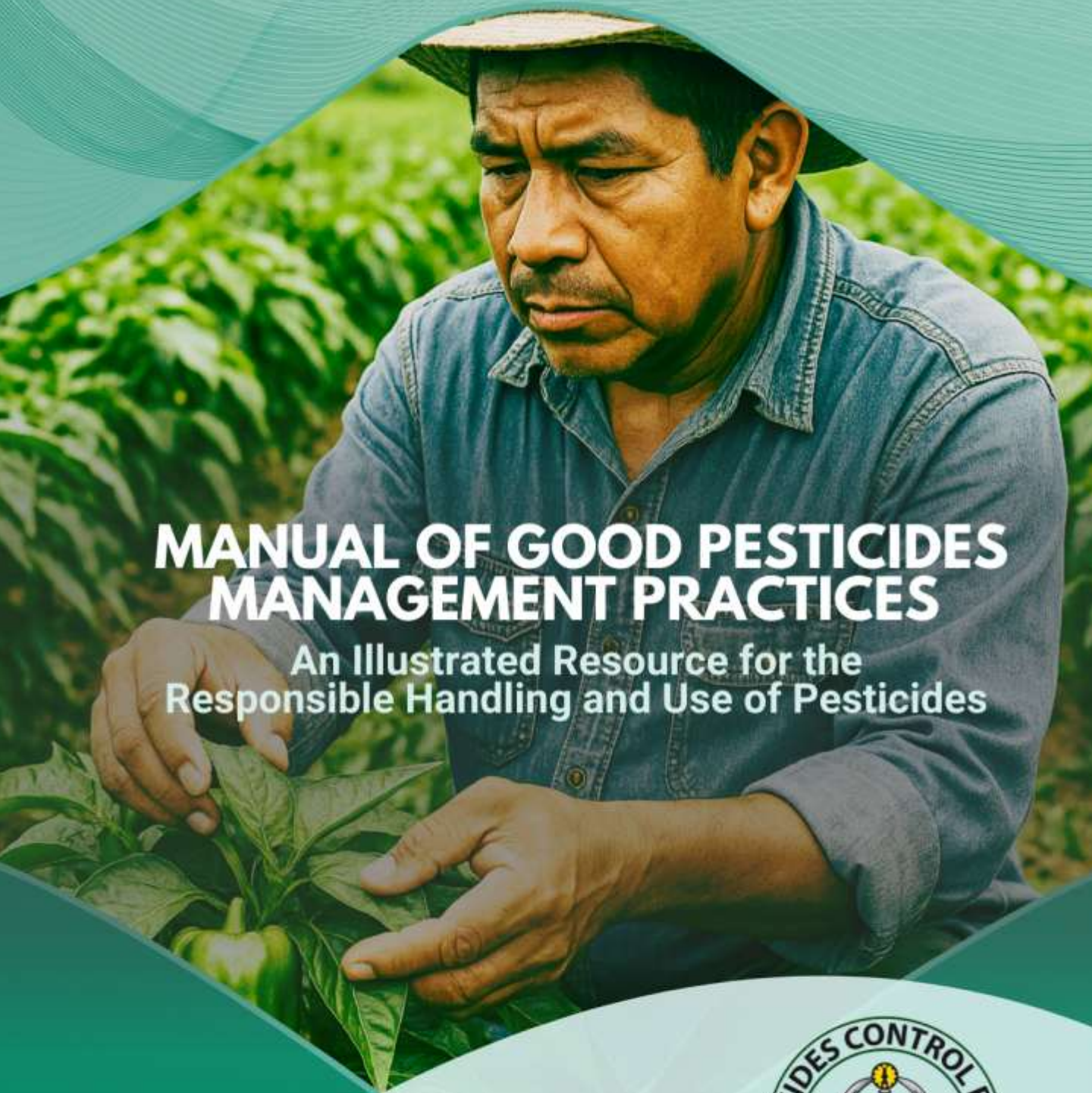
Belize

National Pesticides Training and Certification Program



MANUAL OF GOOD PESTICIDES MANAGEMENT PRACTICES

An Illustrated Resource for the Responsible Handling and Use of Pesticides

PESTICIDES CONTROL BOARD
BELIZE

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We appreciate the partnership and support of the International Fund for Agricultural Development through the Resilient Rural Belize (RRB) Programme, whose collaboration helped to make this publication possible along with the training of 376 farmers from beneficiary producer organizations. We also thank the Ministry of Agriculture, Food Security and Enterprise (MAFSE) and partners in agriculture development, for continued support of the PCB's strategic objectives.

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The PCB extends gratitude to Alliance Consulting Services team for editorial support and converting technical information into farmer-friendly visuals.

Finally, we extend sincere thanks to the farmers, producer organizations, farmer associations, extension officers, suppliers of agricultural inputs, agricultural research and educational institutions who help carry good practice into fields and shared day-to-day experience in real conditions. Your feedback has helped to keep the manual practical, clear, and relevant.

To all contributors, thank you.

"Thank you for your contribution."

Acknowledgement

Foreword

Mandate to safeguard health, agriculture, and the environment

When pests threaten our crops, the choices we make on the farm, at the pesticide retail store, and around the home ripple far beyond the field reaching our dinner tables, our rivers, and our markets. That is why the Pesticides Control Board (PCB), Belize exists. We were established to protect people, crops, livelihoods, and the environment by regulating how pesticides are imported, distributed, used, and disposed of so that agriculture can thrive while communities remain healthy. This responsibility, set out in national law, guides everything we do and anchors the training services we provide to our agricultural sector and our people.

National training and certification

Since 1995, PCB launched the National Pesticide Training and Certification Program to equip users with the knowledge and skills to handle pesticides responsibly. The program has helped build competency among farmers, agricultural workers, storekeepers, pesticide retailers, pest control operators, and other users through practical instruction, field support, and certification. From Toledo to Corozal, training participants have learned how good decisions in the field protect family health, improve yields, and safeguard our export reputation.

Practical tools and learning aids

Experience taught us that rules work best when people have tools they can use in real time. Early picture cards and checklists helped turn complex guidance into simple steps. As the needs of our farmers grew, those materials evolved into an Illustrated Training Guide that kept learning going between workshops and during periods when in-person sessions were limited. The aim remained the same: make responsible practices easy to understand, easy to remember, and easy to do.

Manual's features and alignment

This new manual is the next step in that evolution. It presents clear images, short instructions, and a logical flow from planning to clean up, with review activities that support both self-study and group training. The goal is practical and measurable: help every reader make sound decisions, reduce exposure, protect our natural resources, and keep residues within legal limits.

Foreword

Message from the Registrar of PCB

The Pesticides Control Board (PCB) has promoted pesticide life-cycle management since 1988, when the Pesticides Control Act established its Secretariat. With two trainers, a nationwide campaign began to sensitize farmers and the public in responsible pesticide use.

The publication of this manual marks the 30th anniversary of the National Pesticides Training and Certification Programme (NPTCP), formalized in 1996 with Certified Users Regulations. Early implementation, supported by USAID's NARMAP project, trained 10,000 farmers in two years with a team of five trainers.

Certified User Regulations require restricted-use pesticide users to read labels for dosage and precautions, apply safe practices in use, storage, and disposal, distinguish pesticides by hazard, prepare mixtures correctly, calibrate sprayers, and uphold responsibilities to workers and the public. The program has since evolved and is delivered nationwide by five trainers, with adaptable modules for different groups.

We urge you to use this manual to strengthen responsible pesticide handling, protect health and the environment, and adopt Integrated Pest Management, prioritizing prevention and correct pesticide use. Best practices safeguard families, farms, and consumers while ensuring markets for safe Belizean produce.

Thank you for supporting PCB's mission to protect Belizean health and the environment through regulation, training, and responsible pesticide management.

Miriam Ochaeta Serrut
Registrar of Pesticides
Pesticides Control Board, Belize

"Together, we build a culture of responsible pesticide management."

Key Message

Dear Reader,
Welcome to the updated Manual of Good Pesticides Management Practices: An Illustrated Resource for the Responsible Handling and Use of Pesticides. This reference guide was created by the Pesticides Control Board (PCB) to help you protect your health, your family, and your environment while growing healthy food.

Pesticides can be helpful for controlling pests; but, if not used properly, they can harm people, animals, and the environment.

This manual supports the objectives of the National Pesticides Training and Certification Programme as well as those of the PCB's Grow Safe-Belize campaign which aims to assist farmers in reducing their reliance on pesticides by adopting sustainable farming practices such as Integrated Pest Management (IPM).

Inside, you'll find simple explanations, many pictures and activities. The back of the book includes helpful tools like a sample label of a pesticide, safety checklist, first aid tips, and mixing conversions.

Whether you read a little or a lot, this book is made for you. You can read it alone, with your family, or in a group during a training session. You can write in it, draw, or use it in the field. It's your guide.

By learning and working together, we can grow crops safely, protect our health, and keep Belize's environment clean for the future.

Let's grow safe, Belize!

Sincerely,
Pesticides Control Board, Belize

Message

"Ensuring responsible pesticide use for a healthier Belize."

Vision & Mission

VISION

A Belize where the environment and associated eco-systems, human and socio-economic development are protected through the rational use of pesticides.

MISSION

To safeguard the health of the Belizean people and the environment through pesticide regulation and capacity building, thus promoting the availability of wholesome food through rational pesticide management

THEME:

"Responsible Pesticide Management for Sustainable Food Systems."

Acronyms

BAHA	Belize Agricultural Health Authority
CS	Capsule Suspension
DOE	Department of the Environment
EC	Emulsifiable Concentrate
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GHS	Globally Harmonized System
GOB	Government of Belize
HHP	Highly Hazardous Pesticide
IFAD	International Fund for Agricultural Development
IPM	Integrated Pest Management
LD_{50}	Lethal Dose 50%
MAFSE	Ministry of Agriculture, Food Security and Enterprise
MOHW	Ministry of Health & Wellness
MRL	Maximum Residue Limit
NPTCP	National Pesticide Training and Certification Program
P.O.	Producer Organization
PAHO	Pan American Health Organization
PCB	Pesticides Control Board
PHI	Pre-Harvest Interval
PPE	Personal Protective Equipment
REI	Re-Entry Interval
RRB	Resilient Rural Belize Programme
SC	Suspension Concentrate
SDS	Safety Data Sheet
SL	Soluble Liquid
ULV	Ultra-Low Volume
WG / DF	Water-Dispersible Granule / Dry Flowable
WHO	World Health Organization
WP	Wettable Powder

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Introduction

What is the training manual about?

Pesticides can protect crops, reduce losses, and improve harvests, but only when used responsibly.

This training manual was created for farmers like you, to help you manage your pest problems while protecting your health, your family, your livestock, your land, and your profits.

Across Belize, many farmers use pesticides to control pests like aphids, mites, and plant diseases. But using the wrong product, using too much pesticide, or not taking the necessary safety precautions can result in health issues and economic loss.

That's why this manual takes you step-by-step to show you what to do. It has easy words, pictures, and simple activities to help you learn.

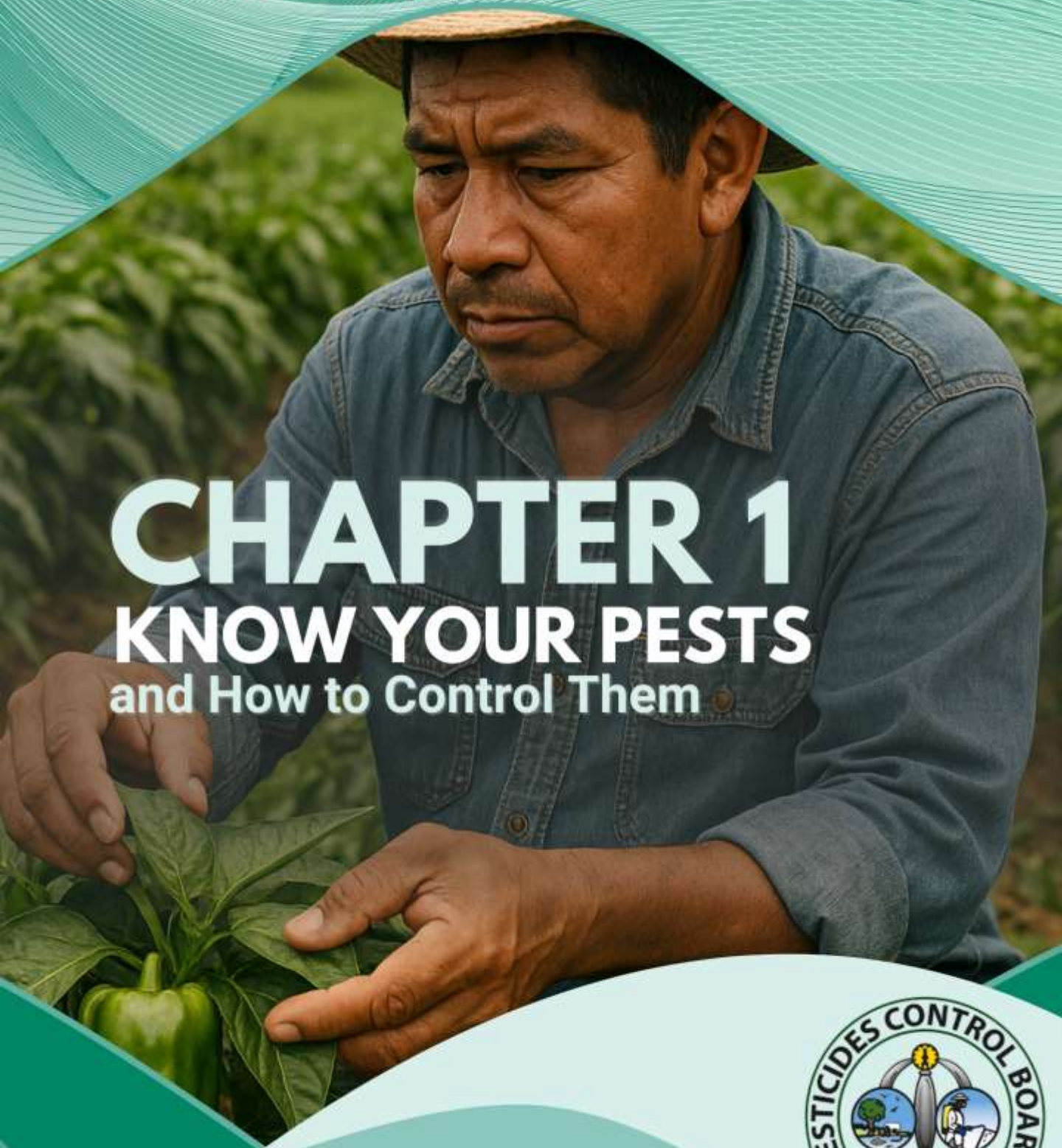
Who can use this manual?

- Farmers (smallholder and commercial)
- Extension officers and field technicians
- Agricultural products suppliers
- Farm supervisors and spray team leaders
- Agroecology and IPM trainers
- Pesticide Safety Trainers and Educators
- Students and trainees in agriculture programs
- Staff from NGOs and cooperatives working in crop protection

Why Does It Matter?

Using pesticides responsibly is not about following rules. It's about protecting your health and improving your yields. Every time you mix, spray, or store pesticides correctly, you're making your farm more productive, your food safer, and your environment cleaner.

Belize
National Pesticides Training
and Certification Program



CHAPTER 1
KNOW YOUR PESTS
and How to Control Them

PESTICIDES CONTROL BOARD
BELIZE

CHAPTER 1: KNOW YOUR PESTS

In this chapter, we will learn how to find out what is really harming our crops and how to manage pests without always using pesticides. Not every insect or brown leaf means you need to apply pesticides. Sometimes, the problem could be too little water, too much rain, too much sun, or lack of nutrients.

By the end of this chapter, you'll see that applying pesticides is not always the best first step. Many times, you can save money, protect your health, and still grow good crops by using safer and simpler methods first.

SESSION 1.1: What is a Pest?

A pest is any living organism that *harms your crops or livestock.*

What are they?

Pests can be insects, mites, weeds, fungi, bacteria, viruses, nematodes, or even snails and slugs. Some pests are big and easy to see, like caterpillars. Others are tiny or invisible, like mites or viruses.

How do they harm crops?

They eat, suck, damage, or spread disease, and they can reduce your yield and quality.

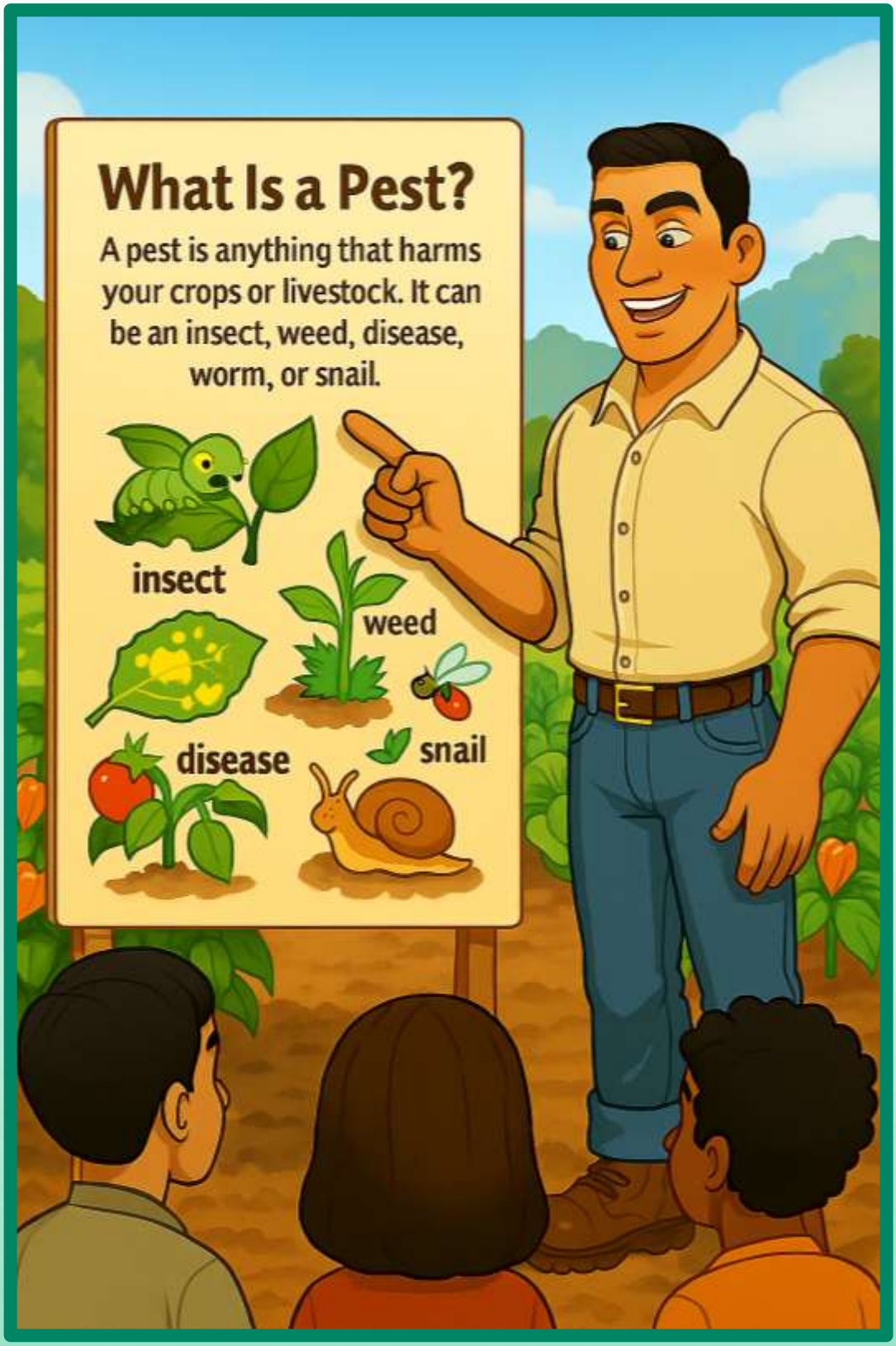
Are all organisms harmful?

