CHAPTER 8

Guide to Exercises and Answers to Quizzes

8.1 Guide to exercises

This chapter provides a guide to the exercises and answers to exercises and quizzes in the manual. For each exercise in Chapters 2-6 of the manual, you will find information on the purpose of the exercise and some guidance on how to teach it. You will see that exercises are often done in pairs or small groups, then the class is brought together for discussion. When checking the answers, make sure you not only KNOW the answers but UNDERSTAND and can EXPLAIN the answers to your trainees.

Note: You will need to ask your trainees to draw up tables on butcher's or brown paper to fill in their answers for some exercises if you are unable to photocopy the templates for them

If you think some of your trainees prefer to work alone, allow them to do so from time to time. Remember, your job is to facilitate learning in ways that work best for your trainees to build their knowledge and confidence in a non-threatening, supportive learning environment. Also, remember that in your class there are likely to be some very experienced people as well as beginners. It is important that everyone has an opportunity to learn, so don't be afraid to call on those with more experience to help others. This will also help their ability to be trainers. You will also be building your own knowledge at the same time – we never stop learning!

REMEMBER

Some of the exercises have definite answers, others do not. This is because:

- some answers depend on the examples you as the trainer decide to use
- some answers depend on the samples you or the trainees bring to the class
- some exercises have more than one correct answer

8.2 PHC trainer planning and preparation checklist

IMPORTANT!!

Thoroughly plan and prepare before conducting your training workshop.

Before you begin, complete this checklist:

- ✓ Read through the manual carefully to become familiar and confident with the contents
- ✓ Work through the exercises and know how to facilitate them with your trainees. This will build your confidence as a trainer
- ✓ You do NOT need your trainees to work through EVERY exercise. It will depend on how much time is available and your judgment of how much they know already
- ✓ Do not be afraid to give your trainees reading to do for homework if you need to have something finished or to be prepared for the next session
- ✓ Make sure you have all the resources you need. A list is provided at the beginning of each chapter.
- ✓ Arrange to run one or two plant health clinics during the training - a simulated one so that your trainees know the process and how to fill in the Prescription and Farmer Feedback forms, then a full clinic with local farmers

8.3 Answers: Chapter 2

Chapters 2, 4 and 5 are the most difficult and important in the manual. Without good knowledge of identification, diagnosis and management, it is very difficult to be an effective plant health doctor.

In Chapter 2, you are helping your trainees to develop their identification skills by carefully observing and describing symptoms before they move to a diagnosis. It is worth taking time to go through these chapters very carefully before you teach them, checking your own understanding by completing the exercises yourself.

EXERCISE 1

ABC: BANANA

1 **BIOTIC:** Banana black cross, *Phyllochora musicola,* fungus.

2 **BIOTIC:** Banana diamond leaf spot, *Cordana musae,* fungus.

3 **ABIOTIC:** Natural variation of an ornamental variety.

4 **BIOTIC:** Cucumber mosaic virus.

5 **BIOTIC:** Banana burrowing nematode, *Radopholus similis.*

6 **BIOTIC:** Scab moth, *Nacoleia octasema.*

7 **ABIOTIC:** Natural colour variation.

8 **BIOTIC:** Banana bunchy top virus.

ABC: BELE (ABELMOCHUS)

1. **CONFUSED**: Could be i) feeding of a jassid (leafhopper), ii) hibiscus chlorotic ringspot virus, or the iii) plants are lacking an essential nutrient**.**

2. **BIOTIC:** Hibiscus chlorotic ringspot virus.

3. **BIOTIC:** Shoot borer, *Erias vitella,* moth.

4. **BIOTIC:** Leafminer, *Acrocercops* species, moth.

5. **BIOTIC:** Flea beetle, *Nisotra basselae.*

6. **BIOTIC:** White peach scale, *Pseudaulacaspis pentagona.*

7. **BIOTIC:** Cotton leaf roller, *Haritalodes derogate,* moth.

8. **CONFUSED:** Same as 1

ABC: CABBAGE

1. **BIOTIC:** Turnip mosaic virus.
2. **BIOTIC:** Damping-off, fungi.
3. **BIOTIC:** Chinese cabbage stalk rot, *Erwinia* species, bacteria.
4. **BIOTIC:** Cabbage centre grub, *Helula undalis,* moth.
5. **CONFUSED:** Possibly stalk rot (see 3) or Black cutworm, *Agrotis ipsilon,* moth.
6. **BIOTIC:** Cabbage black rot, *Xanthomonas campestris* pv. *campestris,* bacterium.
7. **ABIOTIC:** Boron deficiency.
8. **CONFUSED:** Possible snail damage.

ABC: CASSAVA

1. **BIOTIC:** Cassava green mottle virus.
2. **ABIOTIC:** Natural variation of an ornamental variety.
3. **BIOTIC:** Cassava *Amblypelta* dieback, bug.
4. **BIOTIC:** Spiralling whitefly, *Aleurodicus disperses.*
5. **BIOTIC:** White peach scale, *Psedaulacaspis pentagona*
6. **BIOTIC:** Spider mite, *Teranychus* species.
7. **BIOTIC:** Bacterial blight, *Xanthromonas axonopodis* pv. *Manihotis.*
8. **CONFUSED:** Possible mineral deficiency.

ABC: CITRUS

1. **CONFUSED:** Caused by scale insects on the underside of the leaf.

2. **BIOTIC:** Citrus sooty blotch, *Meliola citricola,* fungus.

3. **BIOTIC:** Greening or Huanglongbing disease of citrus, *Candidatus liberibacter asiaticus*, bacterium.

4. **BIOTIC:** Citrus tristeza virus.

5. **BIOTIC:** Greening or Huanglongbing disease of citrus, *Candidatus liberibacter asiaticus,* bacterium.

6. **BIOTIC:** Citrus scab, *Elsinoe fawcettii,* fungus.

7. **ABIOTIC:** Zinc deficiency.

8. **BIOTIC:** Fruit piercing moth, *Eudocrima fullonia***.**

ABC: COCONUT

1. **BIOTIC:** Foliar decay virus.
2. **ABIOTIC:** Potassium deficiency on fan palm.
3. **BIOTIC:** Coconut thread blight, *Corticium penicillatum,* fungus.
4. **CONFUSED:** Coconut Bogia disease or lightning strike.
5. **BIOTIC:** Coconut termite, *Neotermes rainbowi.*
6. **BIOTIC:** Coconut leafminer, *Promecotheca* species.
7. **CONFUSED:** Sooty mould, fungi - but this is not the main cause of the problem.
8. **CONFUSED:** Feeding lines created by *Promecotheca* species - *Brontispa longissimi,* the coconut hispine beetle causes similar symptoms.

ABC: TOMATO

1. **BIOTIC:** Tomato black leaf mould, *Pseudocercospora fuligena,* fungus.

2. **ABITOIC:** Calcium deficiency, blossom end rot.

3. **CONFUSED:** One of the many tomato fungal leaf spots.

4. **ABIOTIC:** Catface. Cause unknown, possibly irregular growth during flowering

5. **CONFUSED:** Purple patches on leaves can be caused by phosphorus deficiency, one of a number of viruses, or old age.

6. **CONFUSED:** Spots on fruit can be caused by fungi or bacteria.

7. **BIOTIC:** Eriophyid mite, *Polyphagotarsonemus latus.*

8. **ABIOTIC:** Tomato fruit splitting caused by irregular temperatures and/or water.

9. **BIOTIC:** Bacterial wilt, *Ralstonia solanacearum.*

ABC: MIXED

1. **BIOTIC:** Maize mosaic virus.

2. **ABIOTIC: T**omato sunscald.

3. **CONFUSED:** Cocoa cherelle wilt or *Phytophthora palmivora,* oomycete.

4. **BIOTIC:** Maize boil smut, *Ustilago zeae,* fungus.

5. **CONFUSED:** Cocoa dieback caused by lack of shade, sunscald or nutrient deficiency.

6. **ABIOTIC:** Maize zinc deficiency.

7. **BIOTIC:** Coconut tinangaja viroid.

8. **CONFUSED:** One of several tomato viruses or herbicide damage.

EXERCISE 2: SPEED DATING

This exercise gives more practice on how to describe symptoms on plants carefully and accurately before making a diagnosis.

Ask the trainees to form two lines facing each other so they are standing opposite a partner. Give each trainee a sample of a plant pest or disease, or they could collect their own. One of the pair now carefully describes the symptoms to their partner (their 'date') opposite them, and then both try to decide whether it is caused by abiotic (A) or biotic (B) factors, or it is confused (C).

Give no more than two minutes! When you say 'stop' the other partner has to do the same with their sample. Next, everyone in one line moves to the left so that each has a new partner. Repeat the process of describing the symptoms one more time each (or more if you think trainees need more practice).

Now ask the trainees to place their sample on one of three tables marked A, B or C, depending on whether they think the cause is A, B or C. ***Do not give any answers at this stage!***

Preparing for Exercise 3

Now that you have gone through Exercises 1 and 2, you have set up your trainees' 'need to know' about pests and diseases. It is time to introduce your PowerPoint presentation on pest and diseases which you will need to prepare from the information in Sections 2.3 to 2.8 in Chapter 2.

Alternatively, if they have access to a manual, you can ask trainees to read these sections for their homework, emphasising how important this information is, and ask if there are any questions. These are long sections with a lot of information, so take your time and give trainees plenty of breaks and time for discussion and questions during the presentation, and check for understanding.

