collect the papers. Make sure that the participants have written their names on the papers.

4. Participant Course Evaluation, Networking, and Marking of Papers

30 minutes

Distribute the compiled list of participant contact details prepared from Handout 1.4, distributed in Session 1. Ask participants to check that their details are correct.

Distribute Handout 13.2, *Participant Course Evaluation*.

Say that participants can now have a short break while you mark the papers.

Ask them to complete Handout 13.2 during this break. Ask one of the participants to collect the completed questionnaires while you are marking the post-course papers.

Encourage them to establish longer term relationships and contacts during this period (if they have not already done so) as these could be valuable in the future, particularly if participants are from both the public and private sectors.

Mark the papers.

5. Evaluation Results

20 minutes

Present the post-course evaluation results to participants. Compare these to the pre-course results, congratulating those who have made good progress, particularly those who had low marks at the start of the course and who have improved their results.

Give each participant both sets of their answer papers.

TRAINER NOTE: In certain countries, public announcement of the results could be sensitive to participants. In these circumstances the trainers should use their local knowledge to decide how best to present the results, if at all.

It is important, however, that individual participants receive their marked pre- and post-course papers so that they can self-evaluate their progress as a result of the course

Ask the participants:

- Has the course helped them to understand what is meant by IPM and how it is implemented?
- Will this knowledge be of benefit to them?
- How will they use this knowledge?
- Now that they have the results, will the pre-and post-course evaluation help them to identify their knowledge strengths and where these could be improved?
- If this was their first experience of participatory training, what they liked / did not like about the training method.

TRAINER NOTE:The trainers should make a note of the responses to these questions. They will be useful in their course evaluation, and also if necessary to make adjustments in the messages and means of transmission in subsequent courses.

13 CERTIFICATE PRESENTATION AND COURSE CLOSURE

6. Presentation of Certificates and Handbook

30 minutes

Present the Certificates of Attendance and a copy of the Handbook to participants, either by the Trainers or by an invited government or private sector representative.

If the latter, thank them for their interest and attendance, and give them time for a short speech.

7. Course Closure

5 minutes

Officially close the course.

Again thank participants for their contributions, and the public or private sector representative if they are present.

13 POST-COURSE EVALUATION

Handout 12.1

Participant Name _____

1 A weed is defined as a plant which:

- [ ] a) Injures humans, domestic animals, useful plants, structures or possessions.
- [ ] b) Annoys humans or animals.
- [ ] c) Is growing where it is not wanted.

2 Cultural control includes, among others, the following method:

- [ ] a) Time of planting
- [ ] b) Chemical pest control
- [ ] c) Release of natural enemies of pests

3 Crop rotation is a form of:

- [ ] a) Cultural control
- [ ] b) Mechanical control
- [ ] c) Sanitation

4 One of the foundations of a successful IPM programme is:

- [ ] a) Breeding and releasing natural enemies of pests.
- [ ] b) Using resistant varieties.
- [ ] c) Good crop management to produce a healthy crop with a high yield potential

5 Excessive rates of fertiliser applied to a crop can:

- [ ] a) Reduce crop growth.
- [ ] b) Encourage insect pests and diseases.
- [ ] c) Increase the farmer's profits.

6 Repeated cultivation of the same crop on the same field:

- [ ] a) Ensures optimal uptake by the plant of the fertilisers applied
- [ ] b) Increases the risk of the build-up of soil pests, weeds and diseases
- [ ] c) Promotes higher yields

7 Cultivating resistant varieties means:

- [ ] a) Pesticide use has to be increased
- [ ] b) Less chemical control measures may be necessary
- [ ] c) The risk of pest attack is higher.

13 POST-COURSE EVALUATION

8 Natural enemies of pests are:

- [ ] a) More common in fields which have not been sprayed with pesticides
- [ ] b) Favoured by increased pesticide use
- [ ] c) Reduced by high rates of fertiliser

9 Integrated pest management:

- [ ] a) Is a corrective technique which relies on pesticides.
- [ ] b) Uses all available techniques in an overall crop / pest management programme.
- [ ] c) Prohibits the use of pesticides in crop production.

10 Which of the following practices would be part of an IPM programme.

- [ ] a) Repeated cultivation of the same crop in the same field.
- [ ] b) Applying as much irrigation water as possible during the season.
- [ ] c) Planting a resistant crop variety

11 The place of pesticides in integrated pest management is:

- [ ] a) Pesticides should not be used in an integrated pest management programme.
- [ ] b) One of the available tools in an overall crop and pest management programme.
- [ ] c) To provide a quick solution to a pest problem.