No. Not all organisms present on your plant are pests. Some insects, bacteria, and even small viruses can help your farm. They might:

- Kill pests
- Help pollinate crops
- Help your crops grow
- Protect your plants

This is why it's important to know which insects are harmful and which are beneficial.

Box 1: What is a Pest



Types of Pests

Here are the main types of pests, how they behave, how they damage your crops, and what signs to watch out for in the field. Types we will explore are: Insects, Acarids (Mites), Weeds, Nematodes, Molluscs, Fungi, Bacteria, and Viruses.

Type 1: Insects

Know the Basic Parts of an Insect

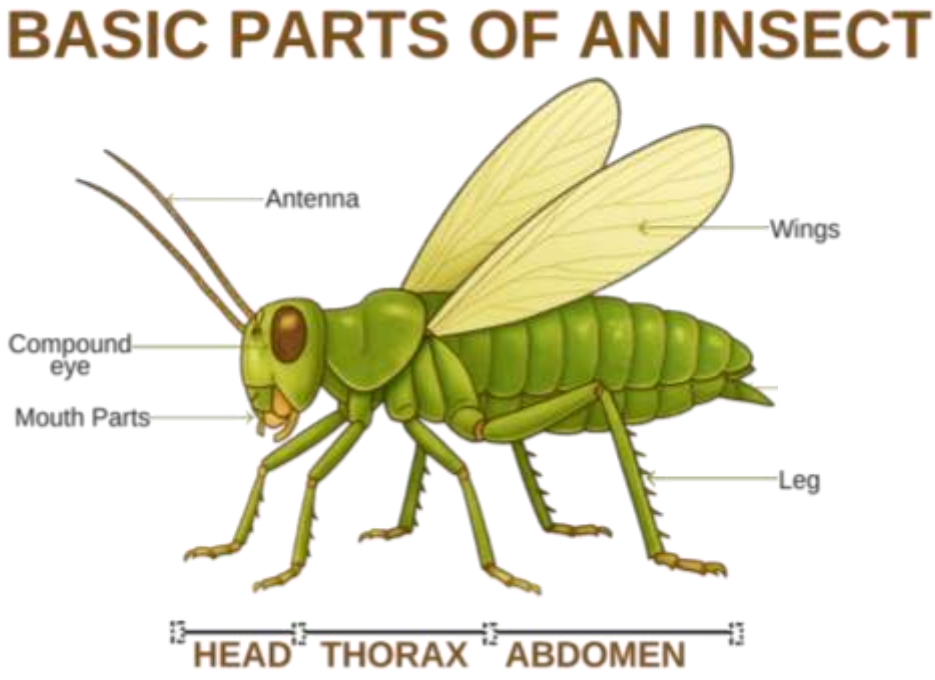
- The diagram shows the main body parts of an insect: the head, thorax, and abdomen.
- It also points out key features like the antennae, eyes, legs, and wings.
- EXAMPLE: Some insects only damage plants at larvae stage, not as adults. If you know how to identify the stage, you can act early and protect your crop.

Why Farmers need to know:

Knowing the basic parts of an insect helps you:

- Identify the stage of the pest's life cycle (egg, larva, adult), so you know the best time to act
- Use the right method to stop the pest, whether to trap, spray, or leave it alone
- Avoid wasting money on pesticides that don't work if used at the wrong time or on the wrong pest.

Figure 1: The Basic Parts of an Insect



Life Stages of Insects

All insects go through different stages as they grow. Some change a little, others change a lot. By understanding these life stages, farmers can spot pests early and control them before they cause economic damage.

Know the Basics of the Life Stages

Table 1: Basic Differences between Incomplete and Complete Insect Life Cycles

Type of Life Cycle	Key Features	What to Watch For	Examples
Incomplete Metamorphosis 3-Stages: Egg → Nymph → Adult	○ Nymph looks like a small adult ○ No wings at first ○ Both nymph and adult feed on same crops	**Watch the nymph**: ○ Starts feeding early ○ Easier to control with natural sprays ⚠ **Adult**: Lays more eggs Can fly or jump away	Leafhopper, Thrips Stink Bug
Complete Metamorphosis 4-Stages: Egg → Larva → Pupa → Adult	○ Larva looks very different from adult ○ Pupa is a resting stage ○ Adult lays eggs or carries disease	**Watch the larva**: ○ Chews leaves, roots, fruits ○ Catch early to save crop ⚠ **Pupa**: Hard to kill ⚠ **Adult**: Spreads fast, lays many eggs	Caterpillar, Beetle, Fruit Fly Weevil Moth

Figure 2: Incomplete Metamorphosis – Insect Life Cycle

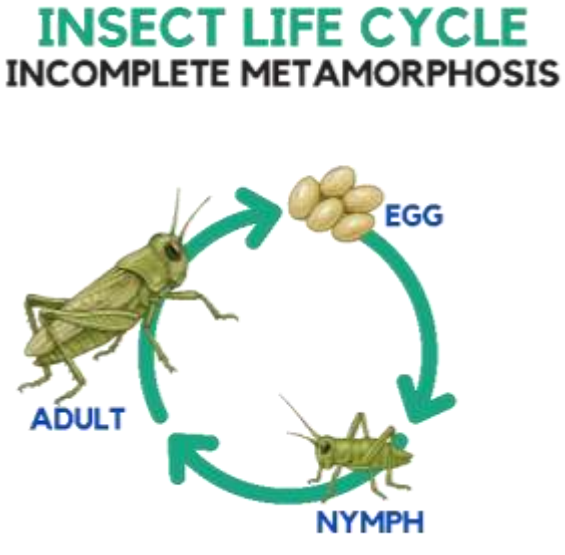
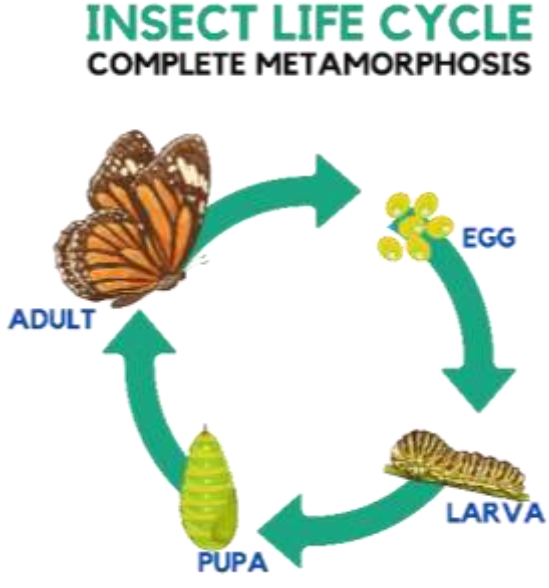


Figure 3: Complete Metamorphosis (Insect Life cycle)



Box 2: Insects that affect crops

Basic Features

- Are organisms with six legs
- Have 3 body parts: head, thorax, and abdomen
- Some have wings and can fly; others only crawl or jump
- Found on leaves, stems, flowers, roots, or fruits

How They Harm Crops

- Some chew holes in leaves, fruits, or stems (e.g., caterpillars)
- Some suck sap from plants, making them weak (e.g., aphids)
- Some lay eggs inside fruits or roots,
- Some carry diseases (like viruses) that harm crops

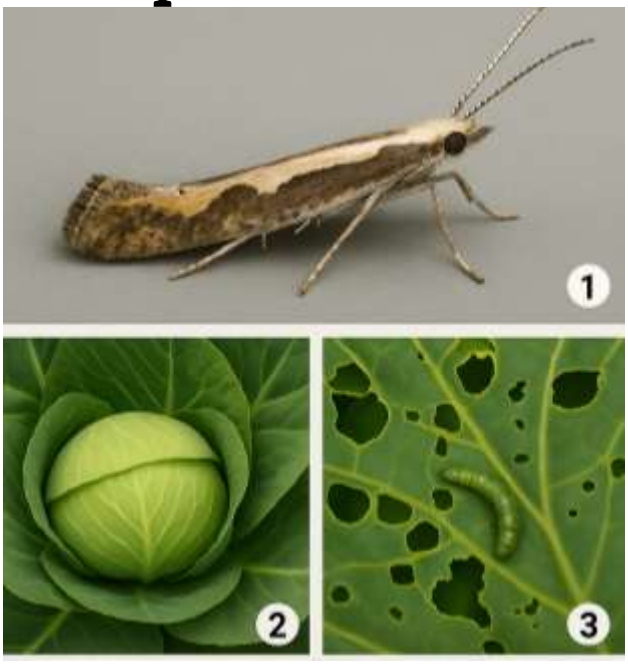
When They Appear

- Most insects multiply quickly in hot or rainy weather
- They can spread fast if not controlled early
- Often hide under leaves or inside flowers

Non-Chemical Approaches

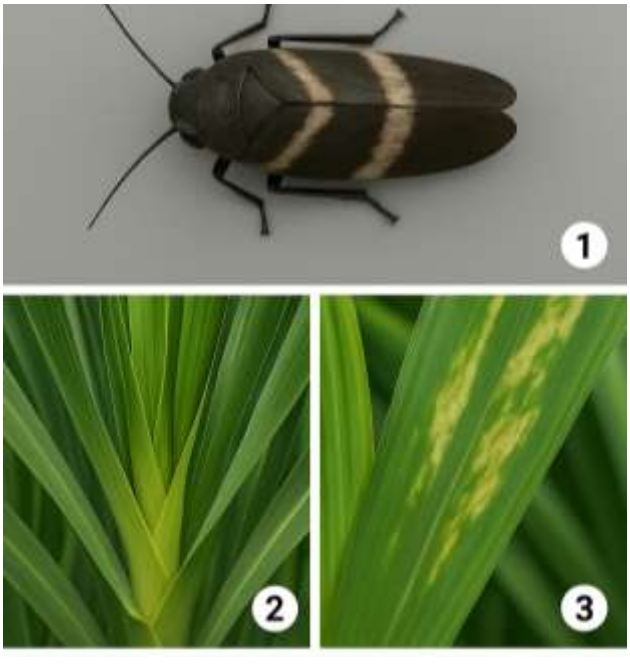
- Hand-pick large insects and egg clusters (e.g., caterpillars, beetles)
- Use neem or soap sprays to knock off soft-bodied insects
- Plant flowers near crops to attract natural enemies
- Use yellow traps for whiteflies or blue sticky traps for thrips
- Rotate crops to break insect life cycles

Examples of Insect Pest



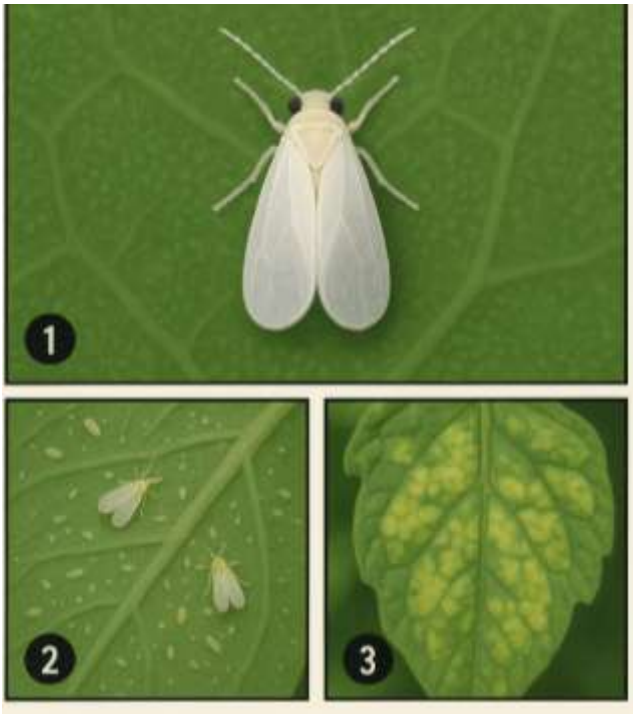
Diamondback Moth

- **Scientific Name**: *Plutella xylostella*
- **Description**: Small gray moth; caterpillars hide under cabbage leaves
- **Crops Targeted**: Cabbage, cauliflower
- **Damages Caused**: larvae feeds on leaves, creating holes near veins; plants stop growing
- **Non-Chemical Strategies**: Remove damaged leaves, rotate crops
- **Pesticides Needed**: insecticides, always rotate to avoid resistance



Sugarcane Froghopper

- **Scientific Name**: *Aeneolamia varia*
- **Description**: Jumping brown insect with wings; nymphs form white frothy masses on stems
- **Crops Targeted**: Sugarcane
- **Damages Caused**: Yellowing, reduced stalk growth, juice quality loss
- **Non-Chemical Strategies**: Drain excess water, encourage natural predators, resistant cane varieties
- **Pesticides Needed**: applied at early nymph stage if infestation is spreading; Always rotate pesticide to avoid pesticide resistance



Whitefly

- **Scientific Name:** *Bemisia tabaci*
- **Description:** Tiny white flying insects found under leaves; move when plant is disturbed
- **Crops Targeted:** Tomato, sweet pepper, cucumber, beans, and squash
- **Damages Caused:** Suck sap from leaves, cause yellowing and stunted growth; **spread viruses** between plants
- **Non-Chemical Strategies:** Use yellow sticky traps, remove heavily infested leaves, avoid overuse of nitrogen fertilizer
- **Pesticides Needed:** insecticides; rotate pesticides to avoid resistance

Signs and Symptoms

Box 3: Signs and Symptoms of Insect Damage

Type 2: Acarids (Mites)

Box 4: Examples of Mites

Basic Features

- Mites are tiny pests, much smaller than insects, often too small to see clearly without a hand lens
- They have 8 legs and look like very small spiders
- Found mostly on the underside of leaves or around the growing tips. Come in different colors: red, yellow, or translucent (almost clear)

When they Appear?

- Hot, dry weather (especially in the dry season)
- Dusty field conditions, such as roadside farms or bare, dry soil
- Periods of drought or water stress, when plants are already weak
- Overuse of pesticides, especially broad-spectrum insecticides, which kill natural predators like ladybugs and predatory mites
- Poor field hygiene – unclean fields with leftover plant debris or weed hosts

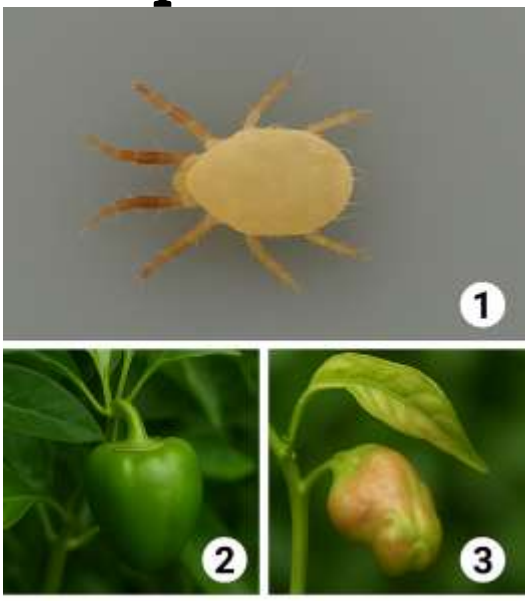
How they Harm Crops

- Suck sap from leaves and stems
- Cause yellowing, curling, bronzing, or drying of leaves
- Leaves may appear speckled or burnt-looking
- Fruit development slows and quality drops
- Weakened plants become more likely to be affected by other pests or diseases

Non-Chemical Approaches

- Spray plants with plain water to reduce mite numbers
- Use neem or soap spray regularly
- Remove and destroy heavily infested leaves
- Maintain soil moisture and use mulch during dry seasons
- Keep the field clean and avoid dusty conditions

Examples of Acarids (Mites)

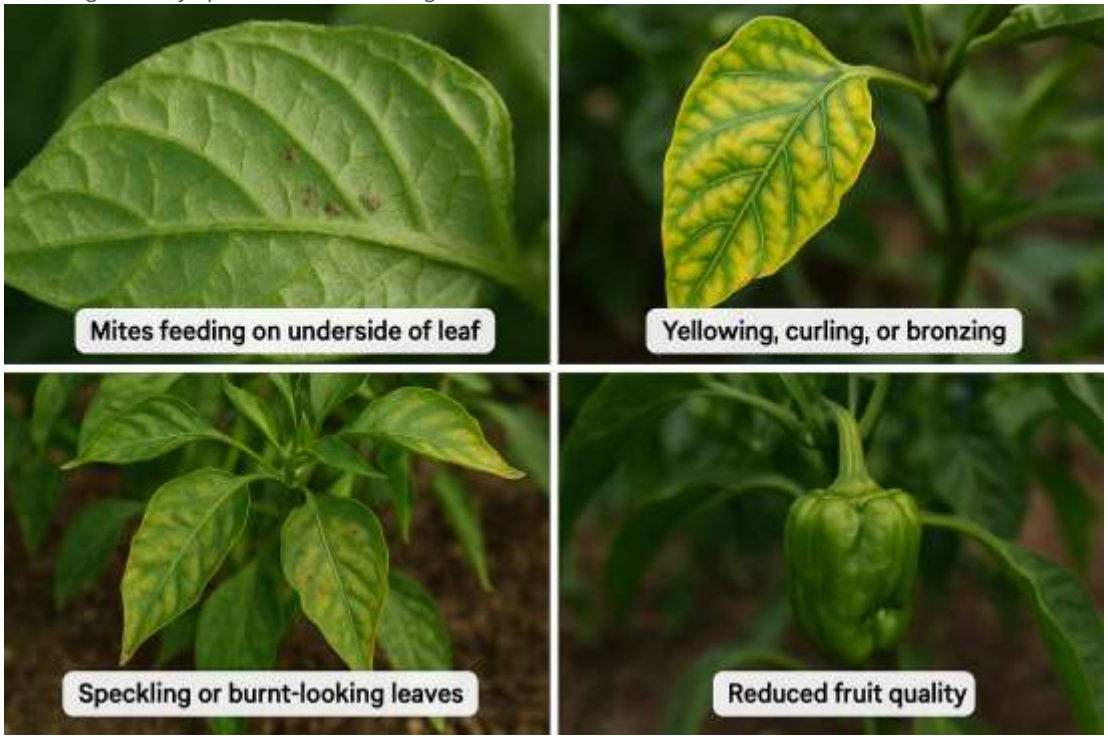


Broad Mite (*Polyphagotarsonemus latus*)
Damages Caused: New leaves become twisted, curled, and rough; buds drop or fail to open; fruit becomes misshaped.