EXERCISE 3: SIMILAR SYMPTOMS, DIFFERENT GROUPS

Table 2.3 shows that pest symptoms can be confusing, as similar symptoms can be caused by many different types of pests and diseases. Exercises 3 and 4 will help your trainees to think about symptoms of pest damage and the range of possible causes.

This is a challenging exercise, but the purpose is for your trainees to recognise that similar symptoms can have many causes. It is not necessary for them to have to learn the names of every pest.

By thinking about and discussing the possible answers in their groups and then with the whole class, your trainees will have a deeper understanding of the complexity of pest diagnosis, so they do not immediately jump to one answer when they see symptoms.

The answers filled in the table below are examples; there will be many other possibilities. Check with Table 2.3 for details.

Symptom	Type of damage (chewing, sucking or piercing)	Two orders (or sub-orders) causing similar symptoms	Stage of pest life cycle	Confirmed by fact sheets #
Holes (stem/trunk)	Chewing	1. Beetle/weevil 2. Moth/butterfly	Adult, nymph Larva (caterpillar)	?
Mines (Leaf	Chewing	1. Fly 2. Moth/butterfly	Larva (maggot) Larva(caterpillar)	?
Galls (leaf)	Sucking	1. Psyllid" 2. Mite (eriophyid)	Nymph Adult, nymph	?
Holes (leaf)	Chewing	1. Grasshopper/Katydid 2. Bee	Adult, nymph Adult	?
Holes (seed)	Chewing	1. Beetle/weevil 2. Moth/butterfly	Adult, larva Larva (caterpillar)	?
Wilt (plant)	Sucking	1. True bug* 2. Scale insect*	Adult, nymph Adult, nymph	?
Distortions (leaf)	Sucking	1. Aphid* 2. Mealybugs*	Adult, nymph Adult, nymph	?
Scraping (Leaf)	Chewing	1. Beetle/weevil 2. Moth/butterfly	Adult, nymph Larva (caterpillar)	?
Speckling (leaf)	Sucking	1. Thrips 2. True bug*	Adult, nymph Adult, nymph	?
Rot (fruit)	Piercing	1. Moth/butterfly 2. Fly	Adult Larva	?
Egg-laying strike (fruit)	Piercing	1. Fly 2. Weevil	Adult Adult	?

***Sub-orders of Hemiptera.**

EXERCISE 4: UNDERSTANDING CHEWING, SUCKING AND PIERCING DAMAGE

For this exercise, try to find samples of leaves, fruit or roots that show symptoms of chewing, sucking or piercing, but with no visible pests. This often happens at a plant health clinic. Give each pair of trainees a different sample of pest damage (or a photograph if you cannot find field samples). Your trainees should examine their sample carefully with a hand lens, and answer the questions in the exercise. Then they should share their answers with the whole class and discuss the diagnosis process and any difficulties.

Refer to Tables 2.2 and 2.3 for answers.

EXERCISE 5: USING SYMPTOMS TO MAKE A DIAGNOSIS

Once your plant health doctor trainees have received more information about pests and diseases from your PowerPoint presentation and/or worked through the sections in the manual, they should collect their samples from tables A, B or C and have another look at them, using a hand lens.

Again, ask the trainees to look at the symptoms (signs) on the plant carefully, and try to make a diagnosis. They may want to change their minds or add information. This is good; it means they have learned something new. Being wrong or only partially correct is an important part of learning.

Once they have finished this, discuss what they have learned and ask your trainees to complete Table 2.4 and fill in the last column.

The answers to this exercise will depend on the samples you or the trainees have collected. You will need to make sure you are able to identify as many of them as you can before discussing the answers.

EXERCISE 6: WHAT HAVE YOU LEARNED ABOUT PESTS AND DISEASES?

Your trainees should now be able to summarise their learning about pathogens. They should complete the table in pairs or threes. In the manual, some cells have been filled in as an example (green text). Here is the table completed with some answers, but there are many other possible answers.

Table 2.5: Test your knowledge of pests and diseases

	Fungi	Bacteria	Viruses	Nematodes	Insects
Size – can they be seen with the naked eye?	Spores – No. Fruiting bodies and cottony growth (mycelium) – Yes	*No*	No	No, with a very few exceptions.	Yes, with very few exceptions.
How do they reproduce?	*Spores*	Cells split in half (binary fission).	Use chemicals from host cells to make more virus particles.	There are males and females reproducing via eggs.	Incomplete or complete life cycles. Males and females reproducing via eggs; some give birth to living young without need for males.
How do they spread?	Produce masses of spores, spread in wind and rain; hyphae and mobile spores in soil, on or in planting materials; also via plants and soil associated with horticultural trade. More rarely carried by boring insects.	In wind, rain, movement of water in soil, on or in planting materials; also via plants and soil associated with horticultural trade.	In insects as they chew and suck sap, on tools, on or in planting materials; also via plants associated with horticultural trade. More rarely in fungi and nematodes.	Move though soil, transported in soil water, on or in planting materials; also via plants and soil associated with horticultural trade.	Mostly by flying (adults) that lay eggs on plants; also via plants and soil associated with horticultural trade.
How do they survive?	In soil, remains of plants after harvest, on leaf litter, on weeds. Many fungi have special survival spores.	In soil, in plants after harvest, on weeds. Some form resistant spores.	*In living cells,* either in plants or in insects.	In soil, feeding on weeds, as eggs. Some form cysts.	Many survive as eggs between crops, or on alternative hosts, especially weeds, and volunteer plants. In the tropics, survival occurs by moving from harvested to new planted crops.
What are some typical symptoms/signs on plants?	Spots, blights, rusts, wilts, mildews, rots, root decay.	*Wilts*, spots, rots, blights.	Mosaics (light and dark green patterns on the leaves), yellowing, stunting, distortions.	Wilts, yellowing of leaves, stunting, root galls	Holes, mines, chewed leaves, wilts due to root damage, silvering of leaves, distortions, rots, galls. Frass sometimes present.

EXERCISE 7: COMPLETE THIS TABLE FOR YOUR OWN COUNTRY

This is an important exercise to prepare your trainees by helping them become familiar with plant pests or diseases they are likely to see at the plant health clinic. Extension staff should already be aware of the major pests and diseases in their area, although sometimes new problems can spring up quickly, especially when weather conditions change.

As a trainer, it is important that you have a good knowledge of local pests and diseases. The tables list the most common pests and diseases in Samoa and Tonga. Trainers in Fiji and Solomon Islands need to ensure they also have country-based or region-based information.

Exercise 8 is an extension of Exercise 7 and optional. It helps your trainees consolidate their learning so far, so they are familiar with the major pests and diseases found in their region before the plant health clinic, and can confidently identify them.

EXERCISE 8: COMPLETING A 'STEM' TABLE (OPTIONAL ACTIVITY)

This exercise helps your trainees summarise their learning so far about pests and diseases. They should do this on their own or in pairs. It is like completing a sentence where the 'stem' is the beginning, starting with the first column (insect pests) and then filling in their ideas down the first column. Then they move down to the second column and so on until they have completed the table. The example in red reads: insect pests are …. a biotic factor

Again, there will be more than one correct answer; the prefilled table below provides some possible answers. Ask trainees which ones they had difficulty with and discuss.

	Insect Pests	Nematodes	N Deficiency	Viruses	Fungi	Bacteria	Drought
Are	A biotic factor	A small worm-like animal	A lack of an essential element needed by plants	*Very small*	A biotic factor.	A single celled organism	Lack of water
Are not:	A mite.	*an insect*	A biotic factor	Visible to the naked eye	An insect	A virus	A biotic factor
Can:	Reproduce quickly	Live in soil	Cause plants to turn yellow	Be spread by insects	Form fruiting bodies called a mushroom	Spread very quickly	Kill crops
Cannot:	*Produce spores*	Fly	Be treated by applying a pesticide	Live outside a host cell	Photosynthesise	Reproduce sexually	Help plants to grow well
May cause:	Holes in leaves	Wilting	Low yields	Mosaics	Leaf spots	*Wilting*	Loss of income for farmer
Does not cause:	Mildew	Rust	Holes in a leaf	Nutrient deficiency	*Chewing of leaves*	Rust symptoms	Floods
Can be controlled by:	Beneficial insects	Marigolds	Adding well-decomposed manure to the soil	Rogueing	Fungicide	Copper	Irrigation
Cannot be controlled by:	Herbicide	White oil	*Fungicide*	Companion planting	Insecticide	Parasitoids	*Fertiliser*

EXERCISE 9: WHAT AM I?

This guessing game exercise is fun and can be carried out at any point during the training. It is also a useful icebreaker to do at the beginning of a training session. It can be as easy or difficult as you decide to make it, and you can make up any words you like that relate to what you are teaching. It makes sure your trainees really focus on the characteristics of what they are trying to guess.

Write a word or group of cards, on a piece of card and stick one card to each trainee's back with masking tape. Do not allow the trainees to see their card!

When you are giving out the cards, try to match the words to the trainees. For example, give the more knowledgeable trainees something more challenging, while you give a simpler word to those who are not as experienced or confident. Everyone needs to be able to guess their word, as this builds confidence.

The trainees pair up or move around the class, asking questions of each other. The idea is to find out what the word is, but the questions can ONLY be answered with '**yes**', '**no**' or **'sometimes/maybe'**. You may need to demonstrate this with a trainee first.