12 What does pesticide resistance mean

- [ ] a) The inherited ability of a pest to tolerate the toxic effects of a pesticide.
- [ ] b) The extended effect of a pesticide against a pest after application.
- [ ] c) The inherited ability of a plant to withstand the effects of pest infestation.

13 What is the first thing you should do when you see a pest infestation in a crop.

- [ ] a) Select the correct pesticide for the pest.
- [ ] b) Identify the pest so that you know exactly what the problem is.
- [ ] c) Determine if the pest level is high enough to need spraying.

14 The use of a pesticide dose lower than that recommended for a specific pest:

- [ ] a) Saves the farmer money
- [ ] b) Protects beneficial insects
- [ ] c) Fails to control the target pest

13 POST-COURSE EVALUATION

15 One of the most common causes of the failure of a pesticide application is:

- [ ] a) Using out-of-date pesticide.
- [ ] b) Using the wrong pesticide.
- [ ] c) The pests have developed resistance to the pesticide.

16 A systemic pesticide is most suitable for the control of:

- [ ] a) Pests which suck the juices of plants.
- [ ] b) Pests which live in the soil and feed on roots.
- [ ] c) Pests which eat the leaves of plants.

17 The crops, pests and dose rate information given on the label:

- [ ] a) Are only some examples of possible uses of the product.
- [ ] b) Restricts the use of the product to the specified crops, pests and dose rates.
- [ ] c) Indicates the most common uses of the product.

18 Gloves should be worn when mixing pesticides:

- [ ] a) To avoid getting dirty hands
- [ ] b) To avoid contamination from pesticides which can be absorbed through the skin
- [ ] c) To be able to eat after the operation without washing the hands

19 The hazard of a pesticide is:

- [ ] a) The inherent property of the pesticide to cause adverse effects.
- [ ] b) A measure of how poisonous the pesticide is.
- [ ] c) The amount of time a person is in contact with the pesticide.

20 The most common way in which pesticides enter the body is:

- [ ] a) Through the mouth
- [ ] b) Through the lungs.
- [ ] c) Through the skin

21 The pesticide formulations which are absorbed most readily are:

- [ ] a) Emulsifiable concentrates
- [ ] b) Wettable powders
- [ ] c) Granules

13 POST-COURSE EVALUATION

22 The minimum amount of protective clothing to wear for a specific pesticide formulation and activity is:

- [ ] a) Overalls.
- [ ] b) Overalls and rubber gloves.
- [ ] c) Given on the label of the pesticide container.

23 During application, pesticide contamination of the environment can be minimised by:

- [ ] a) Using a low dose rate of the pesticide.
- [ ] b) Avoiding excess application and run-off from the plants.
- [ ] c) Placing warning signs around the treated area.

24 The environment is:

- [ ] a) Air, soil, water.
- [ ] b) Air, soil, water, plants, animals, houses.
- [ ] c) Everything around us.

25 A pre-harvest interval between the last pesticide application and harvest is to:

- [ ] a) Allow time for the pesticide to degrade.
- [ ] b) Allow time for the pesticide to kill all pests.
- [ ] c) Allow time for the crop to fully ripen.

Participant Course Evaluation

	Excellent	Good	Average	Poor	Very Poor
Training method					
Course contents					
Course structure					
Training venue					
Trainer skills					
Trainer knowledge					
Food					
Accommodation					
Did the course meet your expectations?					
Has the course been of benefit to you?					
What did you like best about the course?					
What did you like least about the course?					
How could the course be improved?					
Any other comments					

13 PRE- AND POST-COURSE EVALUATION – ANSWERS

DO NOT GIVE THIS TO THE PARTICIPANTS!!!

1 A weed is defined as a plant which:

- [ ] a) Injures humans, domestic animals, useful plants, structures or possessions.
- [ ] b) Annoys humans or animals.
- [X] c) Is growing where it is not wanted.

2 Cultural control includes, among others, the following method:

- [X] a) Time of planting
- [ ] b) Chemical pest control
- [ ] c) Release of natural enemies of pests

3 Crop rotation is a form of:

- [X] a) Cultural control
- [ ] b) Mechanical control
- [ ] c) Sanitation

4 One of the foundations of a successful IPM programme is:

- [ ] a) Breeding and releasing natural enemies of pests.
- [ ] b) Using resistant varieties.
- [X] c) Good crop management to produce a healthy crop with a high yield potential

5 Excessive rates of fertiliser applied to a crop can:

- [ ] a) Reduce crop growth.
- [X] b) Encourage insect pests and diseases.
- [ ] c) Increase the farmer's profits.