Red Spider Mite (*Tetranychus urticae*)
Damages Caused: Mites suck sap from leaves, causing yellow speckles, curling, and drying.

Signs and Symptoms

Box 5: Signs and Symptoms of Acarid Damage



Type 3: Weeds

Box 6: Examples of Weeds

Basic Features

- Unwanted plants that grow among crops
- Can be broadleaf, grasses, or sedges
  Some grow from seeds; others regrow from roots or tubers

How They Harm Crops

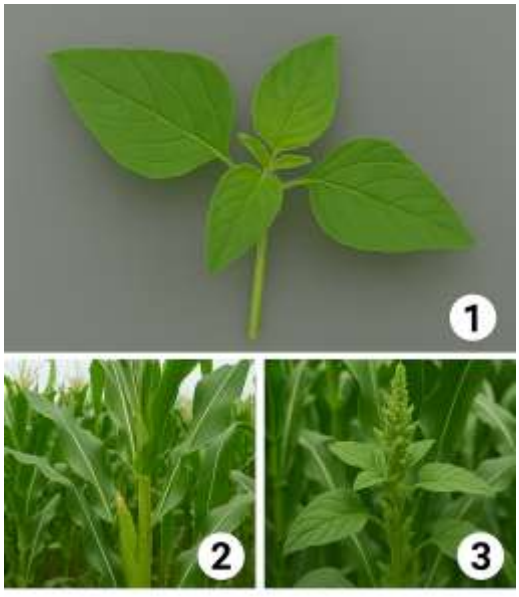
- Competing for nutrients from the soil
- Make it harder to plant, weed, or harvest
- Can host insects and diseases
- Reduce yield and crop quality

When They Appear

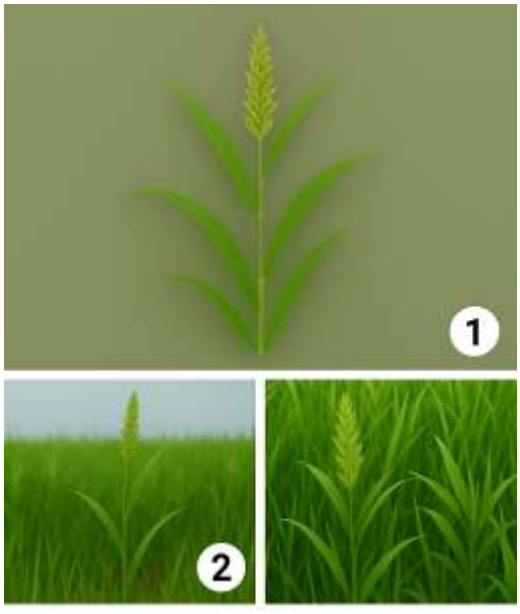
- Grow quickly after rainfall or land preparation
- Can return every season if not removed fully
- Some weeds are hard to control once mature

Non-Chemical Approaches

- Timely hand-weeding or hoeing
- Mulching with dry grass or plastic
- Crop rotation and cover crops
- Keep field borders clean
- Plant crops with proper spacing to shade out weeds



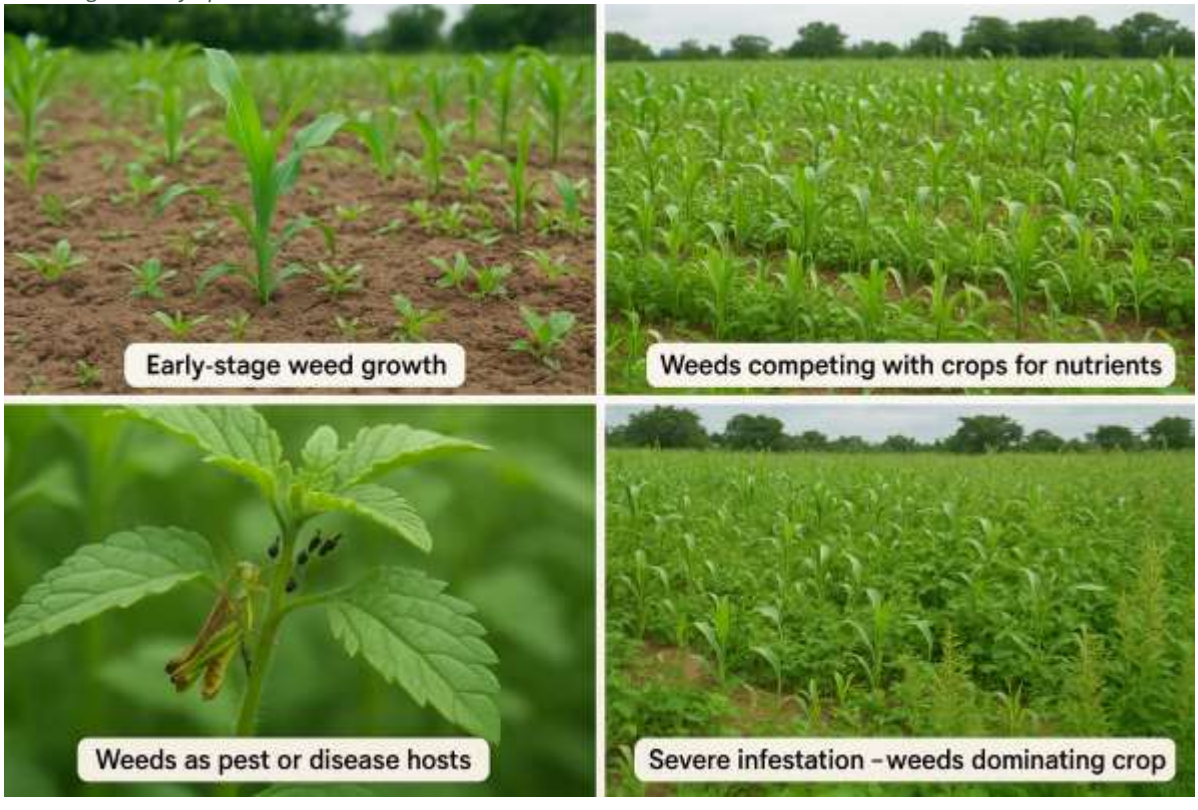
Weed (Broadleaf – *Amaranthus* sp.)
Pigweed (*Amaranthus retroflexus*)
Competes with maize, damages crops through rapid growth that chokes and shades plants, and significantly reduces yield.



Weed Grass – Jungle Rice (*Echinochloa colona*)
Affects rice paddies, and damages crops through dense, fast growth that suppresses rice seedlings.

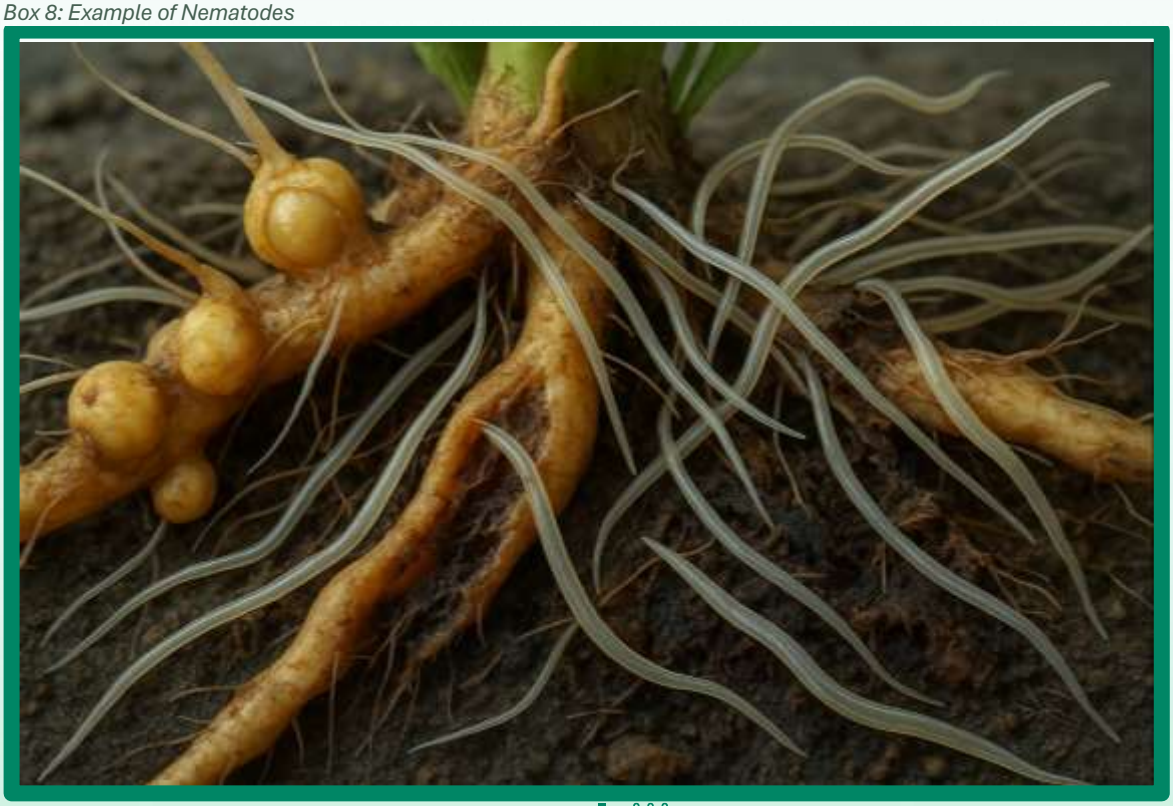
Signs and Symptoms

Box 7: Signs and Symptoms of Weeds



Type 4: Nematodes

Box 8: Example of Nematodes



Basic Features

- Tiny worm-like organisms that live in the soil and attack plant roots
- Too small to see without a microscope
- You won't see them, but you'll notice your plants turning yellow, stunting, or dying early.
  Pull up a plant; you might find swollen or knotted roots.

When They Appear

- Common in warm soils and sandy fields
- May return every season if soil is not treated
- Often seen in vegetables like tomato, okra, and cucumber
-

How They Harm Crops

- Roots get weak and cannot take up water or nutrients
- Plants look yellow or wilt during the day
- Yields are low; fruits are small or poorly developed
- Problems often appear in patches

Non-Chemical Approaches

- Rotate crops with non-host plants (like corn or grain crops)
- Solarize soil before planting using clear plastic
- Add compost or organic matter to support healthy soil
- Use nematode-resistant varieties
- Avoid replanting in infested soil

Signs and Symptoms

Box 9: Signs and Symptoms of Nematodes

Type 5: Molluscs (Snails and Slugs)

Box 10: Examples of Molluscs (Snails and Slugs)

Basic Features

- Soft-bodied pests, some with shells (snails), others without (slugs)
- Feed mostly at night or during damp weather
- Leave slime trails on leaves and fruits
- Hide under weeds, mulch, stones, or trash

How They Harm Crops

- Chew large holes in leaves, stems, or fruits
- Damage seedlings and reduce plant population
- Lower the market value of vegetables
- Create entry points for diseases

When They Appear

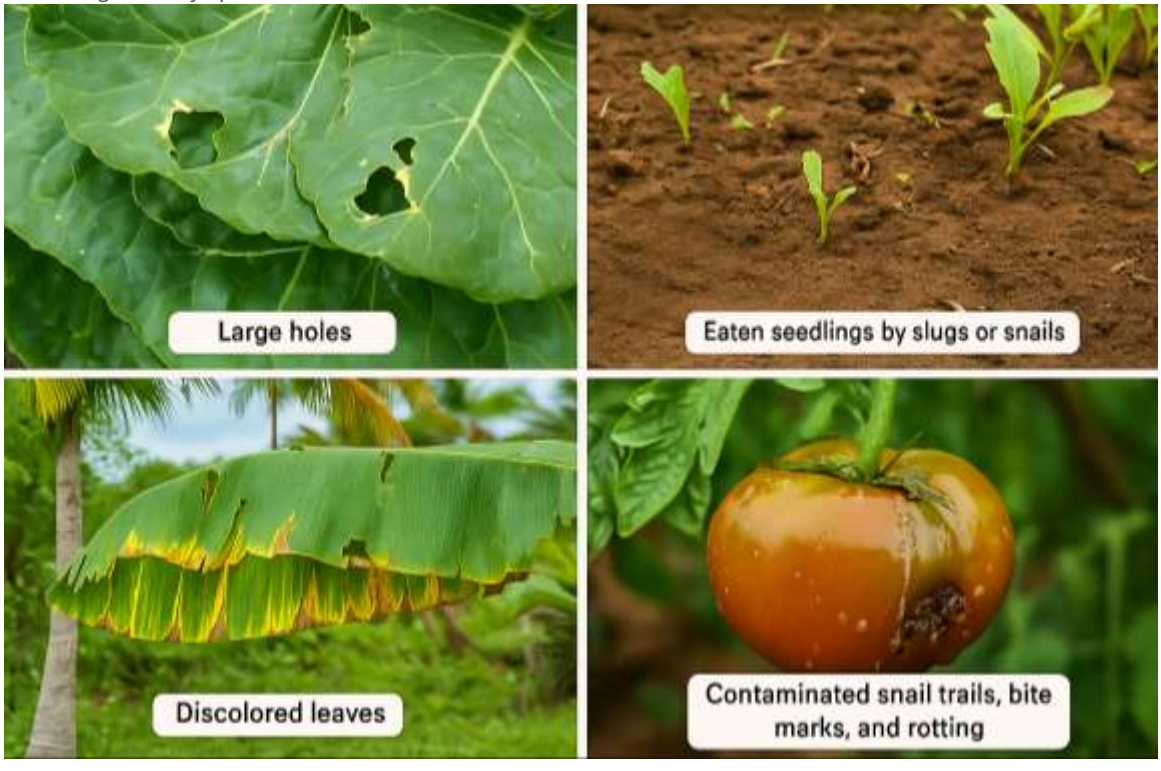
- After rains or in areas with high humidity
- Common near water sources, shaded areas, or dense weeds
- More active during the early morning or evening

Non-Chemical Approaches

- Hand-pick early in the morning or late evening
- Remove weeds, mulch piles, and trash where they hide
- Use barriers like ash, lime, or crushed eggshells around plants
- Dig shallow traps or bury containers with bait like over-ripe fruit or yeast water
- Avoid over-irrigating or creating wet conditions

Signs and Symptoms

Box 11: Signs and Symptoms of Molluscs



Type 6: Fungi

Box 12: Examples of Fungi

What is it?

Fungi are microscopic organisms that causes diseases. They cause spots, rotting, mold, and wilting. A healthy-looking plant today could be covered in fungus tomorrow if not managed early.

Why Know them

- Most fungal diseases are easier to manage early
- Avoiding excess moisture can reduce fungal problems
- Resistant varieties are available for many crops

How They Harm Crops

- Cause damping-off in seedlings, leaf spots, fruit rot, or wilting
- Spread quickly across fields if not managed early
- Can reduce both crop yield and market quality

Basic Features

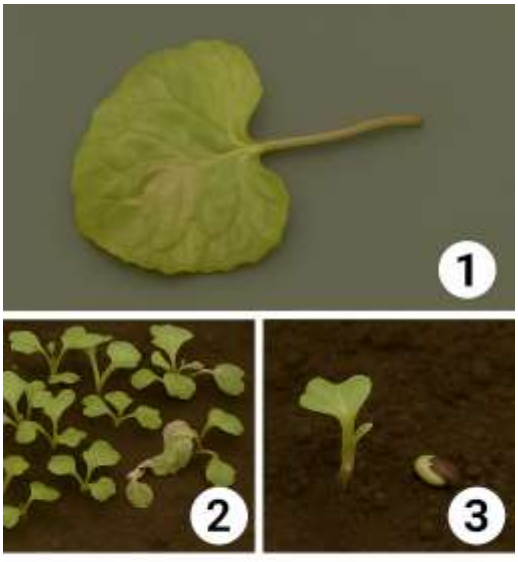
- Tiny organisms that cause disease, especially in warm, wet conditions
- Spread through rain, wind, hands, and tools
- Appear as leaf spots, powder, mold, or rotting stems and fruits

When They Appear

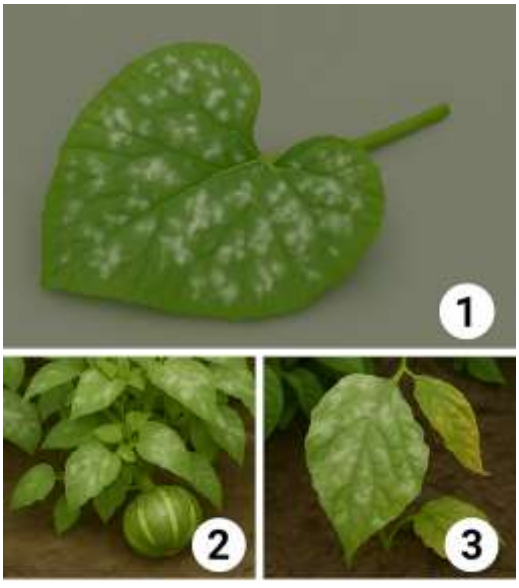
- Common during rainy or humid seasons
- Worse in crowded fields or where water stands
- Start small and spread fast under moist conditions

Non-Chemical Approaches

- Improve drainage and avoid standing water
- Space plants properly for airflow
- Remove and burn infected plant parts
- Avoid watering late in the day
- Use resistant or tolerant crop varieties
- Rotate crops to reduce soil-borne fungi