You should check in with the trainees while the exercise is in progress, as they may have been given wrong information! Ask: "What do you already know so far about your word?" Correct them where necessary. If a trainee is stuck, you may give a clue.

Ask trainees to sit down when they have correctly guessed their word.

Discuss the exercise afterwards. Was it easy? Difficult? Why?

EXERCISE 10,11,12: USING THE POSSIBLE AND PROBABLE APPROACH

By this stage in Chapter 2, your trainees have covered a lot about symptoms and have started to think about diagnosis. In Exercises 10, 11 and 12, they apply their A,B,C learning to use the **possible** and **probable** step approach to making a diagnosis. This is something they need to be able to do at the plant health clinic.

First of all, carefully go through the example of eggplant with the class to demonstrate the steps.
Your trainees should then use the same steps to work through the examples in Exercises 10,11 and 12, working in pairs or threes, or alone if they prefer.

Once they have finished, it is important to ask them why they have decided on a diagnosis, as you may be able to pick up any misconceptions.

Only when they have carried out the steps should they check their answers with the Pacific Plant Pests, Pathogens & Weeds App. They also need to think about what extra information they might need for a diagnosis, and what further questions they would ask if a farmer brought in this problem. If you think that your trainees need more practice, you can make up your own examples.

EXERCISE 10: USING THE POSSIBLE AND PROBABLE APPROACH

EXAMPLE: Large blotches on cassava leaves
Symptoms:
1. Yellow spots and blotches
2. Many spots and blotches alongside the midrib of the leaves
3. Lower leaves affected
4. No sign of wilt, rot, fungal/bacterial spots or blights

Possible Causes	Possible? ✓✖	Probable? ✓✖	Why did you decide this?
BIOTIC			
Insects	✓	✓	But first need to see the back of the leaf.
Mites	✓	✓	But first need to see the back of the leaf.
Fungi	✖	✖	Unlikely; would have expected some darker spots if fungus
Bacteria	✖	✖	Unlikely; would have expected some darker spots if bacteria
Viruses	✓	✖	Possible; but not a known symptom of a virus disease of cassava in Pacific Islands
Phytoplasmas	✓	✖	Unlikely; not a known symptom of a phytoplasma disease of cassava in Pacific Islands
Nematodes	✖	✖	NA for these symptoms
Weeds	✖	✖	NA for these symptoms
Parasitic plants	✖	✖	NA for these symptoms
Slugs & Snails	✖	✖	NA for these symptoms
Mammals	✖	✖	NA for these symptoms
Birds	✖	✖	NA for these symptoms
ABIOTIC			
Nutrient deficiencies	✓	✖	Unlikely; yellow blotches not typical of any cassava nutrient deficiency symptom in Pacific islands
Sun scald	✖	✖	NA for these symptoms
Water (too much or too little)	✖	✖	NA for these symptoms
Lightning	✖	✖	NA for these symptoms

Herbicide	✓	×	Unlikely; no growth distortions and farmer says no herbicide used.
It's natural	×	×	NA for these symptoms

NOTES: Once the leaf is turned over, the answer is made clear – it is spiralling whitefly.

EXERCISE 11: USING THE POSSIBLE AND PROBABLE APPROACH

EXAMPLE: YELLOWING OF VEINS AND PATCHES ON SWEET POTATO LEAVES

Symptoms:

1. Yellow spots on the leaves (mosaics)
2. Yellowing along the veins
3. Symptoms on the young leaves
4. Leaves are normal size

Possible Causes	Possible? ✓✖	Probability? ✓✖	Why did you decide this?
		BIOTIC	
Insects	✖	✖	Not a symptom of insects; no sign of presence or frass
Mites	✖	✖	Unlikely, but turn leaf over to look for mites and webbing to make sure
Fungi	✖	✖	Not a symptom of fungi
Bacteria	✖	✖	Not a symptom of bacteria
Viruses	✓	✓	Irregular yellow patches, and especially yellowing along veins are typical of known viruses of sweet potato.
Phytoplasmas	✓	✖	Little leaf of sweet potato exists, but leaves are not “little”
Nematodes	✖	✖	NA for these symptoms
Weeds	✖	✖	NA for these symptoms
Parasitic plants	✖	✖	NA for these symptoms
Slugs & Snails	✖	✖	NA for these symptoms
Mammals	✖	✖	NA for these symptoms
Birds	✖	✖	NA for these symptoms

ABIOTIC			
Nutrient deficiencies	✖	✖	NA for these symptoms
Sun scald	✖	✖	NA for these symptoms
Water (too much or too little)	✖	✖	NA for these symptoms
Lightning	✖	✖	NA for these symptoms
Herbicide	✓	✖	Yellowing of veins not typical; and no growth distortions
It's natural	✖	✖	NA for these symptoms

EXERCISE 12: USING THE POSSIBLE AND PROBABLE APPROACH

EXAMPLE: WILTING OF *XANTHOSOMA*

Symptoms:
1. Only four leaves
2. Leaves 'cup-shaped'
3. Leaves wilting
4. Root decay

Possible Causes	Possible? ✓✖	Probable? ✓✖	Why did you decide this?
		BIOTIC	
Insects	✖	✖	No signs of insects and no frass
Mites	✖	✖	No sign of mites
Fungi	✓	✓	Edges of leaves are decayed, but damage likely to be result of leaves dying early. Root damage likely to be causing wilt. Fungal wilt diseases of *Xanthosoma* known.
Bacteria	✓	✖	Edges of leaves are decayed, but damage likely to be result of leaves dying early. Bacterial wilt diseases of *Xanthosoma* not known.
Viruses	✖	✖	NA for these symptoms
Phytoplasmas	✖	✖	NA for these symptoms
Nematodes	✖	✖	NA for these symptoms
Weeds	✖	✖	NA for these symptoms
Parasitic plants	✖	✖	NA for these symptoms
Slugs & Snails	✖	✖	NA for these symptoms
Mammals	✖	✖	NA for these symptoms
Birds	✖	✖	NA for these symptoms

ABIOTIC			
Nutrient deficiencies	✖	✖	NA for these symptoms
Sun scald	✖	✖	NA for these symptoms
Water (too much or too little)	✖	✖	NA for these symptoms
Lightning	✖	✖	NA for these symptoms
Herbicide	✓	✖	Not a symptom of herbicide damage
It's natural	✓	✖	Loss of leaves not due to plant maturity; other plants have many more leaves

END OF CHAPTER 2 QUIZ: Test your knowledge

Your plant health doctor trainees can do this on their own or in pairs. Ask them which they prefer.

The answers are given in **bold underline**. When they have all finished, go through the answers. You do not need to ask what marks the trainees got; they will have learned the correct answers by going through the test as a class.

Make sure you always discuss with the class any answers they are not sure about.

Explain that if there is anything they are still not sure about, trainees should read the manual again and/or ask for help.

You can change or add your own questions.

1. **In ORDER, abiotic and biotic factors that cause damage on plants are:**

A. a fungus and a mite
B. a bird and drought
C. potassium deficiency and a virus
D. phytoplasma and poor soil.

2. **Symptoms on tomatoes and cabbages caused by bacteria are:**

A. leaf spots and evenly spread leaf yellowing
B. wilt and V-shaped yellowing at the edges of leaves
C. rust spots and mosaics
D. dieback and with leaves going purple

3. **A common disease of tomatoes in the Pacific is:**

A. witches' broom
B. tobacco mosaic
C. Late blight
D. ring spot

4. **The smallest of these pathogens is:**

A. virus
B. phytoplasma
C. bacteria
D. fungus spore

5. A plant doctor finds a plant with symptoms of wilt. The most unlikely cause would be:

A. bacteria in the soil
B. powdery mildew
C. nematodes
D. stalk borer

6. Pests with eight legs:

A. mites
B. insects
C. nematodes
D. millipedes

7. Which of these diseases is caused by a fungus?

A. bunchy top on banana
B. blossom end rot on tomato
C. citrus canker
D. damping-off on cabbage seedlings

8. A plant doctor finds a cabbage with a lot of holes in the leaves. Which are not possible causes?

A. Diamondback moth
B. large cabbage moth
C. leaf chewing nematodes
D. snails

9. A virus cannot be spread between plants by:

A. bacteria
B. tools
C. rhinoceros beetles
D. aphids

10. Two insects with complete life cycles are:

A. aphids and beetles
B. <u>butterflies and bugs</u>
C. grasshoppers and ants
D. bees and moths

11. Where do you find the eggs of this spiraling whitefly?

A. inserted into the leaf
B. whiteflies don't lay eggs; they give birth to living young
C. <u>in the waxy spirals</u>
D. underneath the female whiteflies

12. What is the most likely cause for this hibiscus wilt?

A. mites or thrips have attacked the young leaves, and they have wilted
B. it was planted on a slope, and there has been a long drought
C. old age
D. <u>a fungus or an insect is destroying the roots</u>

8.4 Answers: Chapter 3

There are no exercises for Chapter 3. Just work through the chapter to ensure your trainees have joined their country WhatsApp group and know how to use CommCare (if available), the Pacific Pests, Pathogens & Weeds app, and are familiar with PestNet.

8.5 Answers: Chapter 4

In Chapter 2, your plant health doctor trainees learned to identify and diagnose pest and disease symptoms on plants, and Chapter 3 introduced digital resources to help diagnose unknowns. Chapters 4 and 5 help your trainees to understand ways of managing pests and diseases. Chapter 4 covers IPDM options using cultural and biological control methods, which should always be the first option. Chapter 5 covers pesticides.