6 Repeated cultivation of the same crop on the same field:

- [ ] a) Ensures optimal uptake by the plant of the fertilisers applied
- [X] b) Increases the risk of the build-up of soil pests, weeds and diseases
- [ ] c) Promotes higher yields

7 Cultivating resistant varieties means:

- [ ] a) Pesticide use has to be increased
- [X] b) Less chemical control measures may be necessary
- [ ] c) The risk of pest attack is higher.

13 PRE- AND POST-COURSE EVALUATION – ANSWERS

8 Natural enemies of pests are:

- [X] a) More common in fields which have not been sprayed with pesticides
- [ ] b) Favoured by increased pesticide use
- [ ] c) Reduced by high rates of fertiliser

9 Integrated pest management:

- [ ] a) Is a corrective technique which relies on pesticides.
- [X] b) Uses all available techniques in an overall crop / pest management programme.
- [ ] c) Prohibits the use of pesticides in crop production.

10 Which of the following practices would be part of an IPM programme.

- [ ] a) Repeated cultivation of the same crop in the same field.
- [ ] b) Applying as much irrigation water as possible during the season.
- [X] c) Planting a resistant crop variety

11 The place of pesticides in integrated pest management is:

- [ ] a) Pesticides should not be used in an integrated pest management programme.
- [X] b) One of the available tools in an overall crop and pest management programme.
- [ ] c) To provide a quick solution to a pest problem.

12 What does pesticide resistance mean

- [X] a) The inherited ability of a pest to tolerate the toxic effects of a pesticide.
- [ ] b) The extended effect of a pesticide against a pest after application.
- [ ] c) The inherited ability of a plant to withstand the effects of pest infestation.

13 What is the first thing you should do when you see a pest infestation in a crop.

- [ ] a) Select the correct pesticide for the pest.
- [X] b) Identify the pest so that you know exactly what the problem is.
- [ ] c) Determine if the pest level is high enough to need spraying.

14 The use of a pesticide dose lower than that recommended for a specific pest:

- [ ] a) Saves the farmer money
- [ ] b) Protects beneficial insects
- [X] c) Fails to control the target pest

13 PRE- AND POST-COURSE EVALUATION – ANSWERS

15 One of the most common causes of the failure of a pesticide application is:

- [ ] a) Using out-of-date pesticide.
- [X] b) Using the wrong pesticide.
- [ ] c) The pests have developed resistance to the pesticide.

16 A systemic pesticide is most suitable for the control of:

- [X] a) Pests which suck the juices of plants.
- [ ] b) Pests which live in the soil and feed on roots.
- [ ] c) Pests which eat the leaves of plants.

17 The crops, pests and dose rate information given on the label:

- [ ] a) Are only some examples of possible uses of the product.
- [X] b) Restricts the use of the product to the specified crops, pests and dose rates.
- [ ] c) Indicates the most common uses of the product.

18 Gloves should be worn when mixing pesticides:

- [ ] a) To avoid getting dirty hands
- [X] b) To avoid contamination from pesticides which can be absorbed through the skin
- [ ] c) To be able to eat after the operation without washing the hands

19 The hazard of a pesticide is:

- [X] a) The inherent property of the pesticide to cause adverse effects.
- [ ] b) A measure of how poisonous the pesticide is.
- [ ] c) The amount of time a person is in contact with the pesticide.

20 The most common way in which pesticides enter the body is:

- [ ] a) Through the mouth
- [ ] b) Through the lungs.
- [X] c) Through the skin

21 The pesticide formulations which are absorbed most readily are:

- [X] a) Emulsifiable concentrates
- [ ] b) Wettable powders
- [ ] c) Granules

22 The minimum amount of protective clothing to wear for a specific pesticide formulation and activity is:

- [ ] a) Overalls.
- [ ] b) Overalls and rubber gloves.
- [X] c) Given on the label of the pesticide container.

13 PRE- AND POST-COURSE EVALUATION – ANSWERS

23 During application, pesticide contamination of the environment can be minimised by:

- [ ] a) Using a low dose rate of the pesticide.
- [X] b) Avoiding excess application and run-off from the plants.
- [ ] c) Placing warning signs around the treated area.

24 The environment is:

- [ ] a) Air, soil, water.
- [ ] b) Air, soil, water, plants, animals, houses.
- [X] c) Everything around us.

25 A pre-harvest interval between the last pesticide application and harvest is to:

- [X] a) Allow time for the pesticide to degrade.
- [ ] b) Allow time for the pesticide to kill all pests.
- [ ] c) Allow time for the crop to fully ripen.

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