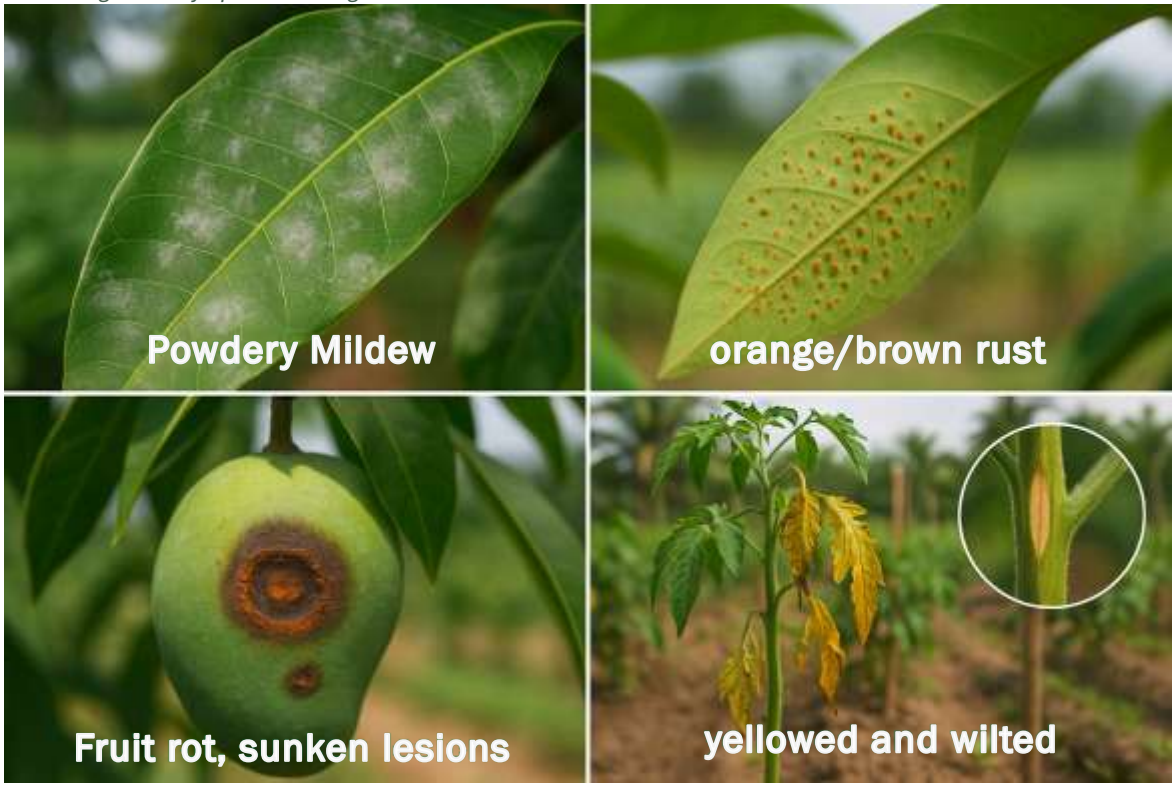
Fungi (Damping Off - *Pythium* spp., *Rhizoctonia* spp.)



Fungi (Powdery Mildew - *Oidium* spp.)

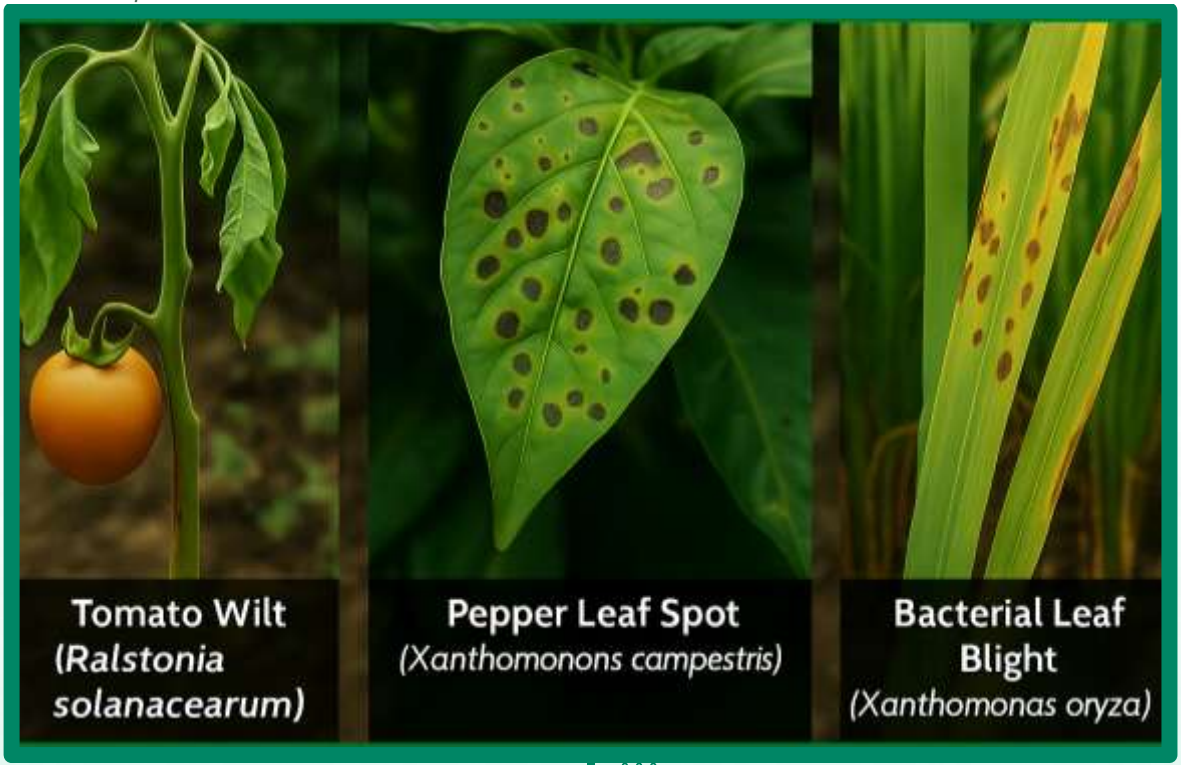
Signs and Symptoms

Box 13: Signs and Symptoms of Fungal Disease



Type 7: Bacteria

Box 14: Examples of Bacteria



Basic Features

- Bacteria are living microorganisms that infect plants.
- They enter plants through cuts, water, or insect bites
- Spread by tools, hands, rain splash, or irrigation

How They Harm Crops

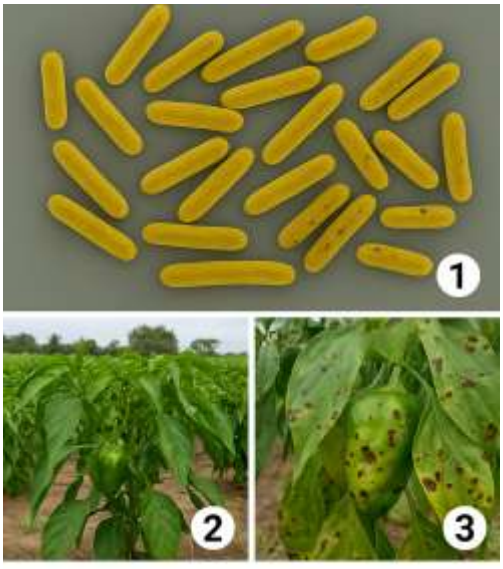
- Cause wet-looking spots or sudden wilting
- Plants may wilt suddenly without yellowing first
- Cause leaf blight, fruit rot, or stem cracks
- Can rot fruits even after harvest

When They Appear

- Often during rainy seasons
- Spread quickly in fields with poor sanitation
- Enter through damaged plant parts or insect wounds

Non-Chemical Approaches

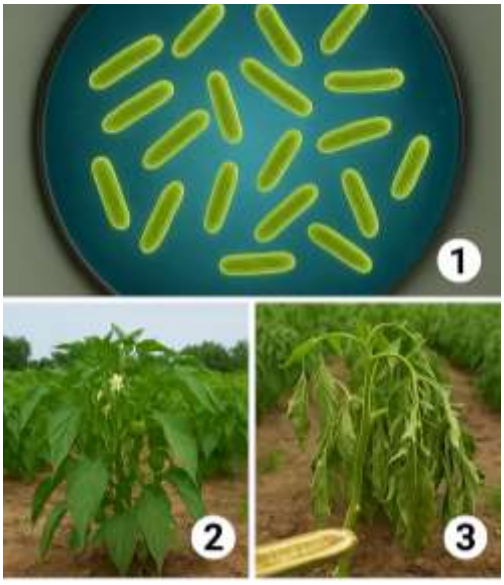
- Remove and destroy infected plants
- Clean tools regularly
- Use well-drained soil and avoid overhead watering
- Use certified clean seeds and cuttings
- Practice crop rotation



Xanthomonas campestris pv. Vesicatoria

Bacterial spot of sweet pepper

Small, dark, water-soaked spots with yellow halos on leaves and fruits. Lesions may turn necrotic; fruits show scarring and rough spots, lowering quality.



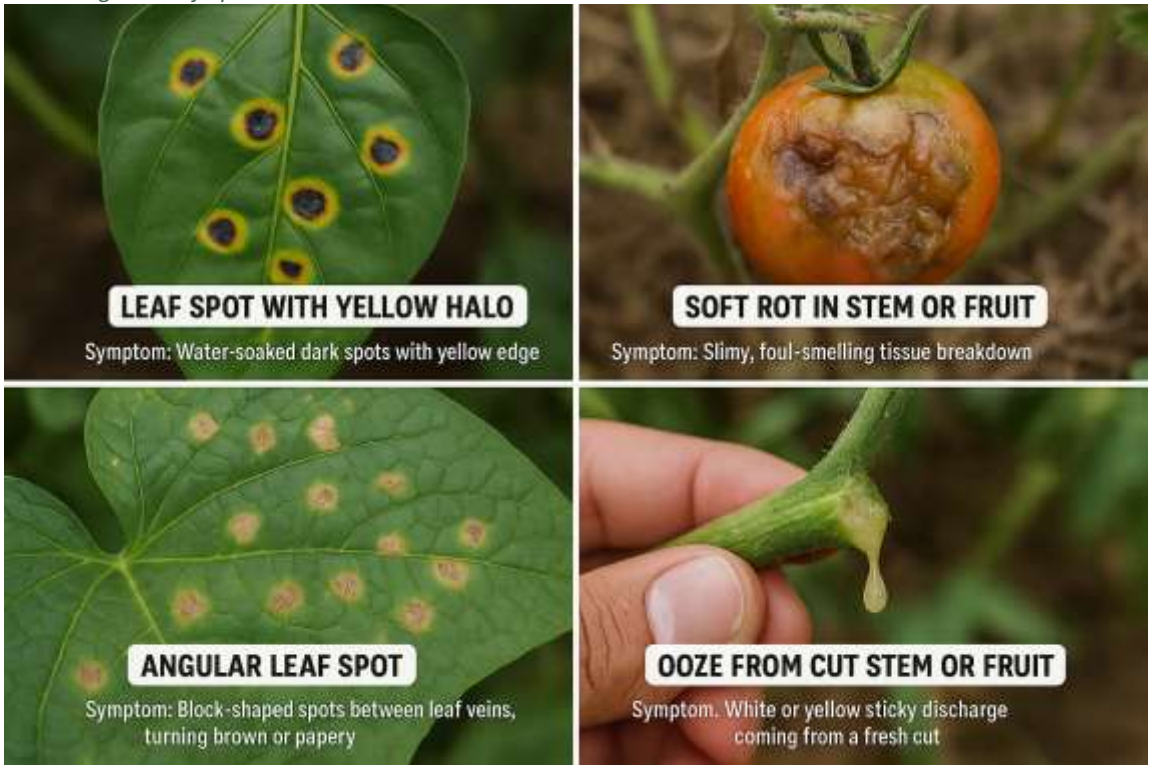
Ralstonia solanacearum

Bacterial wilt of tomato

Plants suddenly wilt without leaf yellowing. Branches droop, whole plant may collapse. Cut stems show brown vessels and sometimes bacterial ooze.

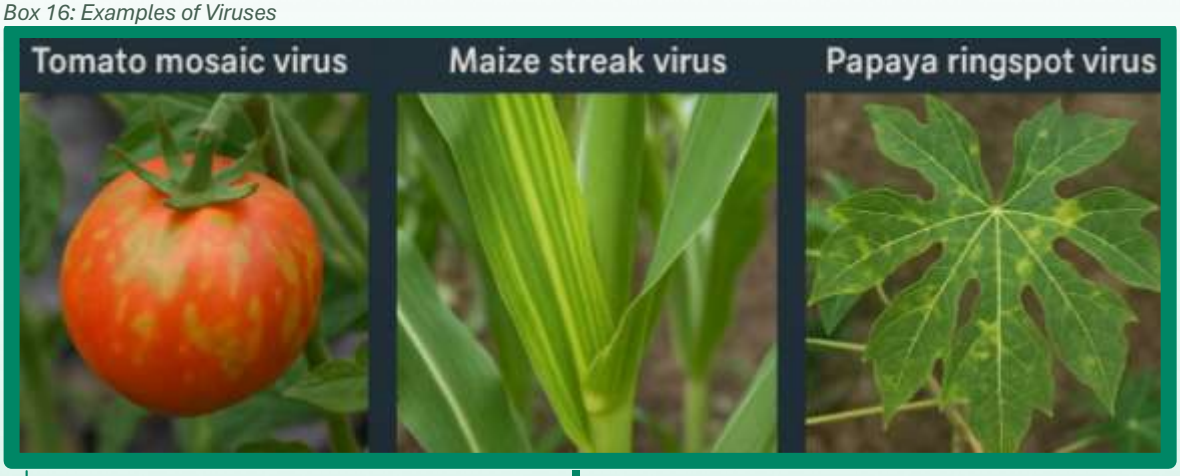
Signs and Symptoms

Box 15: Signs and Symptoms of Bacterial Infections



Type 8: Viruses

Box 16: Examples of Viruses



What is it?

Viruses are tiny infectious organisms that invade plant cells. Once infected, the plant won't grow normal; leaves curl, colors change, fruits get deformed. There is no cure, so prevention is key.

Why Know them

- Helps you remove sick plants early
- Knowing symptoms saves other crops from getting sick
- Controlling the insects that spread viruses is key

How They Harm Crops

- Leaves may curl, turn yellow, or show mosaic patterns
- Plants grow slowly, produce less, or not at all
- Fruits may be small, deformed, or drop early
- Can spread across fields quickly if not stopped

Basic Features

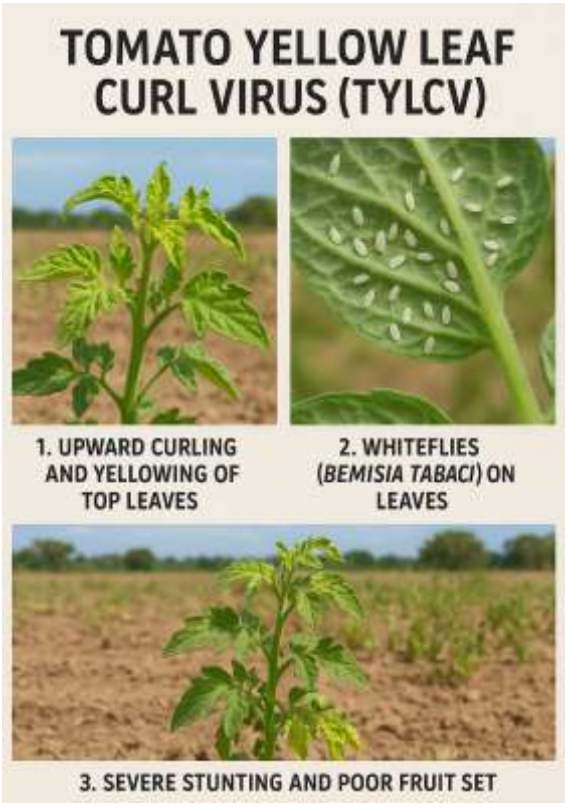
- Tiny disease agents that live inside the plant
- Spread mainly by insects like whiteflies, aphids, and thrips
- Cause changes in leaf color, shape, and plant growth
- No cure once a plant is infected

When They Appear

- Early in the crop season or during hot weather
- Carried by insects feeding on crops
- Can spread from weeds or nearby infected plants

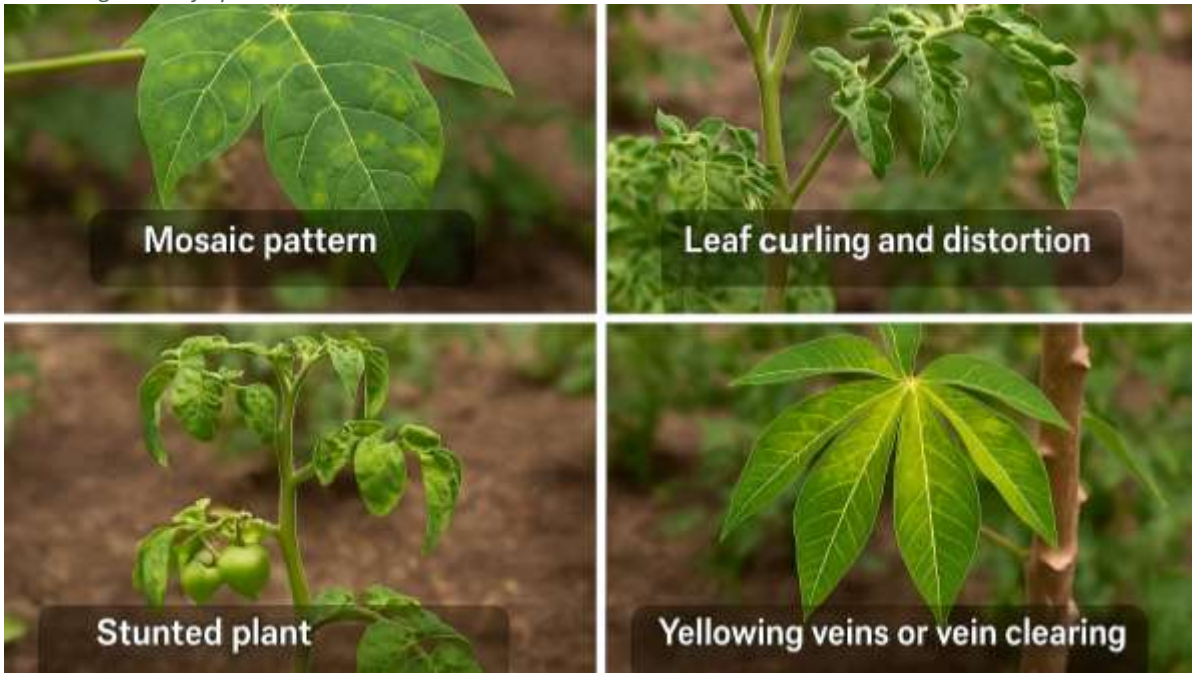
Non-Chemical Approaches

- Use virus-resistant seeds and varieties
- Remove and destroy infected plants early
- Control insect vectors using neem spray or traps
- Keep nurseries weed-free and protected
- Avoid planting near weedy field borders
- Practice crop rotation to break disease cycles



Signs and Symptoms

Box 17: Signs and Symptoms of Viruses



SESSION 1.2: Plant Diseases

(Caused by: Fungi, Bacteria, and Viruses)

What Is a Plant Disease?