Exercise 13: What do you already know about IPDM cultural control methods for specific pests and diseases?

Your trainees will already have a lot of knowledge about cultural methods of control. In groups, they should write down and discuss any IPDM pest and disease control methods they know about for two pests and two diseases from their region, for both large- and small-scale cropping, and how the methods work. They should fill in the table below, then share and discuss their answers with the rest of the class. Answers will depend on the examples chosen.

	Crop	What IPDM cultural control methods are possible?			
		For large scale	How it works	For small scale	How it works
Insect/mite pest					
Example: Diamondback moth (DBM)	*Brassicas*	*Remove weeds in the Brassica family*	*Reduces DBM populations that maintain populations between crops*	*Hand picking caterpillars*	*Removes pest*
1.					
2.					
Diseases					
1. (Example) Citrus scab (Elsinoe fawsetti)	*Citrus*	*Isolate nurseries from orchards.*	*Prevents spread of fungus.* *Prune to keep canopy open.*	*Isolate nurseries from orchards. Prune to keep canopy open*	*Prevents spread of fungus.*
2.					

Exercise 14: Using IPDM - Working out the steps

For IPDM to work properly, several steps need to be taken. This is what your trainees will need to tell the farmers at the plant health clinic. This exercise helps your trainees work through the correct steps for applying IPDM. When they have had time to think about their answers, ask each group to share their ideas with the class. If they have anything in the wrong order, discuss this.

The correct order:

E. Knowledge - Identify the pest or disease and know its life cycle.

A. Go to the garden regularly. Look for damage.

D. Decide how much damage the crop can tolerate before yields are affected.

C. Make a plan of action for the present crop and the next crop: A) before planting (next crop); B) during growth of present crop; and C) after harvest of present crop. If it is a pest, count the pests (can you see natural enemies?). Is the problem getting worse or not? KEEP NOTES.

B. Was your plan successful or not? Are any changes needed? Is it a problem likely to be caused by a pest or a disease? Use the possible/probable approach in Chapter 2.

Exercise 15: Applying crop rotation

It is important that your trainees are familiar with the principles of crop rotation and are able to explain it.

The example shows possible crops to plant in a rotation based on Fig. 4.4. Each column represents a separate plot and has four cycles.

Note that as long as the crops are in the correct families and follow the current sequence, the actual crop that the trainees suggest does not matter. There is more than one correct answer, but there are also incorrect answers.

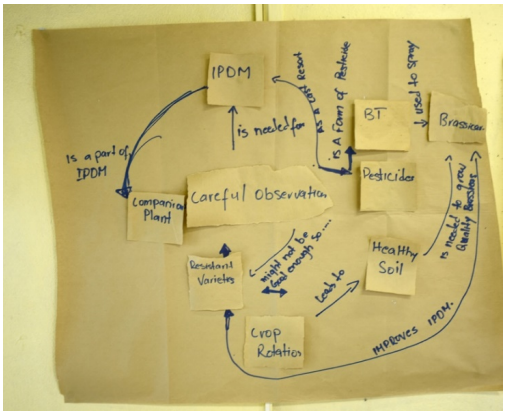
Cycle	Plot 1	Plot 2	Plot 3	Plot 4
1	Leafy crop e.g. bele	Legume crop e.g. Mucuna	Root crop e.g. taro	Legume crop e.g. Mucuna
Reason why you chose this crop rotation:				
2	Solanaceae crop e.g. capsicum	Curcubit crop e.g. cucumber	Brassica crop e.g. bok choy	Leafy crop e.g. lettuce
Reason why you chose this crop rotation:				
3	Root crop e.g. cassava	Root crop e.g. carrot	Legume crop e.g. bean	Solanaceae crop e.g. chilli
Reason why you chose this crop rotation:				
4	Legume crop e.g. peanut	Brassica crop e.g. cabbage	Cereal crop e.g. maize	Cucurbit crop e.g. watermelon
Reason why you chose this crop rotation:				

Exercise 16: Concept mapping of IPDM

Creating a concept map is a very useful exercise to help your trainees make connections between concepts in any topic. It is best done in pairs or small groups. The concepts are written on a sticky note or piece of paper with blu-tak or sellotape on the back, then moved around on brown paper or butcher's paper until the group agrees where they fit. The process of discussing and making decisions is an important part of the learning process.

You might want to start with a simple map of concepts that all trainees are familiar with, e.g. **house, mother, garden, chicken, taro, child**, so that they understand the process. They should write on the connecting lines how the concepts are linked.

You can decide to leave out or add other terms or change them if you think others might be better. About eight terms work well, but you can add more if your trainees need more challenges. Alternatively, you can ask the trainees to give you the terms to work with.



There is no one correct answer, but some answers could be incorrect. Some trainees will decide to create a flow diagram - 'this' leads to 'that' - while others will link the concepts. It does not matter how people relate the concepts, but trainees **must write how they are related** on the linking lines, as in the example here. See Fig.7.3 in section 7.3 for other examples.

When they have finished, ask the trainees to put their map on the wall, and explain it to the rest of the class.

You can use concept mapping at any time during the training to help your trainees deepen their learning and make connections between content.

Exercise 17: Summary of cultural control for IPDM control of some common pests and diseases

Exercise 17 is designed to help your plant health doctor trainees bring all their knowledge about cultural control for IPDM together. They should discuss the answers in their small groups, using their own knowledge as well as the resources and information you have covered in this chapter, to complete the table. Or you could set it as a homework exercise. When they have finished, discuss the answers with the whole class. Not everyone will be aware of all these cultural controls, so spend some time on the discussion.

The answers will depend on the examples the trainees use. You can provide them with examples, or they can come up with their own. Some examples are provided here.

Cause	Example	Crop and part affected	CR*	GH*	F*	GD*	CP*	V*	HPM*	HP*	TC*	BC*
Pests (Insects and mites)	Tomato fruit borer	Tomato fruit	✓	✓	×	×	×	×	×	✓	✓	✓
Nematodes	Dry rot *(Pratylenchus)* nematode	Yam, roots	✓	✓	✓	×	×	×	✓	×	×	×
Pathogens (fungi, bacteria and viruses)	Bacterial wilt	Tomato, whole plant	✓	✓	✓	✓	✓	✓	✓	×	×	×

***KEY**

- CR: Crop rotation
- GH: Good hygiene
- F: Fertiliser/compost/organic matter
- GD: Good drainage
- CP: Companion planting
- V: Resistant variety
- HPM: Healthy planting material
- HP: Hand picking
- TC: Trap crop
- BC: Biological control

END CHAPTER 4 QUIZ: TEST YOUR KNOWLEDGE

Your trainees can do this on their own or in pairs. Ask them which they prefer.

The answers are given **in bold underline**. When they have all finished, go through the answers. You do not need to ask what marks the trainees got, they will have learned the correct answers by going through the test as a class.

Make sure you always discuss with the class any answers they are not sure about. Then explain that if there is anything they are still not sure about they should read the manual again and/or ask for help.

1. In IPDM, pesticides should be used:

A. always
B. never
C. as a last resort
D. only if the farmer can afford them

2. The adult in the picture shown below is most likely to be:

A. a beetle
B. a wasp
C. a lacewing
D. a fly

3. In order, a companion plant, a biological insecticide and a beneficial organism are:

A. taro, DBM, *Trichoderma*
B. Chinese cabbage, kocide, ladybird
C. coconut, pyrethrum, *Trichogramma*
D. marigold, Metarhizium, spider

4. **An example of a good crop rotation would be:**

A. lettuce, cabbage, broccoli, bean.
B. cucumber, squash, potato, cassava.
C. potato, tomato, eggplant, capsicum.
D. bean, cabbage, cassava, cucumber.

5. Rogueing means:

A. using bio-insecticides
B. destroying infected plants
C. using companion plants
D. planting resistant varieties

6. In IPDM, monitoring involves:

A. deciding whether the problem is caused by a pest or a disease
B. using the best pesticide for the pest
C. checking the level of damage and looking for bugs and eggs
D. identifying the pest or disease

7. The correct sequence for applying IPDM is:

A. monitoring, evaluation, making a plan, identification of pest or disease
B. evaluation, monitoring, identification of pest or disease, making a plan
C. making a plan, identification of pest or disease, monitoring, evaluation
D. identification of pest or disease, monitoring, evaluation, making a plan

8. Which plants are all in the same plant family?

A. cabbage, bok choy, broccoli, chilli
B. potato, cassava, taro, sweet potato
C. bitter gourd, pumpkin, cucumber, squash
D. capsicum, chilli, eggplant, bean

9. The best way to control a soil borne bacterial infection is:

A. use a resistant variety if it can be obtained
B. spray with a pesticide
C. find a virus that attacks the bacteria
D. add compost to the soil

10. Which of the following is NOT thought to be a characteristic associated with companion planting?

A. companion plants can provide food for parasitoids
B. companion plants may have a smell that repels pests
C. companion plants put copper into the soil
D. companion plants may repel root knot nematodes

8.6 Answers: Chapter 5

In Chapter 4, your plant health doctor trainees learned about some of the cultural controls that can be applied to IPDM. Chapter 5 introduces them to pesticides. Remember to stress that these should be used only as a last resort, given the damage they cause to humans, natural enemies and the environment, as well as the problem of build-up of resistance in pest populations.

Chapter 5 reviews many aspects of pesticides and their uses, and Exercises 18-25 will test your trainees' knowledge on this topic. The following pages provide the answers for these exercises, as well as some tips on how to administer the exercises during your training sessions.

EXERCISE 18: WHAT DO YOU ALREADY KNOW ABOUT BOUGHT PESTICIDES?

Exercise 18 helps you find out what your trainees already know about some commonly used (commercial) pesticides. They can check their own answers in Table 5.2. If any answers are incorrect, discuss. Add any others not on the list. Exercise 18 also draws your trainees' attention to the fact that some pesticides may contain the same active ingredients but are sold under different trade names. It is important that they know this to be able to advise farmers properly. Trainees should carry out this exercise in pairs or small groups. Discuss with the class and add any they do not know. Pesticides with different trade names, but the same active ingredients, are grouped and highlighted below.

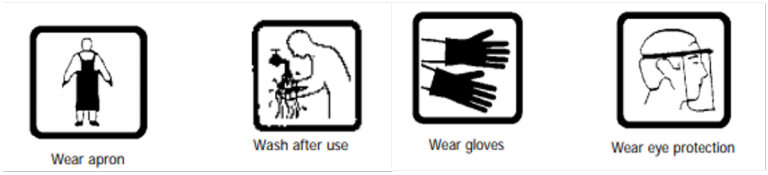
Pesticide name	Purpose	Type of pesticide	Active ingredient
Attack	Caterpillar, aphids.	I	Pirimiphos-methyl/permethrin
Sundomil	Broad-spectrum.	F	Mancozeb
Glyphosate	Perennial, woody weeds.	H	Glyphosate
Kocide	Broad-spectrum.	F (and a bacteriocide)	Copper hydroxide
Confidor	Sucking insects - aphids, leafhoppers, thrips, whitefly, mealybugs, scale insects and taro beetle.	I	Imidacloprid
Orthene	Chewing and sucking insects - caterpillars, aphids, thrips, leafminers, leafhoppers, cutworm on vegetables and fruits.	I	Acephate
Agazone	Annual and grass weeds.	H	Paraquat
Suncloprid	Sucking insects - aphids, leafhoppers, thrips, whitefly, mealybugs, scale insects and taro beetle.	I	Imidacloprid
Talendo	Broad-spectrum.	F	Chlorothalonil/ Thiophanate
Blitzem	Snails and slugs.	M	Metaldehyde
Steward	Caterpillars, pod borer, armyworm, centre grubs, cutworm, leafroller, leafminers.	I	Indoxacarb
Prevathon	Caterpillars, pod borer, armyworm, centre grubs, cutworm, leafroller, leafminers.	I	Rynaxypyr or chlorantraniliprole
Others:			
Farmers' imidacloprid	Sucking insects - aphids, leafhoppers, thrips, whitefly, mealybugs, scale insects and taro beetle.	I	Imidacloprid
Manzate	Broad-spectrum.	F	Mancozeb
Kotek	Broad-spectrum.	F	Mancozeb

EXERCISE 19: UNDERSTANDING THE PESTICIDE LABEL

Understanding a pesticide label is critically important for the correct and safe use of pesticides. Exercise 19 focuses your trainees on the information on the labels. Make sure each group has a different label to work with. They should write their answers on brown paper or butcher's paper. When finished, each group should hold their paper up and read out their answers to the class and discuss.

What kind of pesticide is it? (i.e. fungicide, insecticide, etc.)	Depends on label allocated to trainees
What is the pesticide used for?	Depends on label allocated
What is the common name of the pesticide?	Depends on label allocated
What is the trade name of the pesticide?	Depends on label allocated
Is the label divided into separate panels? If so, what information does each of these panels give you? Centre panel? Left panel? Right panel?	Depends on label allocated
What is an emulsifiable concentrate (EC)?	This will form a milky liquid when mixed with water
What is a sticker?	A substance that is put into a pesticide to make it stick to crop plants
What is a spreader?	A substance that helps spread the pesticide across the leaf surface
What is meant by compatibility?	Pesticides that can be used together

What should you avoid doing when spraying, but do immediately after spraying?	Avoid contact with undiluted pesticide during preparation Avoid getting spray on people, animals or into waterways Clean the tank immediately after spraying so that the chemical does not dry on the inside: To do this, open the tank, remove the strainer, fill the tank with 1.5 L of water, replace the cap and shake Pour the water out onto area that has been sprayed, or the ground nearby Add another 1.5 L of water and spray to clean the hose, lance and nozzle
What clothing is recommended when preparing the spray and spraying?	Masks (including respirators) and goggles to protect the mouth and eyes, gloves, boots, hat and overalls. *As a minimum, wear a long-sleeved shirt, long trousers, rubber boots and a hat*
What is the recommended way to store the pesticide?	Store the product in its original container, tightly closed, and away from heat and food, and out of reach of children, preferably in a locked cupboard
What does run-off mean?	Pesticide that has left the crop and run off into the soil, drains, waterways, etc.
Is there a hazard number on the label? What is it and what does it mean?	1a - extremely hazardous 1b - highly hazardous II - moderately hazardous III - slightly hazardous U - unlikely to present acute hazard
What should you do after spraying and before eating, drinking or smoking?	Remove your clothes and shower. Wash the clothes separately from other clothing Do not eat or drink after spraying until you have washed
Can you wash the sprayer or empty container in the river? If not, why not?	No. It may contaminate the water to make it undrinkable, as well as kill fish and other aquatic creatures that live there
Where are the best places to put the container when it is empty?	Bury it or send it to a landfill. Do not re-use the container or leave it in the field

Is it recommended that you induce vomiting if a person has drunk the pesticide?	Depending on the pesticide, the label will tell you whether vomiting should be induced or not
If you spill the pesticide, what should you do?	Wear protective clothing Cordon off the area Prevent the chemical from entering drains Absorb it with inert material (soil, sand or sawdust) Place it in bins for disposal in a landfill Wash the contaminated area with water
Can you give livestock feed that has been sprayed with the pesticide?	Depends on the pesticide. There may be a withholding period till the animals can be slaughtered when they have grazed on sprayed crops. The pesticide label should tell you this
What is meant by the pre-harvest interval (also known as the withholding period)?	How long before the crop can be marketed after spraying to be considered safe to eat
What do these pictograms mean, if they are present on the label? a) b) c) d) 	a) Wear protective clothing b) Always wash after applying pesticide c) Wear gloves d) Wear a mask or face guard

Exercise 20: Making up a pesticide for spraying

Exercise 20 asks your trainees to calculate the quantities needed to make up pesticide concentrations correctly for spraying. It is very important that they are confident with this sort of calculation. Go through it step by step if anyone is having difficulties.

Use the following information to determine how much pesticide is needed.

- The pesticide label (*Eko*) tells you that you should apply *Eko* in **400 L of water per ha**.
- *Eko* is made up at **34 ml per 20 L sprayer** (see Fig 5.6).
- The farmer has a **5 square chain tomato field**.
- Area: 5 square chains is equivalent to 0.2 ha (**25 sq chains = 1 ha, 5/25**)
- Spacing**: 0.5 m x 1 m.**
- The farmer has a **15 L** knapsack.

By yourself, calculate:

1. **How many knapsack sprayers are needed to spray 1 ha of tomato?**

Answer: 26.7 knapsacks if using a 15 L sprayer (40 if a 10 L sprayer; 20 if a 20 L sprayer).

2. **How much (*Eko*) chemical will you need to spray 1 ha of tomato?**

Answer: 680 ml of *Eko* chemical.

3. **What advice would you give the farmers on the amount of chemical (*Eko*) that he/she will use?**

Answer: 136 ml of *Eko* chemical.

Trainees should check their answers with a partner and then share with the whole class.

Exercise 21: Important factors in spraying

This exercise is also critically important to help trainees understand spraying safety. Some answers are given here, and trainees should check the manual for more information. Discuss all answers with the class. Here are some answers; trainees may be able to add others.

Before spraying	• Do not spray on windy days. • Have another person with you. • Check that your knapsack is not leaking and was cleaned properly after its last use. • Check you have the correct nozzle for the pesticide you are using. • Check you have the correct concentration of pesticide (consult label). • Wear proper protective clothing.
During spraying	• Spray either early in the morning or late in the afternoon, when wind is less strong. • Spray down wind. • Use a spray shield to prevent chemical drift. • If accidents happen, refer to the label. • In case of a spill, cover with sand, sawdust or soil, and bury away from the house at the edge of the garden or field, or take to land fill.
After spraying	• Clean the tank immediately after use so that the chemical does not dry on the inside. • Open the tank, remove the strainer, fill the tank with 1.5 L water, replace the cap and shake. • Pour the water out onto the area that has been sprayed, or the ground nearby. • Add another 1.5 L water and spray to clean the hose, lance and nozzle. • After spraying, remove your clothes and shower. • Wash these clothes separately from other clothing. • Do not eat or drink after spraying until you have washed.

Exercise 22: Advantages and disadvantages of using pesticides

Your trainees have now covered Chapters 4 and 5 on IPDM methods of management of pests and diseases. They should now be able to discuss what they have learned about the advantages and disadvantages of using pesticides compared with other methods included in IPDM. Some possible answers are given here.