- A plant disease is any condition that makes a plant unhealthy and prevents it from growing normally.
- Unhealthy plants may grow slowly, lose leaves, turn yellow, rot, wilt, or give fewer and smaller fruits and vegetables.

Types of Plant Diseases

There are two basic types of plant diseases: **infectious and non-infectious plant diseases**. Infectious diseases can spread from plant to plant through wind, rain, insects, tools, water, and even seeds.

Infectious Plant Disease

These are caused by living organisms that can spread from plant to plant. They are often called "pathogens".

FUNGAL DISEASE
Early Blight

BACTERIAL DISEASE
Bacterial spot

VIRAL DISEASE
Tomato Yellow Leaf

NEMATODE DAMAGE

Non-Living Factors that cause Plant Diseases

1. Too much or too little nutrients
2. Droughts
3. Flood
4. Extreme heat or cold
5. Spraying wrong chemicals or too much
6. Incorrect soil pH
7. Air pollution
8. Physical injury: Wind, animals, tools, or rough handling of plants.
9. Too much or too little sunlight
10. Poor drainage or compacted soil
11. Toxic metals or dirty water: Polluted soil or water can poison plants slowly.

Non-Infectious Plant Diseases

These are caused by non-living factors. They do not spread from plant to plant but still make the plant weak or sick.

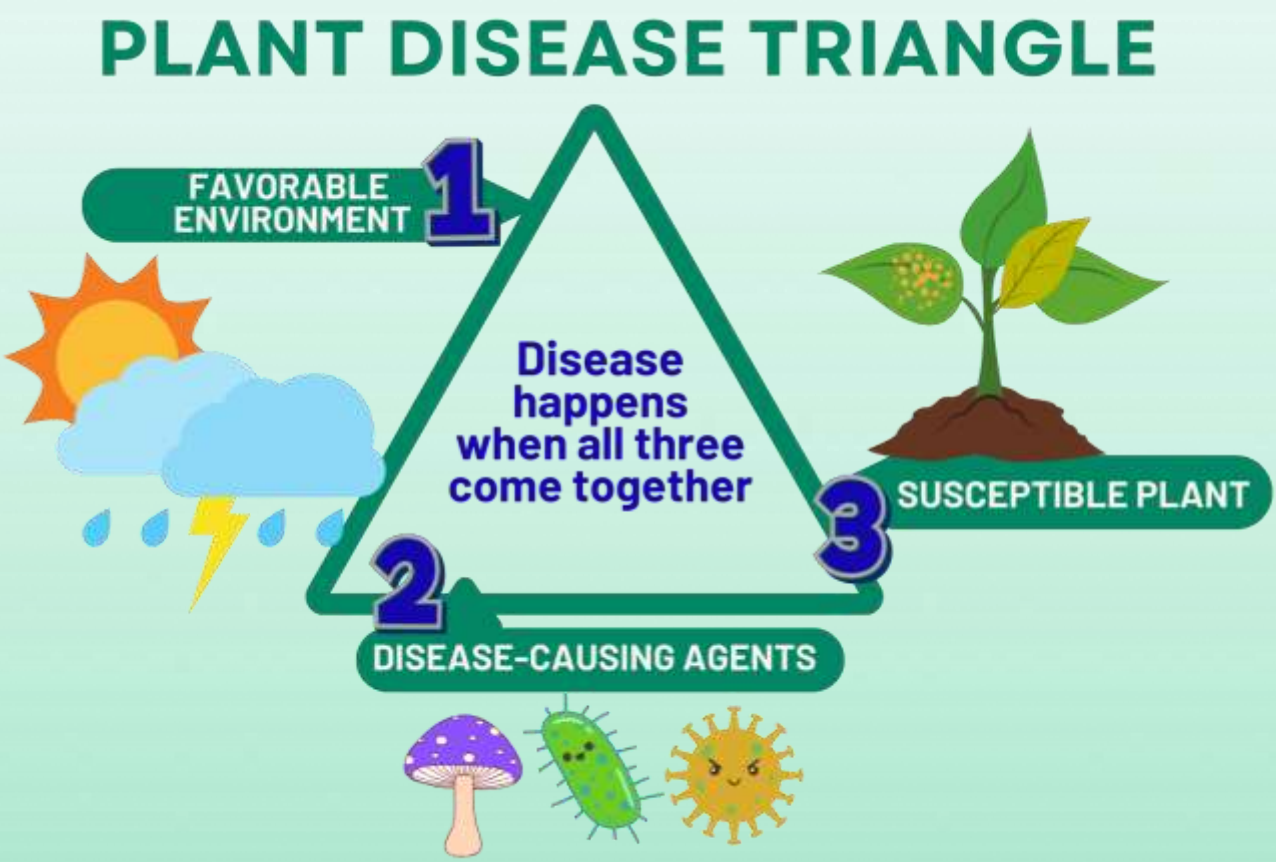
The Plant Disease Triangle

For a disease to happen, three things must be present at the same time:

1. The **right environment** (e.g., humidity, moisture, temperature)
2. A **pathogen** (fungus, bacteria, or virus)
3. A **susceptible plant** (weak or vulnerable)

Note: If one part of the triangle is missing, the disease may not appear.

Figure 4: Plant Disease Triangle



SESSION 1.3: Beneficial vs Harmful Insects

What Are Beneficial Insects?

Beneficial insects are insects that help farmers by protecting crops. They do not harm plants, instead, they eat harmful pests, pollinate flowers, or help keep the farm healthy.

How to Recognize Beneficial Insects

- They do not damage crops
- Often found near flowers or leaves with pests
- Many are small and fast-moving
- They may look different in their young stage (larvae) but still help

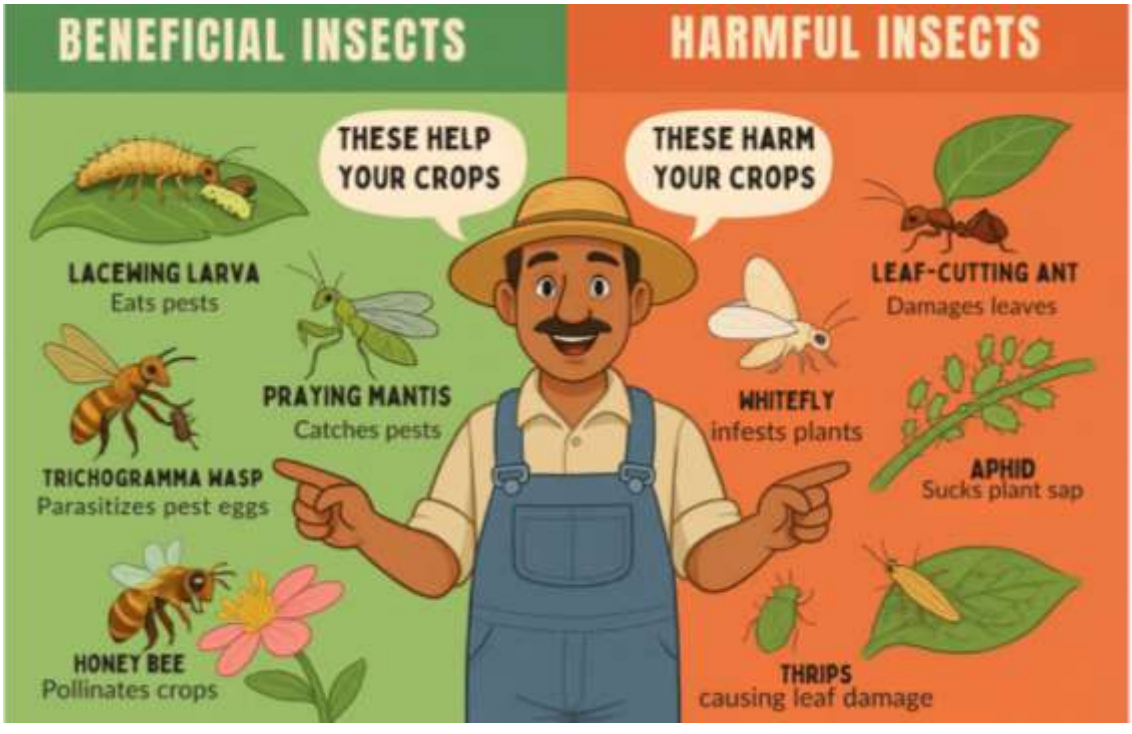
Why Beneficial Insects Matter

- Reduce the need for pesticides
- Protect your harvest naturally
- Support a healthy farm ecosystem
- Save you money and time

Tip for Farmers: Protect Beneficial insects by:

- Avoiding unnecessary spraying
- Using natural pest control methods first (like neem or soap spray)
- Growing flowering plants near crops to attract them
- Not burning or over-cleaning the field, leave some safe places for them to live

Box 18: Difference between Beneficial and Harmful Insects



Types of Beneficial Insects

1. Insects that Eat Pests (Natural Enemies)

These are insects that help crops by feeding on harmful pests. Beneficial insects are mainly categorized as predators or parasitoids.

Table 2: Insects that eat pests (natural enemies)

Insect	What It Eats	Where You See It
Ladybug (*Coccinellidae*)	Feeds on aphids, whiteflies, small caterpillars	On leaves and stems of vegetables and plants
Lacewing (*Chrysopidae*)	Feeds on thrips, aphids, whiteflies & diamondback moths	In vegetable crops, especially at night
Hoverfly (*Syrphidae*)	The larvae eat aphids and thrips	Hovers over flowers and crops
Parasitic Wasp (*Trichogramma*, etc.)	Control lepidopteran pests in corn, sugarcane, and fruit trees	Very small; not harmful to people
Predatory Stink Bug (*Podisus spp.*)	Eats caterpillars like fall armyworm	In corn and leafy crops
Assassin Bug (*Reduviidae spp.*)	Feed on caterpillars, beetles, aphids, and leafhoppers.	In vegetable crops, on leaves and stems, often hiding in the foliage during the day.
Minute Pirate Bug (*Orius spp.*)	This small, fast-moving insect eats thrips, aphids, spider mites, and whiteflies.	On flowers, leaves, and among crops like tomato, sweet pepper, and cabbage.

Ladybug
(Coccinellidae, etc.)

Lacewing
(Chrysopidaespp.)

Hover Fly
(Syrphida spp.)

Assassin Bug
(Reduvidae spp.)

Minute Pirate Bug
(Orius spp.)

Parasitic Wasp
(Trichogramma, etc.)

2. Insects That Help with Pollination

These insects help crops make fruits or seeds by moving pollen from flower to flower.

Insect	What It Helps With	Where You See It
Honeybee (*Apis mellifera*)	Help pollinate fruits, vegetables, and trees	On flowers during daylight
Butterfly	Carries pollen while feeding on nectar	Around flower gardens or crop edges
Native Wild Bees	Pollinate small crops and bush plants	In bushy areas or nearby forests

Honeybee
(Apis melifera)

Morpho
butterfly

Native wild bees

3. Natural Clean-Up Crew

There are insects that help keep the farm environment healthy by breaking down waste, eating harmful insects, and improving soil fertility. They are important for composting, nutrient cycling, and keeping pest levels low, without chemicals.

Insect	What It Does	Where You See It
Dung Beetle (*Scarabaeidae spp.*)	○ Rolls and buries animal droppings; helps return nutrients to the soil	○ In pastures, near livestock pens, and manure piles
Ground Beetle (*Carabidae spp.*)	○ Hunts at night for pests like cutworms, slugs, and maggots; also eats decaying matter	○ In soil under mulch, leaves, stones, and compost
Rove Beetle (*Staphylinidae spp.*)	○ Feeds on fly larvae, aphids, mites, and decaying matter; fast and active	○ Around compost, manure piles, and under rotting vegetation
Springtail (*Collembola spp.*)	○ Tiny insect-like soil creatures; feed on dead plant matter, fungi, and bacteria	○ Inside healthy compost piles, moist soils, or under leaf litter
Soldier Fly Larvae (*Hermetia illucens*)	○ Break down food waste, manure, and rotting crops; turn waste into compost	○ In compost bins, manure heaps, or organic waste pits

SESSION 1.4: Non-Chemical Pest Control Methods

What Are Non-Chemical Pest Control Methods?

- Non-chemical pest control methods are natural or low-cost ways to protect your crops without using synthetic pesticides.
- These methods include things like hand-picking pests, using neem or soap spray, planting trap crops, and bringing in beneficial insects to eat the harmful ones.

Why Do Belizean Farmers Need Them?

- Pesticides are expensive and not always needed.
- Overuse can kill beneficial insects, harm your health, or damage the environment.
- Some pests have developed resistance to them, making pesticides less useful.
- Non-chemical methods help you save money, protect our environment, and grow safer food.

When to Use Them

- Early in the season, before pests spread
- When damage is small or moderate
- Use along with good agricultural practices

How to Use Them

- Choose the method that fits your crop and pest
- Apply it early and regularly
- Combine 2–3 methods for better results
- Always check your field and watch what works best.

1

Hand-Picking and Removal

Physically remove visible pests like caterpillars, beetles, snails, and egg clusters from crops.
Best used in small plots or during early infestation.

2

Neem Oil Spray

Neem is a natural, plant-based pesticide that repels many insects like aphids, whiteflies, and thrips.
Less toxic to people and beneficial insects when used correctly.

3

Soap or Homemade Insecticidal Spray

A mild soap-and-water solution can be sprayed on soft-bodied pests like mites, aphids, and mealybugs.
Helps break down the outer coating of pests, causing them to dry out.

4
Sticky Traps (Yellow or Blue)

Colored glue traps attract flying pests such as whiteflies and thrips.
Helps monitor pest populations and reduce numbers.

5
Crop Rotation

Plant different crops in the same field each season to break the life cycle of pests and soil-borne diseases.
For example, rotate tomatoes with corn or beans.

6
Intercropping or Trap Cropping

Plant companion or “trap” crops that either repel pests or attract them away from the main crop.
Example: Planting beans near peppers to draw mites away.

7
Field Sanitation and Hygiene

Remove and burn infected plant parts and weeds that host pests or diseases.
Helps prevent carry-over of pests between seasons.

8
Mulching

Use dry grass, leaves, or plastic to cover the soil.
Suppresses weeds, keeps soil moist, and can reduce some soil pests like nematodes.

9
Use of Resistant or Tolerant Varieties

Choose seeds or plants that are known to resist specific pests or diseases.

10

Encouraging Beneficial Insects

Avoid using broad spectrum insecticides to protect ladybugs, lacewings, parasitic wasps, and predatory stink bugs that naturally reduce pest populations.

11

Proper Plant Spacing and Airflow

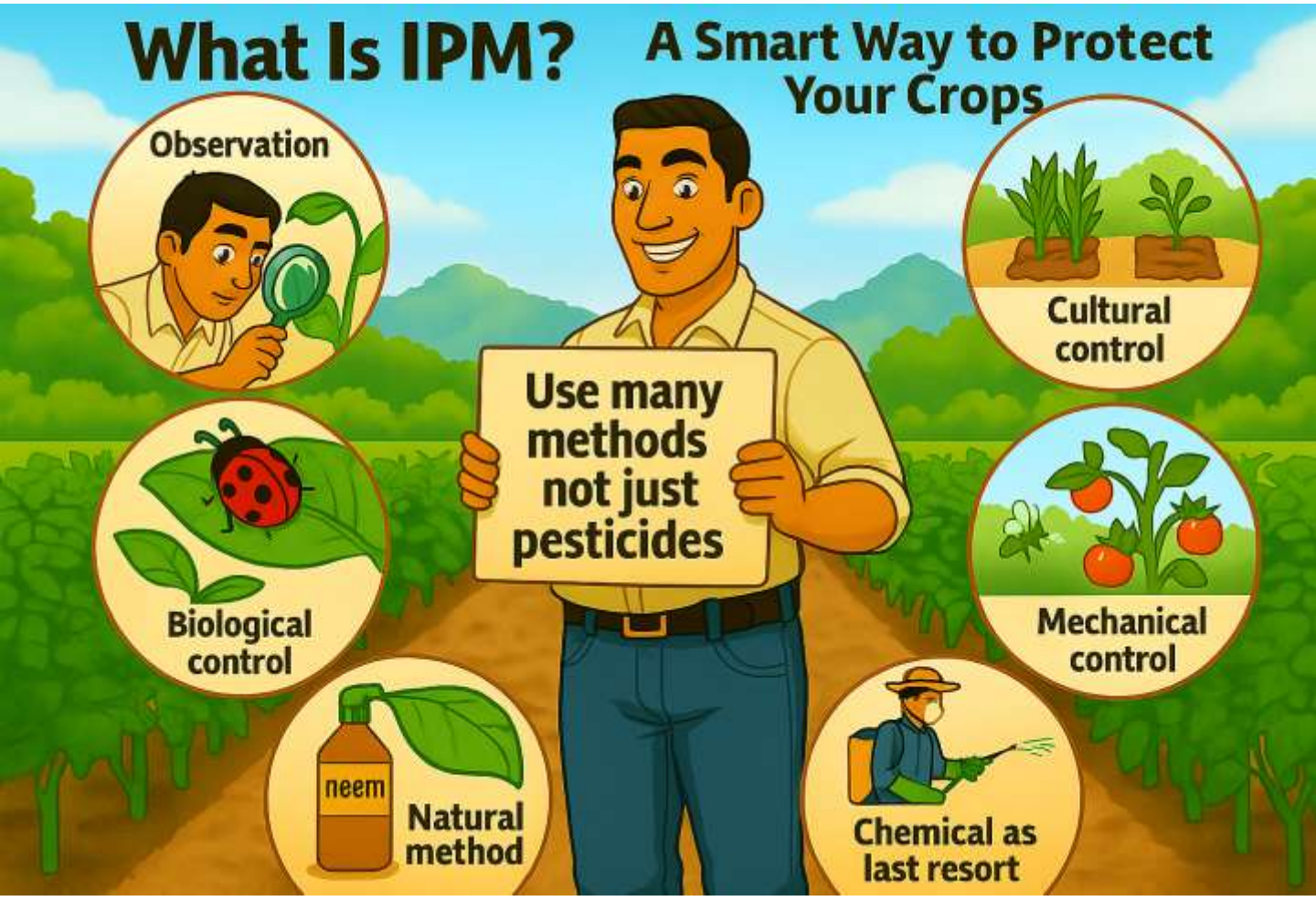
Space crops to improve air movement and reduce humidity. Helps prevent fungal diseases like mildew and leaf spot.