Advantages of using pesticides	Disadvantages of using pesticides	Safer alternatives
• They are cheap. • Farmers see their effects immediately. • They can be applied quickly over large areas.	• They are toxic to human beings and the environment. • They destroy beneficial insects. • Pests become resistant to them. • For many people, they are difficult to choose and use at the correct rate.	• Cultural control strategies For example: ▪ Crop rotation ▪ Destruction of crop debris at harvest • Resistant varieties

Exercise 23: Using trainees' knowledge to identify and develop a management strategy for a farmer

Your trainees have now studied identification, diagnosis and management of pests and diseases. The next step is to put their knowledge into practice by working through the kinds of issues and problems they may encounter at a plant health clinic. Practice and experience are essential, as by now your trainees would have realised that being a good plant health doctor is complicated and takes effort.

This exercise is **very important,** as it prepares your trainees for the clinics, and is a good introduction to Chapter 6, where they will actually run a real plant health clinic. It also gives them practice in filling out the prescription forms that are used at clinics, and asks them to reflect on their advice and to think about what they could do better.

The exercise is in five parts:

(1) identification and diagnosing the problem
(2) what questions to ask the farmer about the problem
(3) how to manage the problem now and into the future: making a plan
(4) completing the Prescription Form
(5) discussion and reflection on the process

Allow your trainees plenty of time to work through each part carefully.

Part 1 – Identifying and diagnosing the problem

Using the photos, trainees should now work through the process of identification and diagnosis of the problems. They should use all the information from the manual, fact sheets and Pacific Pests, Pathogens & Weeds app, as well as their own knowledge and experience.

Now is the time to remind trainees to use the identification and diagnosing process in Chapter 2:

1. Is it A, B, or C? (Abiotic, Biotic or Confused)
2. Possible and probable
3. Check with the app *only after they have done steps 1 and 2.*

Part 2 – Asking the farmer questions about the problem

As well as examining the sample at a clinic, trainees will need to ask the farmer questions to provide more detail and information to help diagnose and understand the seriousness of the pest or disease.

Trainees should make a list of questions they would ask the farmer. These questions could include:

1. How widespread is the problem? (e.g. a whole field, a few plants only)
2. Have other farmers in the area got the same problem?
3. Has the farmer seen the problem before?
4. Is it a new problem or does it occur every year?
5. How serious is the problem? (e.g. only a few leaves affected, the whole plant is affected)
6. How has the farmer tried to manage the problem? Was he or she successful?
7. What has the weather been like? (e.g. rain, drought, cyclone, frost, etc.)
8. Other questions?

Each pair should show the class their photos, discuss their diagnosis and read out their questions.

For unknowns, refer your trainees to the online tools in Chapter 3.

Part 3 – Managing the problem - making a plan

Once you are satisfied that the trainees have the correct diagnosis, next ask them to discuss and write down all the different ways the problem could be managed, both now and into the future.

- Biological control
  - Are there any natural enemies that are important to preserve, and which might be killed with pesticides?
- Cultural control
  - What to do before planting
  - During growth
  - After harvest e.g. crop rotation, hygiene

- Resistant varieties?
  - These can only be recommended if they are known to be available in the country
- Chemical control
  - Homemade pesticides
  - Commercial pesticides

Part 4 – Completing the Prescription Form

Once they think the problem has been diagnosed and they have thought about a management plan, trainees should now practise completing the plant health clinic Prescription Form. This is the form they will use at the clinics, so it is **very important they are familiar with it.** Stress that they should fill in **ALL** parts, **using clear handwriting**. (They can make up the farmer's details.)

Stress to your trainees that plant doctors should NEVER give advice if they are uncertain.

If using a language other than English, an English copy will be needed as well for record-keeping, or use the CommCare on a smartphone or a tablet.

Make it very clear that the Pacific Pests, Pathogens & Weeds app should be used to check a diagnosis and to guide management strategies **ONLY** after this process is complete. Suggest to your trainees that they use the mini fact sheets in preference to full fact sheets as they present a summary of problems.

Part 5. Discussion and reflection

Reflection is also a very important part of the process. Discuss the exercise as a whole class, encouraging your trainees to discuss not only what they were able to diagnose easily, but also the unknowns and other difficulties. Ask them what they need to do to give a farmer better advice? What further study do they need to do?

If time, this exercise should be repeated using a sample from a garden or field. Your trainees can never have enough practice!

Answers: End of Chapter 5 quiz:

The plant health doctor trainees can do this on their own or in pairs. Ask them which they prefer.

The answers are given in **bold underline**. When they have all finished, go through the answers. You do not need to ask what marks the trainees got; they will have learned the correct answers by going through the test as a class.

Make sure you always discuss with the class any answers they are not sure about.

Then explain to the trainees that if there is anything they are still not sure about they should read the manual again and/or ask for help.

You can add your own questions.

Multiple choice. Pick only one answer

1. Which of the following are all fungicides?

A. Manzate, milk, baking soda, malathion
B. Sundomil, Kotek, Kocide, Talendo
C. Glyphosate, neem, Blitzem, pyrethrum
D. Confidor, Orthene, Bt, Manzate

2. A sprayer nozzle suitable for fungicides should:

A. be an anvil type and the spray should form a light rain
B. be a flat type and the spray should form a mist
C. be a hollow cone type and the spray should form a mist
D. be a flat type and the spray should form a cloud

3. A pesticide label says that it should be made up at a concentration of 10 ml pesticide to 10 L water. The concentration of the pesticide is:

A. 10%
B. 1%
C. 0.1%
D. 0.01%

4. A farmer has 10 ha of a crop to be sprayed. The pesticide label tells her that the spray should be 30 ml pesticide per 20 L of water and the crop should receive 400 L per ha. How many ml of the *pesticide* should she use to make up the spray to cover the whole crop properly?

A. 4000 ml
B. 600 ml
C. 6000 ml
D. 2400 ml

5. Build-up of insecticide resistance in a pest can be prevented by:

A. alternating the spraying between an insecticide and a fungicide
B. spraying early in the morning
C. using the correct type of nozzle for spraying
D. making sure the same type of insecticide is not used all the time

6. Which of these pesticides are not allowed in organic farming?

A. copper fungicides
B. tobacco
C. castor oil
D. glyphosate

7. Which action should you NOT do if you accidently spill some pesticide?

A. cover the area with sand
B. make sure you wash yourself and your clothes thoroughly
C. get the dog to lick it up
D. keep children away from the spill

8. Pesticide resistance in insects is caused by:

A. a genetic mutation that is passed on to new generations of the insect
B. a fungicide being used by mistake
C. a virus getting into the insect
D. using the wrong crop rotation

9. Which of the following information is NOT usually found on a pesticide label?

A. the type of product
B. which pests are resistant to it
C. what it contains
D. what crops it may be used on

10. An emulsifiable concentrate:

A. is the same as a wettable powder
B. is incompatible with all other pesticides
C. cannot be mixed with water
D. forms a milky liquid when mixed with water

11. A pesticide withholding period means:

A. how long before it is safe to enter a field after spraying
B. the period during which animals are not allowed to graze on the crop at any time
C. the number of days between the last application of a pesticide and crop harvest
D. how long before a pesticide is allowed into a country

12. Copper can be used to control:

A. phytoplasmas and viruses
B. nematodes and mites
C. snails and insects
D. <u>bacteria and fungi</u>

13. Pests in a small farm or garden are best controlled by:

A. ignoring them
B. using pesticides as soon as they are seen
C. <u>encouraging beneficial insects and spiders</u>
D. using insecticides and fungicides weekly

14. Pesticides allowed in organic farming:

A. come only from plants
B. are the same as bought pesticides only weaker
C. <u>are controlled under organic standards</u>
D. are always safe

8.7 Answers: Chapter 6

Chapter 6 brings together everything your trainees have learned in the previous chapters to plan, run and reflect on a PHC, first as a simulation and then a real one for farmers.

Exercise 24: What do we need to run a successful plant health clinic?

This exercise helps your trainees to think about everything they will need for a successful clinic.

When asking them to report back, start with 'before' and let each group give their ideas. After the first group has spoken, the other groups should just add anything that has been left out (see section 6.2). Otherwise it will take too long, be repetitive and people might get bored. An example is given here, but check the manual for the full list.

What do we need?		
Before the PHC	**During the PHC**	**After the PHC**
• Good location for farmers • Awareness of the clinic before it is held • Tables/chairs • Banner • Join country WhatsApp group	• Pacific Pests, Pathogens & Weeds app • CommCare app • Prescription forms • Pen or pencil • Knives • Hand lens • Camera	• Samples brought by farmers • Farmers' Feedback Forms • Prescription Forms (copies) • Photosheet summary template

Exercise 25: WhatsApp - How to use it

The country WhatsApp groups were discussed in Chapter 3. Here, your trainees learn to send pictures of unknowns or confusing samples to the WhatsApp group as part of running a clinic. Trainees should send their phone numbers to the person in charge of the WhatsApp groups before the clinic.

You should ask members of the country and other WhatsApp groups if they can be available when you run this exercise.

Exercise 26: Role play - filling out the prescription form

This exercise builds on Exercise 23 in Chapter 5. Ask the trainees to go outside and collect a sample of each of:

- a pest
- a disease
- an unknown problem

If this is not possible, you need to provide the samples yourself, or use one of the photos in the manual or from the Pacific Pests, Pathogens & Weeds app.

You should carefully model the process of the clinic first, acting as the plant doctor while one of your trainees plays the role of the farmer. Go through the farmer interview process step by step, explaining clearly what you are doing at each step while the trainees observe.

After you have done this and discussed any issues or questions, ask trainees to form pairs. Provide each pair with a **Prescription Form** to fill in.

Remind the trainees to go through the A,B,C and possible/probable identification and diagnosis steps carefully (see Chapter 2). **They should not** go straight to the Pacific Pests, Pathogens & Weeds app. When doctors do this at clinics, they often make the wrong diagnosis, something similar to humans self-diagnosing a disease using Google!

The 'doctor' should interview the 'farmer' and fill in the Prescription Form carefully and clearly. The data can also be added to the CommCare app to practise using it.

Sometimes doctors give a farmer incorrect information because they do not want the farmer to think they do not know something. Stress to your trainees that they should not fill in answers if they do not know what the problem is. It is much better to tell a farmer they do not know and they will find out, than give incorrect advice. In this case, they should write on the Prescription Form 'unknown'.

When they have finished, discuss the exercise with the class. It is really important that proper reflection is done at this stage to uncover problems the trainees may have encountered.

Exercise 27: Using the CommCare Prescription Form

Demonstrate to the class how the CommCare form works. Have the trainees download the CommCare app to their smartphone or tablet and open the plant health clinic Prescription Form. Now take any pest or disease sample and fill in the form (offline), as has been done for the hard copy.

Even if we find a way to print out the form, there may still be a need to have the completed form translated into local languages first. There is also the difficulty of deciding how to treat Solomon Islands Pijin where it is not used commonly as a written language.

These issues need to be discussed and resolved by the plant health team in each country.

Exercise 28: Filling in the Farmer Feedback Form

The farmer feedback form is an important document to be used after the farmer has seen the plant health doctor at the clinic. The clinic manager or another designated person (especially someone who speaks the farmer's language) interviews each farmer about his/her experience of the clinic and completes the feedback form. The team in each country should ensure translations into their language (Fijian, Samoan, Solomon Islands Pijin or Tongan) are made available, as well as English.

The manager collects and collates all the feedback forms to present and discuss during the reflection after the clinic. This is an important part of reflection, as well as monitoring and evaluation.

After each interview, the person who played the role of the farmer should use the form to give feedback to the plant health doctor on the diagnosis process and suggested recommendations. Discuss the answers with the whole class and reflect on what improvements could be made.

Exercise 29: What to do if large number of farmers attend the clinic with the same problem

Often, a number of farmers bring the same problems to the clinic if there is an outbreak of an insect pest or disease in the area. If the clinic manager notices this, and if there is time after they have received their prescription from the doctor, it would be very useful to gather the farmers together and ask one of the doctors to give them a short talk about the problem. This will give the farmers the opportunity to talk to each other about the problem and what they are trying to do about it.

Note that it is important that all farmers see the doctor first.

It is very important that you prepare your trainees for the possibility that many farmers will bring the same problem; you can do this by helping them become familiar with plant pests or diseases that they are likely to see at the clinic. Extension staff should already be aware of the major pests and diseases in their area, though sometimes new problems spring up quickly, especially when weather conditions change.

As the trainer, it is important that you have some knowledge about what these pests and diseases are likely to be. Tables 2.6 and 2.7 in Chapter 2 have a list of the most common pests and diseases in Samoa and Tonga. Trainers in Fiji and Solomon Islands need to ensure they also have country-based or regional-based information.

For this exercise, give your trainees an example of a pest or disease which is likely to be a problem in the area where the clinic is to be held. If you cannot find a live sample, use a picture or an example from the Pacific Pests, Pathogens & Weeds app. The trainees should prepare a short presentation about the problem for the class covering:

- the symptoms
- the diagnosis
- recommendations for control now and in the future

Ensure each group presents on a different pest or disease.

Exercise 30: Reflection on the clinic process

Exercise 31: Looking at the farmer feedback forms

Exercise 32: Reflection on diagnosis and recommendations

These three exercises are critically important for learning and improving the clinics, and should be gone through carefully. Emphasise that being wrong is nothing to be ashamed of, rather it is a vital part of the learning process, and that everyone gains from it, however experienced we may be. It is something we can all share in.

Exercise 33: Sending 'unknown' samples for identification

This is an exercise in sending a sample to an expert for examination, locally or overseas, so that an identification can be made. Make sure that you have the equipment needed before starting this exercise.

Set up three tables, with examples of either: (1) a fungal or bacterial disease; (2) a pest; or (3) a virus.

Write the instructions for sending away each type of problem and place on the table.

To start, each group should write a label to put inside the parcel containing:

- Crop/plant name
- Code given at the clinic
- Location of the clinic
- Farmers' name
- Farmer's village
- Short description of the problem

Trainees should follow the instructions for their pest or disease, and when they have finished, they should unwrap or dismantle the sample for the next group and move to the next table.

Exercise 34: Plant health doctor self-evaluation form

Now it is time to ask your trainees to evaluate themselves as a plant health doctor using the self-evaluation form. Emphasise that this is anonymous. Self-evaluation is important. It helps the trainees think about their progress and helps the extension service to monitor how well the program is running, and what further training may be needed.

Collate and report the overall results from the class. Discuss what this says about your trainees' confidence and ability to conduct a clinic. Ask:

- What do they think needs to be done to improve?
- How should this take place?

Exercise 35: Making a plant health clinic photosheet summary

It is very important to make a summary for the clinic to record the main points and to send it to senior officers, the media and others who are interested in the clinic program. This should be done on the day of the clinic if possible, usually by the clinic manager. The template for this is in Appendix 3.

END OF CHAPTER 6 QUIZ: Test your knowledge

The answers are given **in bold underline**. When they have all finished, go through the answers. You do not need to ask what marks the trainees got; they will have learned the correct answers by going through the test as a class. Make sure you discuss any answers they are not sure about. Then explain that if there is anything they are still not sure about, they should read the manual again and/or ask for help.

1. Plant health clinics are important parts of:

A. a country's food security
B. a country's plant health system
C. the agricultural extension system
D. all of the above

2. The best place to hold a clinic is:

A. where many farmers gather, e.g. a market
B. at the research station
C. on a farm
D. at the university

3. Important advice for farmers when raising awareness about a forthcoming clinic is:

A. to bring the whole plant, including roots
B. to bring a few leaves
C. to bring a soil sample
D. to bring your phone

4. If you do not know what the problem is, you should:

A. leave that part of the prescription form blank
B. tell the farmer something, even if you are not sure
C. ask if anyone else knows what the problem is
D. send the farmer away

5. Look at the steps below for identifying a disease sample.

1. Make a parcel for the specimens with newspaper
2. Write a label and put the specimen in a plastic bag with a water and seal the bag
3. Collect samples showing a full range of symptoms

The correct order to do these steps in is:

A. 1, 2, 3
B. 3, 2, 1
C. 2, 1, 3
D. 1, 3, 2

6. Insect samples to be sent away for identification are best preserved in:

A. methanol
B. isopropyl alcohol
C. 70% alcohol
D. beer

7. A plant doctor suspects a farmer's sample has a bacterial wilt. She can test this by:

A. smelling it to see if it smells rotten
B. cutting the stem and dipping the end of it in water and looking for milky streams
C. finding the bacteria under a microscope
D. looking for spots on the leaves

8. The most important items to take to a clinic are:

A. chairs
B. kava
C. uniforms
D. prescription forms

9. After a clinic, a plant health doctor must always:

A. follow up with a farmer if the farmer has been told that will happen
B. reflect on and review the clinic data and plan to improve for next time
C. collect all the samples for looking at later with the other plant health doctors
D. <u>do all of the above</u>

10. A farmer brings yams that have died and gone black. The farmer tells the plant health doctor they have been damaged by lightning. The doctor thinks the problem is anthracnose. The doctor should help the farmer straight away by:

A. <u>agreeing that lightning might be the cause but also offering other ideas of the cause, and suggesting what the farmer could do</u>
B. offering to visit the farm
C. telling the farmer he or she cannot be helped at the clinic
D. asking the farmer to bring in more samples

The Big Quiz - Answers

This should be done at the end of the training as a revision exercise, and afterwards, celebrate the end of the training!

The answers are given **in bold underline**.

1. A plant health system should include:

- **A. plant health clinics, extension staff, research staff, ministries of agriculture staff**
- B. biosecurity staff, research staff, hospital staff, quarantine staff
- C. plant health doctors, vets, extension staff, research staff
- D. media, tourism, agriculture, horticulture

2. Which of the following are all insecticides?

- A. Manzate, milk, baking soda, Taratek
- B. Sundomil, Attack, Multiguard, Confidor
- C. Glyphosate, neem, Blitzem, pyrethrum
- **D. Confidor, Orthene, Bt, Taratek**

3. A sprayer nozzle suitable for fungicide should:

- A. be an anvil type and the spray should form a light rain
- B. be a flat type and the spray should form a light rain
- **C. be a hollow cone type and the spray should form a mist**
- D. be a flat type and the spray should form a cloud

4. A pesticide label says that it should be made up at a concentration of 1 ml pesticide to 10L water. The concentration of the pesticide is:

- A. 10%
- B. 1%
- C. 0.1%
- **D. 0.01%**

5. A farmer has 10 ha of a crop to be sprayed. The pesticide label tells her that the spray should be 30 ml pesticide per 20 L water and the crop should receive 500L per ha. How many ml of the pesticide should she use to make up the spray to cover the whole crop properly?