12

Soil Solarization

Cover the soil with clear plastic for 4–6 weeks before planting to trap heat from the sun.
Kills nematodes, weed seeds, and harmful fungi in the topsoil.

SESSION 1.5: What is Integrated Pest Management (IPM)



Integrated Pest Management (IPM) is a sustainable approach to managing to control pests by using a mix of safe, effective, and affordable methods, not just pesticides.
These methods help farmers protect crops while also reducing risks to people, beneficial insects, and the environment.

Types of Pest Control Methods Used in IPM

There are seven types of pest control methods we will discuss as part of IPM. These can be used together to build a stronger, safer, and longer-lasting pest management plan.

1. Cultural Control

This method involves changing how you grow crops to make it harder for pests to survive or multiply.

Action: change the way you plant, grow, or manage crops to make it harder for pests to survive, grow, or spread.
Purpose: To prevent pests before they start by creating a clean and healthy farm environment.

Examples:

- **Crop rotation:** e.g., planting legumes (beans), corn after tomatoes to break pest cycles and improve soil fertility.
- **Proper spacing** between plants to improve air flow and reduce disease
- **Early planting** to avoid peak pest seasons (like bean thrips or fruit flies)
- **Field sanitation:** removing old crops, weeds, and debris that shelter pests

Activity

Question	Yes	No	Not Sure
Do I rotate crops each season (e.g., corn after tomato)?	◯	◯	◯
Do I space my crops properly for good airflow?	◯	◯	◯
Do I clean my field after harvest (remove weeds, old plants)?	◯	◯	◯

If you checked **No or Not Sure Yet**, what cultural control would you try:

Hand-picking

Sticky traps

Soil solarization

2. Mechanical and Physical Control

This involves using tools, barriers, or direct actions to remove or block pests without chemicals.

Action: You physically remove, trap, or block pests from reaching your crops using hands or tools.

Purpose: To physically reduce pest numbers or keep them away from crops.

Examples:

- **Hand-picking** caterpillars or beetles off vegetables
- **Sticky traps** to catch flying pests like whiteflies and thrips
- **Row covers or nets** to protect seedlings from insects
- **Soil solarization:** covering the soil with clear plastic to kill pests and weed seeds before planting
- **Tillage or ploughing** to destroy weed seedlings or pest eggs

Activity

Question	Yes	No	Not Sure Yet
Do I hand-pick pests like caterpillars or beetles?	○	○	○
Do I use sticky traps for pests like whiteflies or thrips?	○	○	○
Have I tried soil solarization or row covers?	○	○	○

One mechanical method I will try or improve:

Ladybug eating aphids

Parasitic wasp on leaf

Predatory stink bug hunting caterpillar

3. Biological Control

This method uses natural enemies, "beneficial insects", to control harmful pests.

Purpose:
To let nature do the work by supporting helpful insects or organisms already on your farm.

Examples:

- **Ladybugs** eating aphids on pepper and tomato plants
- **Parasitic wasps** laying eggs inside caterpillar or moth eggs
- **Predatory stink bugs** feeding on fall armyworm
- **Fungi** like *Beauveria bassiana* that infect and kill insects

Activity

Question	Yes	No	Not Sure Yet
Have I seen beneficial insects (ladybugs, lacewings) on my farm?	○	○	○
Do I avoid spraying when I see these helpful insects?	○	○	○
Have I planted flowers to attract beneficial insects?	○	○	○

What can I do to attract or protect beneficial insects?

Wearing PPE

Spot Spraying

Reading Pesticide Label

4. Control Chemical (As a Last Resort)

Pesticides should only be used when other methods don't work, and the pest is causing serious crop damage. Use them responsibly, legally, and correctly.

Important: Always use registered pesticides approved by the Pesticides Control Board (PCB).

Examples:

- **Selective insecticides** that kill pests but spare beneficial insects
- **Miticides** to control spider mites
- **Fungicides** for late blight in tomato or downy mildew in cucumber

Activity

Question	Yes	No	Not Sure Yet
Do I use pesticides only when other methods fail?	○	○	○
Do I wear Personal Protective equipment (mask, gloves, boots) when spraying?	○	○	○
Do I read the pesticide label before use?	○	○	○

What can I do to improve the way I use pesticides?

Virus-Resistant Tomato Plant

Blight-Resistant Beans

Nematode-Resistant Okra

5. Genetic Control

This method uses plant varieties that are naturally resistant to pests or diseases.

Purpose: To reduce or avoid the need for pesticides by planting crops that can fight off pests on their own.

Examples:

- **Virus-resistant tomatoes** that can tolerate Tomato Yellow Leaf Curl Virus
- **Blight-resistant beans** or cucumbers that are less likely to rot
- **Nematode-resistant okra** for fields with soil-borne pests

Activity: Genetic Control (Using Resistant Crop Varieties)

Question	Yes	No	Not Sure Yet
Do I plant crop varieties that are resistant to common pests or diseases?	◯	◯	◯
Do I ask my seed supplier or extension officer about resistant seed types?	◯	◯	◯
Have I noticed better results when using resistant seeds in the past?	◯	◯	◯

A crop I want to switch to a resistant variety:

Pheromone Trap

Attract-and-Kill

Reflective mulch

6. Behavioral Control

This method works by using the pest's own behavior to trap, confuse, or drive them away.

Purpose: To interrupt pest activity (like mating or feeding) without harming the crop or the environment.

Examples:

- **Pheromone traps** that attract and trap male moths to stop mating
- **Attract-and-kill lures** used for fruit flies
- **Reflective mulch** to confuse whiteflies or aphids

Activity: Behavioral Control (Using Pest Behavior to Control Them)

Question	Yes	No	Not Sure Yet
Have I used pheromone traps or attract-and-kill baits to catch pests?	○	○	○
Have I used reflective mulch or light-coloured plastic to confuse flying pests?	○	○	○
Do I understand how pest behavior (mating, feeding) can be used to stop them?	○	○	○

One behavior-based method I plan to try or improve:

Quarantine Sign

Extension Officer Inspecting Field

Approved Pesticide List

7. Legal Control (Regulatory Control)

This refers to laws, regulations, and official actions that help stop the spread of serious pests.

Purpose: To protect the country's crops, environment, and markets by following national rules and working with extension officers and agricultural authorities.

Examples:

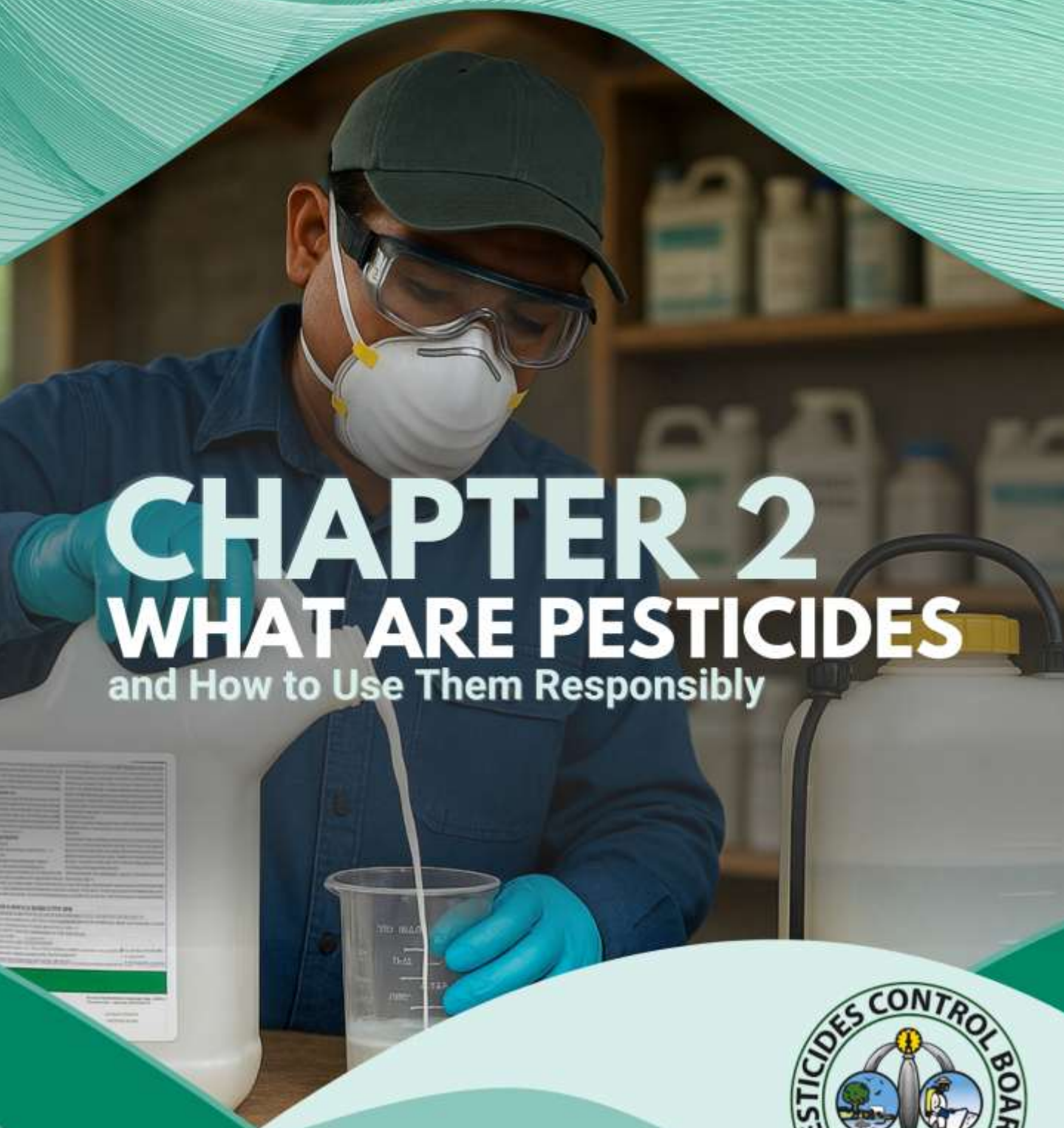
- **Quarantine measures** to stop new pests from entering Belize (e.g., medfly)
- **Destruction orders** for infested plants under government supervision
- **Requirements for responsible pesticide use, training, certification for pesticide use and import controls**

7. Legal (Regulatory) Control (Following Pest Management Laws)

Question	Yes	No	Not Sure Yet
Do I know about quarantine rules or pest alerts issued by the government (BAHA)?	○	○	○
Do I only use pesticides that are registered and approved by the PCB?	○	○	○
Do I ask for help from an extension officer or the PCB when dealing with serious pest outbreaks?	○	○	○

One action I can take to follow farm safety laws better:

Belize
National Pesticides Training
and Certification Program



CHAPTER 2
WHAT ARE PESTICIDES
and How to Use Them Responsibly

PESTICIDES CONTROL BOARD
BELIZE

CHAPTER 2: KNOW YOUR PESTICIDES

In this chapter, we will learn what pesticides are, how they work, and how to choose the most suitable product for the pest problem. Not all pesticides are the same, and using the wrong type, wrong dose, or wrong method can harm you, your family, your crops, and the environment.

By the end of this chapter, you'll understand how to read labels, know what the warning symbols mean, and use pesticides responsibly, only when truly needed. The goal is to protect your crops without putting your health and the environment at risk.

SESSION 2.1: What are Pesticides?

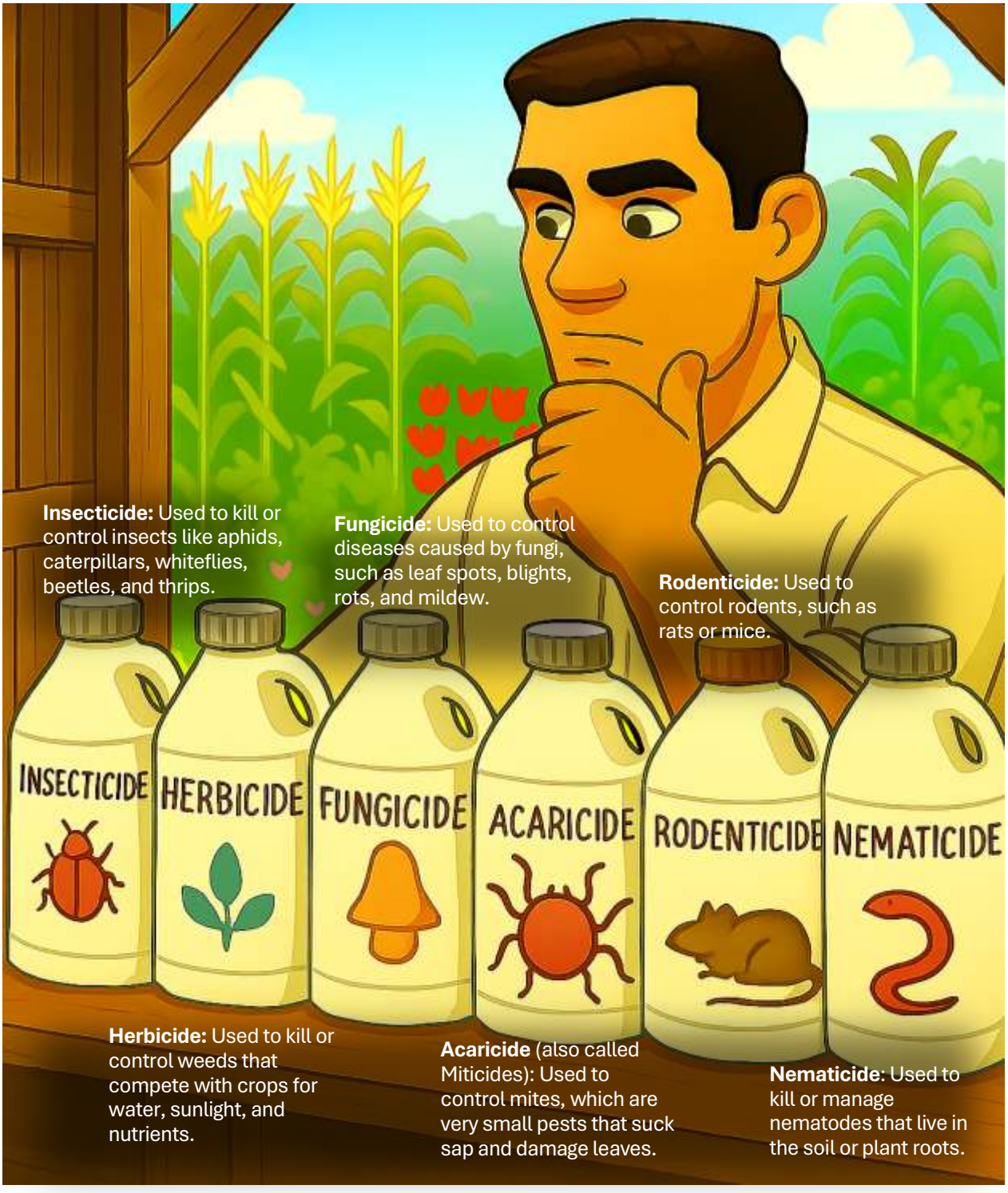
What are Pesticides?

- Pesticides are substances (liquid, powder, or gas) that are used to kill, control, or repel pests that damage crops, animals, or stored food.
- Pesticides may target insects, weeds, fungi, mites, or rodents that affect the quantity or quality of a farmer's harvest.
- Pesticides are tools against pests and should be used only when needed following the label directions.

What are the Main Classes of Pesticides

Class of Pesticides by Target

Pesticides are grouped by what they control. Each type has a specific purpose:



Choosing the Correct Class of Pesticide for the Pest

Do I really know what's attacking my crop?

Before you reach for the pesticide, stop and ask yourself this important question. Many farmers lose time, money, and healthy crops by guessing the problem or using the wrong pesticide. Think of this step as the "doctor's diagnosis" before giving medicine. The wrong treatment can make the problem worse.

To protect your farm, your family, your profit and our environment, you must:

01	02	03
		
Identify the pest	Understand the damage	Choose the correct type of pesticide (only if it's truly needed)

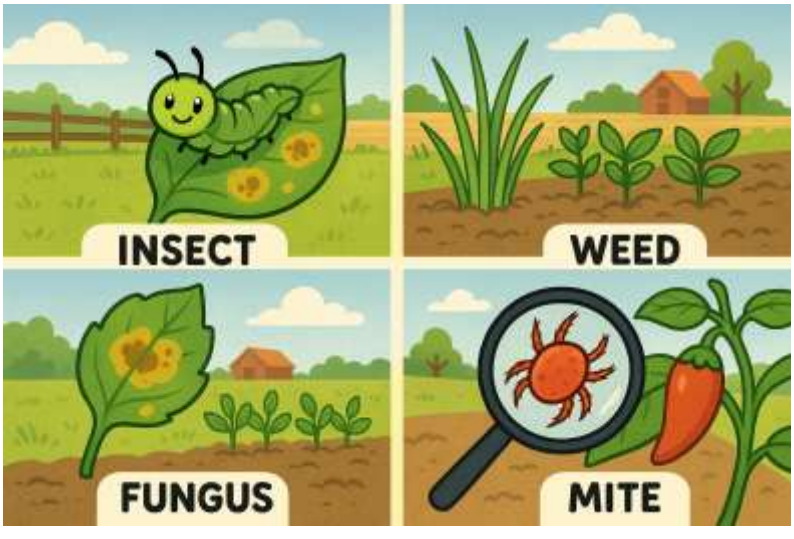
Practical Tool: Ask Yourself These Questions First

QUESTION 1: Is it an insect, fungus, weed, or acarid?

========

Why it matters: To know if you need an insecticide, fungicide, herbicide, or acaricide

What to Check for: Check for Insects, Fungus, Weeds, Mites, Nematodes, etc.

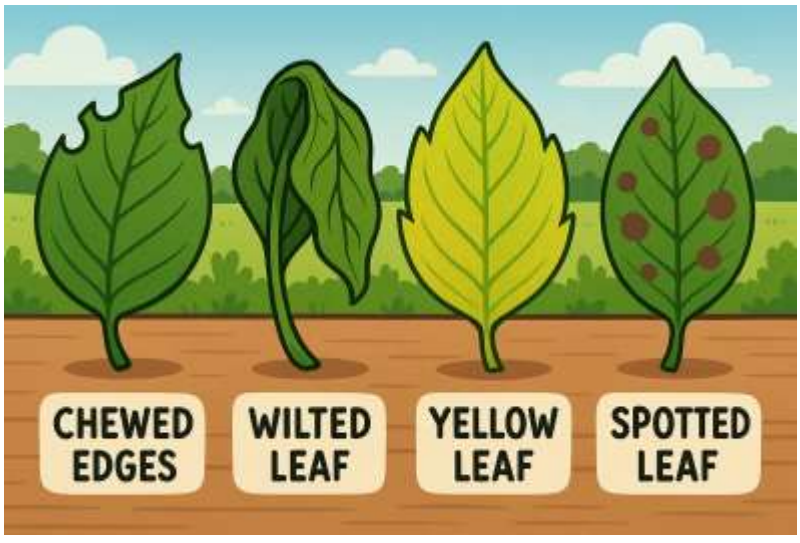


QUESTION 2: What kind of damage is showing? (chewed, wilted, yellow, spots)

========

Why it matters: Helps you match the pest to the symptom

What to Check for: Check the Leaf for damage types (chewed, wilted, yellow, spots).

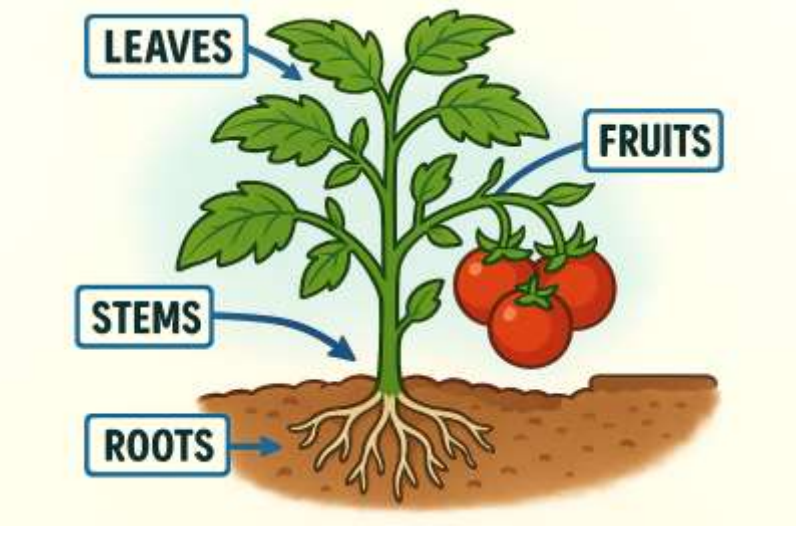


QUESTION 3: Where is the pest located? (leaves, stems, roots, fruits)

========

Why it matters: Some pesticides work only on certain plant parts

What to Check for: Check which part of the plant is affected
(leaves, stems, roots, fruits).

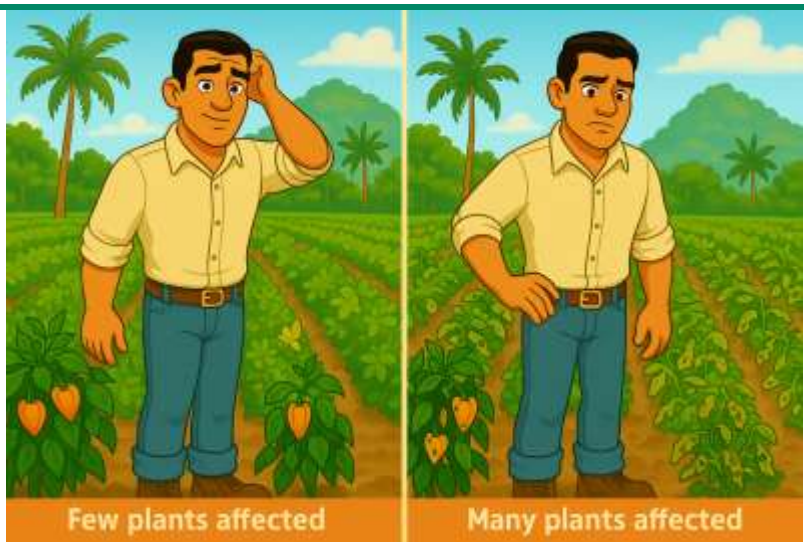


QUESTION 4: Is it affecting many plants or just a few?

========

Why it matters: Minor problems may not need chemicals

What to Check for: Check how many plants or area of field with infested plants.



QUESTION 5: Is the pest spreading quickly or staying in one area?

========

Why it matters: If the pest is spreading fast, you may need to act quickly to stop it. Non-chemical methods may be enough.

What to check:
Check if the pest is appearing on new plants or staying in the same patch. Observe if nearby crops or fields are also affected.

QUESTION 6: Have you already tried a non-chemical method first? E.g. hand-pick, remove infected parts, use sticky traps, or spray neem/soap water

========

Why it matters:
Safe, non-chemical options are often effective, especially in the early stages of pest problems.

What to check: Look for any results or changes after your non-chemical attempt. If none, try a new approach.

QUESTION 7:
Which pesticide is needed?

========

Why it matters: Choosing the wrong pesticide can waste money, harm your crops, and even make the problem worse by killing beneficial insects or encouraging resistance.

What to check: Match the pest to the correct pesticide type.

Practical Matching Exercise

The table below shows how identifying the pest is important to match it with the correct pesticide. It shows five main types of pests, the crops they usually affect, and the signs of damage they leave behind. Once you know what kind of pest you're dealing with, you can choose the right type of pesticide.

- Recognize what's causing the problem (insect, fungus, weed, mite, or bacteria)
- Understand what to look for on your plants
- Match the pest to the correct solution
- Avoid wasting time, money, or harming your crops with the wrong chemical

Use the table below as a quick guide:

Table 3: Mapping Pest with Pesticides

Pest Type	Common Crop Affected	Signs of Damage	Pesticide Type
Insects	Pepper, tomato, beans	Chewed or curled leaves, tiny insects moving	Insecticide
Fungus	Tomato, banana, beans	Spots on leaves, moldy stems, wilting	Fungicide
Weed	Corn, beans, sugarcane	Grasses or broadleaf growing near crops	Herbicide
Acarid (Mite)	Papaya, okra, pepper	Yellowing, speckling, tiny webs	Acaricide or Miticide
Bacteria	Cabbage, pepper, citrus	Water-soaked spots, wilting	Bactericide

How to Decide on a Pest Management Plan

CHECK FOR PESTS

ASSESS CROP DAMAGE

EVALUATE THE PLANT GROWTH

COUNT THE PEST NUMBERS

APPLY PESTICIDE CORRECTLY

RECORD DATA

CHECKLIST: Should I Use Pesticides?

Instructions: Read each question and check YES or NO. Follow the guide at the end to help you decide if pesticide use is needed or if there's a better option.

Step 1: Check Your Crop and the Pest

QUESTION	YES	NO
1. Can I clearly see the pest or signs of damage?	○	○
2. Do I know which pest is causing the problem?	○	○
3. Is the pest known to cause serious damage to this crop?	○	○

Step 2: Look at the Level of Damage

QUESTION	YES	NO
4. Is the pest affecting more than 25% of my crop?	○	○
5. Is the crop young and still worth protecting?	○	○
6. Is the damage spreading fast in just a few days?	○	○

Step 3: Try Safer, Non-Chemical Options First

QUESTION	YES	NO
7. Have I already tried hand-picking, neem or soap spray, or traps?	○	○
8. Did I remove infected plants, clean the field, or rotate crops?	○	○
9. Did I check for beneficial insects (ladybugs, lacewings) that eat the pests?	○	○

Step 4: If Pesticide is the Last Option

QUESTION	YES	NO
10. Do I have the approved pesticide for this crop and pest?	○	○
11. Do I have proper PPE (gloves, mask, boots) and know how to apply it?	○	○
12. Will I spray only the affected area, and not the whole field?	○	○

YOUR RESULTS: What To Do Next

Mostly "NO" in Step 1 or 2:	Wait and observe. The pest may not be serious or could go away on its own.
Mostly "YES" in Step 3:	Use non-chemical methods and give them time to work.
Mostly "YES" in Step 4:	You may consider using pesticides, but only with caution, and after trying safer options.

Reminder:

Never apply just because you "see something." Always know the pest and check the damage level. Always read the label before using any pesticide.

CASE STUDY: Fall Armyworm Problem in Corn

What Happened:

When: From 2017 to 2019, many corn farmers in Belize had trouble with a pest.
Pest: Fall Armyworm
Crop: Corn (maize)
Damage: Leaves looked chewed up, had a see-through look ("windowpane"), and some young plants died in the middle ("dead heart").

Why This Story Matters:

It shows why it's important to identify the pest correctly, spray at the right time, and choose the right pesticide.

Guessing can lead to crop loss, wasted pesticide, and pests that don't go away.

The Problem:

At first, some farmers thought it was a regular leafworm and applied contact insecticide. But the fall armyworm hid deep in the plant. The pesticide didn't reach them.

The Solution:

Farmers were advised to use systemic products like **Emamectin benzoate** or **Spinetoram** early, before the worm entered the plant.

SESSION 2.2: Pesticide Toxicity Levels & Color Bands

Toxicity refers to the ability of pesticide to cause harm to humans or animals.

Note: It is usually measured by **LD50,** which is the dose that kills 50% of test animals (usually rats), expressed in milligrams of pesticide per kilogram of body weight (mg/kg).

Table 4: Pesticide Toxicity Levels & Color Bands

The color band system below is used to classify pesticides according to their acute toxicity to humans. By placing color bands on product labels, this system helps users, especially farmers, quickly recognize how dangerous a pesticide is and take the right safety precautions.

CLASS Ia EXTREMELY HAZARDOUS	CLASS Ib HIGHLY HAZARDOUS	CLASS II MODERATELY HAZARDOUS	CLASS III SLIGHTLY HAZARDOUS	CLASS IV PRECAUTION
				(NO SYMBOL)
LD50 <5 mg/kg (oral)	LD50 5- 50 mg/kg (oral)	LD50 = 50-500 mg/kg (oral)	LD50 = 500-5000 mg/kg (oral)	LD50 = >5000 mg/kg (oral)

SESSION 2.3: Pesticide Use Safety Symbols

Box 19: Pesticide Pictograms

Advice Pictograms


Wear gloves


Wear rubber boots


Wear protection over nose and mouth


Wear respirator


Wear overalls


Wear apron

Environmental Hazard Pictograms


Toxic to pollinators


Toxic to birds and poultry


Toxic to livestock


Dangerous/harmful to fish. Do not contaminate lakes, rivers, ponds or streams

Activity Pictograms


When handling liquid concentrate...


When handling dry concentrate...

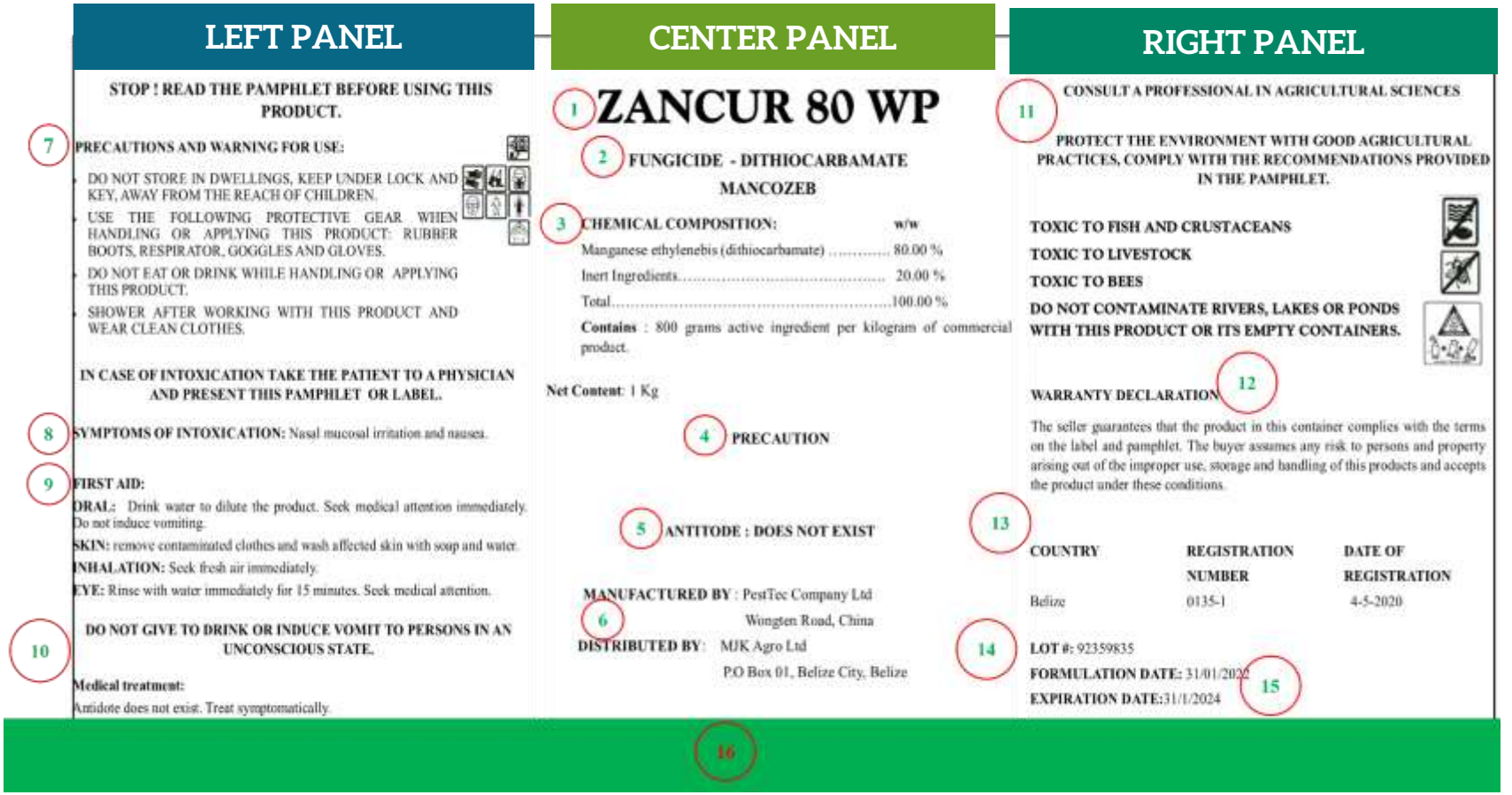

When applying pesticide....

Storage Pictogram


Keep locked away and out of reach of children

SESSION 2.4: Pesticide Label & Pamphlet

Figure 5: Sample of Pesticide Label

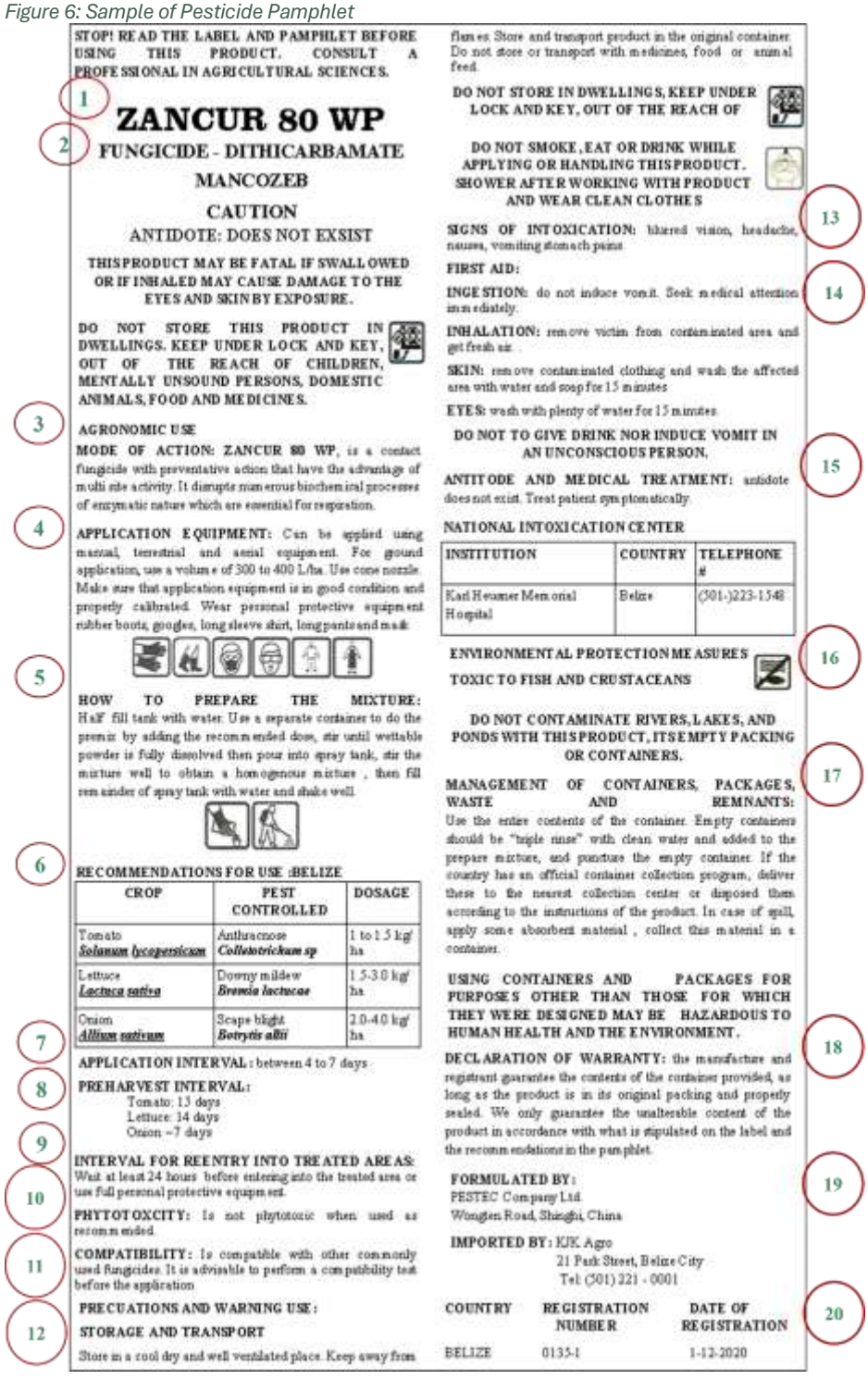


What kind of information can you find on a Pesticide Label?

Left Panel		Center Panel		Right Panel	
7	Safety Precautions	1	Trade Name / % of Active Ingredient / Formulation	11	Environmental Precautions
8	Symptoms of Intoxication	2	Class of pesticide / Chemical Family / Common Name	12	Warranty Declaration
9	First Aid Treatment	3	Chemical Composition	13	Registration Number
10	Medical Treatment	4	Signal Word & Symbol	14	Lot Number
		5	Antidote	15	Formulation & Expiration Date
		6	Manufacture & Distributor	16	Color Band

What kind of information can you find on a pesticide Pamphlet?