- A. 3000 ml
- B. 4000 ml
- C. 6000 ml
- **D. 7500 ml**

6. Build-up of pesticide resistance in a pest can be prevented by:

A. alternating the spraying between an insecticide and a fungicide
B. spraying early in the morning
C. using the correct type of nozzle for spraying
D. <u>making sure the same type of pesticide is not used all the time</u>

7. Which action should you NOT do if you accidently spill some pesticide?

A. cover the area with sand
B. make sure you wash yourself and your clothes thoroughly
C. keep children away from the spill
D. <u>leave it to evaporate away</u>

8. Pesticide resistance in insects is caused by:

A. <u>a genetic mutation that is passed on to new generations of the insect</u>
B. using the wrong crop rotation
C. a herbicide being used by mistake
D. a virus getting into the insect

9. Which of the following information is NOT usually found on a pesticide label?

A. the type of product
B. <u>which pests are resistant to it</u>
C. what it contains
D. what crops it may be used on

10. A wettable powder:

A. is the same as an emulsifiable concentrate
B. is incompatible with all other pesticides
C. <u>can be mixed with water</u>
D. forms a milky liquid when mixed with water

11. A pesticide withholding period:

A. is the period before it is safe to enter the crop after spraying.
B. is the period when animals are not allowed to graze on the crop at any time.
C. <u>is the number of days between the last application of a pesticide and crop harvest</u>
D. is the period before a pesticide is allowed into a country from overseas

12. In IPDM, pesticides should be used:

A. always, as a prevention
B. never
C. <u>as a last resort</u>
D. only if the farmer can afford them

13. The adult insect in the picture below is most likely to be:

A. a beetle
B. a wasp
C. <u>a lacewing</u>
D. a fly

14. In order, a companion plant, a biological insecticide and a beneficial organism are:

A. taro, DBM, *Trichoderma*
B. Chinese cabbage, kocide, ladybird
C. coconut, pyrethrum, *Trichogramma*
D. <u>marigold, *Metarhizium,* spider</u>

15. An example of a good crop rotation would be:

A. lettuce, cabbage, broccoli, bean
B. cucumber, squash, potato, cassava
C. potato, tomato, eggplant, capsicum
D. <u>bean, cabbage, cassava, cucumber</u>

16. A plant health doctor is faced with an unknown pest or disease at the clinic. What should s/he do first?

A. send a picture to WhatsApp
B. make up something; it's better than the farmer thinking they don't know
C. <u>see if anyone else in the clinic knows</u>
D. tell the farmer to go away

17. In IPDM, monitoring involves:

A. deciding whether the problem is caused by a pest or a disease
B. using the best pesticide for the pest
C. checking the level of damage and looking for bugs and eggs
D. identifying the pest or disease

18. The correct sequence for applying IPDM is:

A. monitoring, evaluation, making a plan, identification of pest or disease
B. evaluation, monitoring, identification of pest or disease, making a plan
C. making a plan, identification of pest or disease, monitoring, evaluation
D. identification of pest or disease, monitoring, evaluation, making a plan

19. Which plants are all in the same plant family?

A. cabbage, bok choy, broccoli, chilli
B. potato, cassava, taro, sweet potato
C. bitter gourd, pumpkin, cucumber, pineapple
D. capsicum, chilli, eggplant, potato

20. The best way to control a soil-borne bacterial infection is:

A. use a resistant variety if it can be obtained
B. spray with a pesticide
C. use a virus that attacks the bacteria
D. add compost to the soil

21. Which of the following is NOT thought to be associated with companion planting:

A. companion plants can provide food for parasitoids
B. companion plants may have a smell that repels pests
C. always add large amounts of potassium to the soil
D. companion plants may repel root knot nematodes

22. In order, abiotic and biotic factors that cause damage on plants are:

A. a fungus and a mite
B. a bird and drought
C. potassium deficiency and a virus
D. phytoplasma and poor soil

23. Typical symptoms on plants caused by bacteria are:

A. leaf spots, angular or round, with or without haloes
B. <u>wilt and yellowing at the edges of leaves</u>
C. rusty spots and mosaics
D. dieback and the leaves go purple

24. A common disease of tomatoes in the Pacific region is:

A. witches' broom
B. tobacco mosaic
C. <u>Early blight</u>
D. ring spot

25. The smallest of these pathogens is:

A. <u>a virus</u>
B. a phytoplasma
C. a bacterium
D. a fungal spore

26. A plant doctor finds a plant with symptoms of wilt. The most unlikely cause would be:

A. bacteria in the soil
B. <u>rust fungus</u>
C. nematodes
D. stalk borers

27. Pests with eight legs are not:

A. mites
B. <u>insects</u>
C. scorpions
D. spiders

28. Which of these diseases is caused by a fungus?

A. bunchy top on banana
B. blossom end rot on tomato
C. scale on sweet potato
D. <u>damping off on cabbage seedlings</u>

29. A plant doctor finds a cabbage with a lot of holes in the leaves. Which is not a likely cause?

A. Diamondback moth
B. large cabbage moth
C. leaf spot
D. snails

30. A virus can be spread by:

A. bacteria
B. fertiliser
C. rhinoceros beetles
D. **aphids**

31. Two insects with simple life cycles are:

A. aphids and katydids
B. butterflies and bugs
C. grasshoppers and ants
D. bees and moths

32. Plant health clinics are important parts of:

A. a country's food security
B. a country's plant health system
C. the agricultural extension system
D. all of the above

33. The best place to hold a clinic is:

A. where many farmers gather, e.g. a market
B. at the research station
C. on a farm
D. at the university

34. Important advice for farmers when you are raising awareness about a forthcoming clinic is:

A. to bring a whole sample if possible
B. to bring a few leaves
C. to bring a soil sample
D. to bring their phone

35. If you do not know what the problem is, it is best to:

A. leave that part of the Prescription Form blank
B. tell the farmer something, even if you are not sure.
C. send the farmer away.
D. <u>ask if anyone else knows what the problem is</u>

36. Look at the steps below for identifying a disease sample.

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2. write a label and put the specimen in a plastic bag with a few drops of water and seal the bag.
3. collect samples showing a full range of symptoms.

The correct order to do these steps is:

A. 1, 2, 3
<u>B. 3, 2, 1</u>
C. 2, 1, 3
D. 1, 3, 2

37. Insect samples to be sent away for identification are best preserved in:

A. beer
B. methanol
C. isopropyl alcohol
D. <u>70% alcohol</u>

38. A plant doctor suspects a farmer's sample has a bacterial wilt. She can test this by:

A. smelling it to see if it smells rotten
B. looking for spots on the leaves
C. <u>dipping the end of the root in water and looking for milky streams</u>
D. finding the bacteria under a microscope

39. The most important items to take to a clinic are:

A. chairs
B. kava
C. uniforms
D. <u>prescription forms</u>

40. After a clinic, a plant health doctor must always:

A. follow up with a farmer if the farmer has been told that will happen
B. reflect on and review the clinic data and plan to improve for the next clinic
C. collect all the samples for looking at later with the other plant health doctors
D. <u>do all of the above</u>

41. A farmer tells the plant health doctor he thinks his crops have been damaged by an evil spirit. The doctor should help the farmer by:

A. <u>agreeing this might be the case and offering other ideas of what the farmer could do</u>
B. sending the farmer to a priest
C. telling the farmer he cannot be helped at a plant health clinic
D. asking the farmer to bring in more samples

42. Which Pacific countries now have the Guam strain of the rhinoceros beetle?

A. Samoa
B. Tonga
C. Fiji
D. <u>Guam, Palau, Papua New Guinea, Solomon Islands</u>

43. Good soil is likely to have a pH of around:

A. 1
B. 3
C. 9
D. <u>7</u>

44. Which of these home-made pesticides is particularly harmful to fish?

A. chilli
B. *Gliricidia*
C. neem
D. derris

45. What are the pests in this photo?

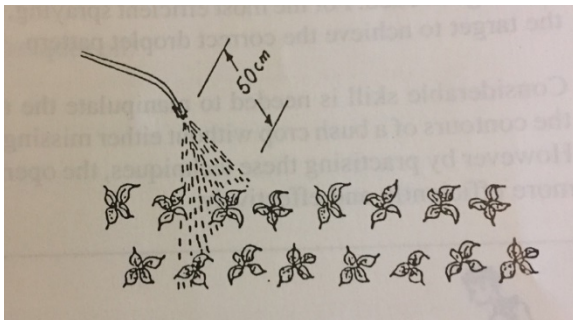
A. rhinoceros beetles on mango
B. green vegetable bugs on tomato
C. black ticks on pumpkin
D. aphids on guava

46. What is the difference between a parasite and a parasitoid?

A. there isn't one: they are the same
B. a parasite does not kill its hosts; a parasitoid does
C. a parasitoid can't be seen with the naked eye; parasites can
D. parasites have complex life cycles whereas those of parasitoids are simple

47. The picture below shows you how:

A. to spray low-growing crops
B. far apart crops should be
C. to use a mist sprayer
D. to water your plants in a drought



48. A farmer brings a plant with large irregular spots on the leaves. It is most likely to be:

A. a wilt
B. a deficiency disease
C. a fungal disease
D. something I know nothing about

49. You want to teach your trainees to think about how plant diseases relate to people going hungry. The best teaching strategy is probably:

A. <u>a cause and effects diagram</u>
B. a picture of a hungry child
C. a role-play
D. a concept map

50. Which symptoms are often confused?

A. a powdery mildew and a leaf spot
B. <u>a virus and a deficiency disease</u>
C. a bacterial leaf spot and a bacterial wilt
D. overwatering and copper deficiency