Figure 6: Sample of Pesticide Pamphlet



STOP! READ THE LABEL AND PAMPHLET BEFORE USING THIS PRODUCT. CONSULT A PROFESSIONAL IN AGRICULTURAL SCIENCES.

1

ZANCUR 80 WP

2

FUNGICIDE - DITHICARBAMATE

MANCOZEB

CAUTION

ANTIDOTE: DOES NOT EXSIST

THIS PRODUCT MAY BE FATAL IF SWALLOWED OR IF INHALED MAY CAUSE DAMAGE TO THE EYES AND SKIN BY EXPOSURE.

DO NOT STORE THIS PRODUCT IN DWELLINGS. KEEP UNDER LOCK AND KEY, OUT OF THE REACH OF CHILDREN, MENTALLY UNSOUND PERSONS, DOMESTIC ANIMALS, FOOD AND MEDICINES.

3

AGRONOMIC USE

MODE OF ACTION: ZANCUR 80 WP, is a contact fungicide with preventative action that have the advantage of multi site activity. It disrupts numerous biochemical processes of enzymatic nature which are essential for respiration.

4

APPLICATION EQUIPMENT: Can be applied using manual, terrestrial and aerial equipment. For ground application, use a volume of 300 to 400 L/ha. Use cone nozzle. Make sure that application equipment is in good condition and properly calibrated. Wear personal protective equipment rubber boots, googles, long sleeve shirt, long pants and mask

5

HOW TO PREPARE THE MIXTURE: Half fill tank with water. Use a separate container to do the premix by adding the recommended dose, stir until wettable powder is fully dissolved then pour into spray tank, stir the mixture well to obtain a homogenous mixture , then fill remainder of spray tank with water and shake well.

6

RECOMMENDATIONS FOR USE :BELIZE

CROP	PEST CONTROLLED	DOSAGE
Tomato *Solanum lycopersicum*	Anthracnose *Colletotrichum sp*	1 to 1.5 kg/ ha
Lettuce *Lactuca sativa*	Downy mildew *Bremia lactucae*	1.5-3.0 kg/ ha
Onion *Allium sativum*	Scape blight *Botrytis alli*	2.0-4.0 kg/ ha

7

APPLICATION INTERVAL: between 4 to 7 days

8

PREHARVEST INTERVAL:
Tomato: 13 days
Lettuce: 14 days
Onion –7 days

9

INTERVAL FOR REENTRY INTO TREATED AREAS: Wait at least 24 hours before entering into the treated area or use full personal protective equipment.

10

PHYTOTOXCITY: Is not phytotoxic when used as recommended.

11

COMPATIBILITY: Is compatible with other commonly used fungicides. It is advisable to perform a compatibility test before the application

12

PRECUATIONS AND WARNING USE:

STORAGE AND TRANSPORT

Store in a cool dry and well ventilated place. Keep away from flames. Store and transport product in the original container. Do not store or transport with medicines, food or animal feed.

DO NOT STORE IN DWELLINGS, KEEP UNDER LOCK AND KEY, OUT OF THE REACH OF

DO NOT SMOKE, EAT OR DRINK WHILE APPLYING OR HANDLING THIS PRODUCT. SHOWER AFTER WORKING WITH PRODUCT AND WEAR CLEAN CLOTHES

13

SIGNS OF INTOXICATION: blurred vision, headache, nausea, vomiting stomach pains

FIRST AID:

14

INGESTION: do not induce vomit. Seek medical attention immediately.

INHALATION: remove victim from contaminated area and get fresh air.

SKIN: remove contaminated clothing and wash the affected area with water and soap for 15 minutes

EYES: wash with plenty of water for 15 minutes

DO NOT TO GIVE DRINK NOR INDUCE VOMIT IN AN UNCONSCIOUS PERSON.

15

ANTITODE AND MEDICAL TREATMENT: antidote does not exist. Treat patient symptomatically

NATIONAL INTOXICATION CENTER

INSTITUTION	COUNTRY	TELEPHONE #
Karl Heusner Memorial Hospital	Belize	(501-)223-1548

16

ENVIRONMENTAL PROTECTION MEASURES

TOXIC TO FISH AND CRUSTACEANS

DO NOT CONTAMINATE RIVERS, LAKES, AND PONDS WITH THIS PRODUCT, ITS EMPTY PACKING OR CONTAINERS.

17

MANAGEMENT OF CONTAINERS, PACKAGES, WASTE AND REMNANTS: Use the entire contents of the container. Empty containers should be "triple rinse" with clean water and added to the prepare mixture, and puncture the empty container. If the country has an official container collection program, deliver these to the nearest collection center or disposed them according to the instructions of the product. In case of spill, apply some absorbent material , collect this material in a container.

USING CONTAINERS AND PACKAGES FOR PURPOSES OTHER THAN THOSE FOR WHICH THEY WERE DESIGNED MAY BE HAZARDOUS TO HUMAN HEALTH AND THE ENVIRONMENT.

18

DECLARATION OF WARRANTY: the manufacture and registrant guarantee the contents of the container provided, as long as the product is in its original packing and properly sealed. We only guarantee the unalterable content of the product in accordance with what is stipulated on the label and the recommendations in the pamphlet.

19

FORMULATED BY:
PESTEC Company Ltd.
Wenglen Road, Shanghi, China

IMPORTED BY: KJK Agro
21 Park Street, Belize City
Tel: (501) 221 - 0001

20

COUNTRY	REGISTRATION NUMBER	DATE OF REGISTRATION
BELIZE	0135-1	1-12-2020

1. Trade Name & Formulation
2. Class of Pesticides / Chemical Family & Common Name
3. Mode of Action
4. Application Equipment
5. How to prepare the mixture
6. Recommendations for use: Crop, Pest & Dosage
7. Application Interval
8. Pre-Harvest Interval
9. Re-entry Period
10. Phytotoxicity
11. Compatibility
12. Precaution and Warning for Use
13. Signs of Intoxication
14. First Aid
15. Antidote and Medical Treatment
16. Environmental Protection Measures
17. Management of Containers, Waste, Packages and Remnants
18. Declaration Warranty
19. Manufacture and Importer
20. Registration number

SESSION 2.5: Pesticides Formulations

Pesticides come in different physical forms, and each one must be used differently.

Liquid Formulations

Powder and Granule-Based Pesticide Formulations

Liquid Formulations

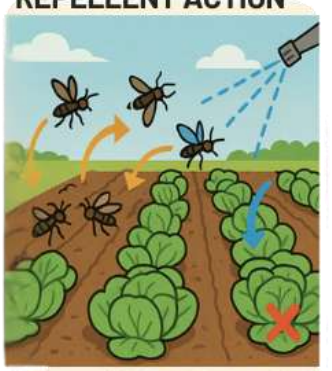
Baits, Ready to Use & Fumigant Formulations

SESSION 2.6: Pesticide Mode of Action

STOMACH ACTION

CONTACT ACTION

REPELLENT ACTION



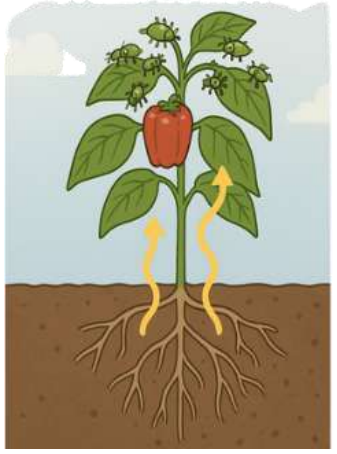
untreated → repellent

INHIBITOR ACTION

PREVENTIVE ACTION

Spray before disease starts

SYSTEMIC ACTION



FUMIGANT ACTION

RESIDUAL ACTION

Long-lasting surface activity

SELECTIVE ACTION

Broadleaf weeds die, but crop is unharmed. Beneficial species are protected.

CURATIVE ACTION

Treat powdery mildew

Table 5: Pesticide Mode of Actions

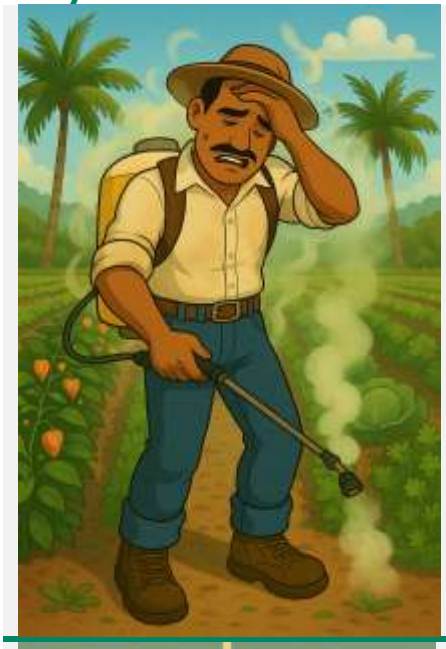
Pesticide Mode of Actions

	Pesticide Action	Mode of Action (How It Works)	Common Uses	Examples of Target Pests/Diseases
1	**Contact Action**	○ Kills pests by direct contact with the chemical	○ Spraying soft-bodied insects	○ Aphids, caterpillars, thrips
2	**Stomach Action**	○ Pest must eat treated plant parts; chemical poisons them internally	○ Chewing insects feeding on leaves	○ Beetles, armyworms, borers
3	**Systemic Action**	○ Absorbed into the plant; moves through sap; kills pests that suck or feed inside	○ Sucking pests or hidden larvae	○ Whiteflies, aphids, leafhoppers
4	**Fumigant Action**	○ Pesticide vapor (gas) fills a sealed space and kills pests by inhalation	○ Grain storage, enclosed areas	○ Weevils, moths, mites
5	**Repellent Action**	○ Does not kill but drives pests away or prevents them from landing or feeding	○ Preventing pest attacks in early stages	○ Mosquitoes, rodents, some crop pests
6	**Inhibitor Action**	○ Disrupts pest growth, molting, feeding, or reproduction	○ Preventing pest maturity or reproduction	○ Insect larvae, mites, fungal spores
7	**Selective Action**	○ Targets specific pests or weeds, sparing beneficial organisms or crops	○ Protecting beneficial insects or crops	○ Broadleaf weeds in corn, sucking insects only
8	**Residual Action**	○ Stays active on leaves, stems, or soil for extended protection against pests	○ Ongoing pest control after spraying	○ Leaf-eating insects, surface fungi
9	**Protective (Preventive) Action**	○ Applied before disease appears; prevents attack or infection	○ Fungal disease management, pre-infestation sprays	○ Rust, downy mildew, leaf spot
10	**Curative (Eradicant) Action**	○ To control disease after infection has already occurred	○ Early-stage infection or infestation treatment	○ Powdery mildew, blight

SESSION 2.7: The Risks of Pesticides to People, Food, and the Environment

Pesticides are meant to help, but if mishandled or misused, they can cause serious harm to you, your family, your soil, your livestock, your crops, and the environment. This section explains the different ways pesticides can go wrong and what you can do to prevent problems.

Key Risks of Pesticides



1. Acute Poisoning (Short-Term)
Breathing in, swallowing, or spilling a large amount can make you very sick fast.

2. Skin Allergies & Rashes
Itching, burns, blisters, or asthma from contact.

3. Chronic Health Effects (Long-Term)
Small doses over years can cause cancer, nerve damage, infertility, liver problems, or birth defects.

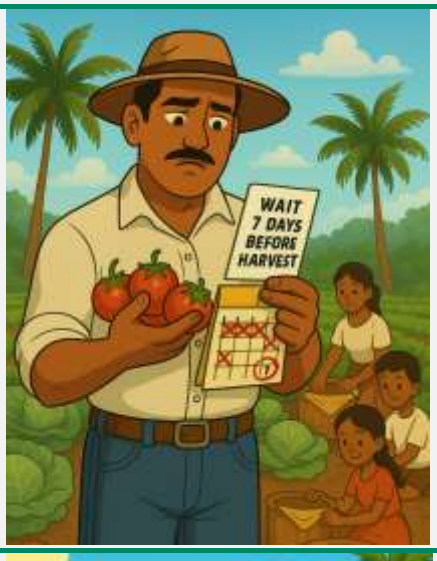
4. Eye Injuries
Splashes can burn eyes or cause blindness.

5. Risk to Family
Pesticide on clothes, hands, or boots can harm children and pregnant women.
Example: storing pesticide in drink bottles.

6. Pregnancy & Fertility Risks
Can harm unborn babies, cause complications, or reduce sperm count.

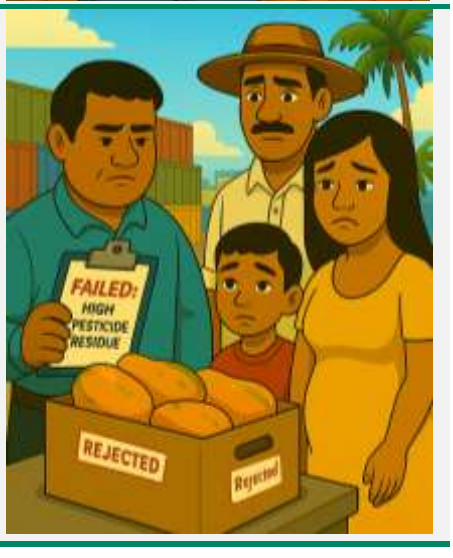
7. Risk to Applicators & Field Workers
Applicators face the highest risk; others can be exposed if they enter too soon.

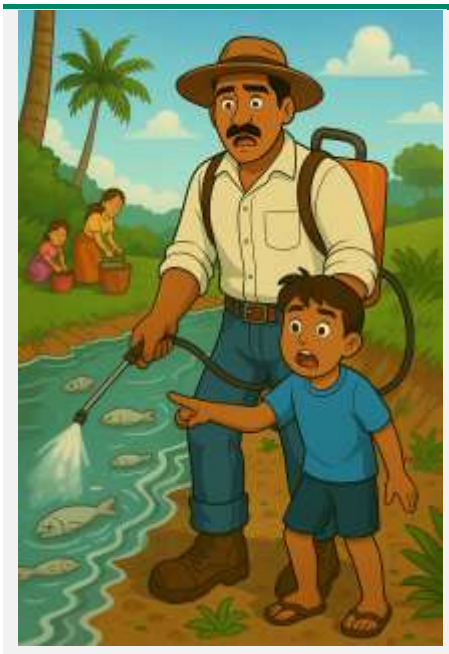
8. Risks to Consumers
Respect the Pre-harvest Intervals and always follow the label instructions.



9. Animal Product Contamination
Grazing on treated fields can contaminate meat or milk.

10. Rejected Crops
Excess residues can lead to rejection of crops and lost income.





11. Risks to the Environment runoff can poison fish and drinking water.
12. Harm to non-target species kills birds, bees, butterflies, earthworms, pets, raptors.
13. Pesticide Persistence in Soil Some remain for years; newer products break down faster but some still last long.

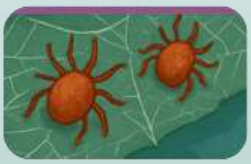
14. Pest Resistance & Resurgence Overuse can make pests develop resistance. Use pesticides from different chemical families in a rotation.

15. Crop Damage (Phytotoxicity) Wrong product, dose, or spraying in hot sun can burn or damage crops.

REVIEW ACTIVITY: Know Pesticides

Section 1: Match Pest to Pesticide

Match the pest with the most likely pesticide type.



Section 2: True or False Questions

No.	Statement	Answer (Select One)	
1	All pesticides kill insects.	☐ **TRUE**	☐ **FALSE**
2	The color band on a pesticide label shows how dangerous the product is.	☐ **TRUE**	☐ **FALSE**
3	It is safe to use pesticide even if the label is missing.	☐ **TRUE**	☐ **FALSE**
4	Pesticides should always be stored away from food, children, and animals.	☐ **TRUE**	☐ **FALSE**
5	Some pesticides stay inside the plant and kill pests that suck sap.	☐ **TRUE**	☐ **FALSE**
6	A skull and crossbones symbol on a pesticide label means the product is highly toxic.	☐ **TRUE**	☐ **FALSE**
7	Always read the label carefully before using any pesticide.	☐ **TRUE**	☐ **FALSE**

Section 3: Multiple Choice Questions

Answer (Select One)

6 What does a red color band on a pesticide label mean?

☐ Safe to use without gloves ☐ Extremely toxic – Danger ☐ Only for spraying weeds

7 Which of these is a type of pesticide used to kill weeds?

☐ Insecticide ☐ Herbicide ☐ Fungicide

8 What is one-way pesticides can enter your body?

☐ Wearing long pants ☐ Through clean water ☐ Through your skin

9 What should you always do before using any pesticide?

☐ Mix it with extra water ☐ Read the label carefully ☐ Guess the dose and test it

10 Which form of pesticide is usually a fine dry powder that needs mixing with water?

☐ WP (Wettable Powder) ☐ EC (Emulsifiable Concentrate) ☐ GR (Granules)

11 What does the skull and crossbones symbol on a pesticide bottle mean?

☐ Safe for drinking ☐ Poison – very dangerous ☐ Keep in the refrigerator

12 What should you do if the label shows a "honey-bee" pictogram?

☐ Spray near flowers ☐ Avoid spraying near bees and bee hives ☐ Avoid spraying near water sources

Section 4: Match Pictogram to Information

Wear gloves

Wear respirator

Wear rubber boots

Wear protection over nose and mouth

Wear apron

When handling dry concentrate...

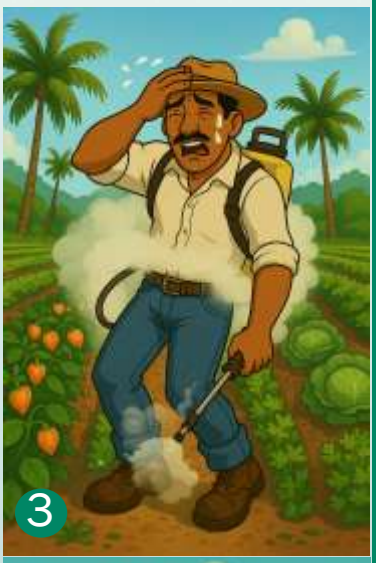
Section 5: What are the Risks?

Instructions:

- Each image is numbered (1 to 6).
- Each picture shows a different risk caused by pesticides.
- Look at each picture carefully.
- Choose the picture that best shows the risk I ask you about.

Which picture shows:

- ☐ The risk of children being poisoned by pesticide?
- ☐ The danger of pregnant women being exposed to pesticides?
- ☐ The farmer suffering from acute pesticide poisoning (fast, strong reaction)?
- ☐ Long-term health damage (chronic poisoning)?
- ☐ Pests that have become resistant to pesticides.
- ☐ Possible contamination of food



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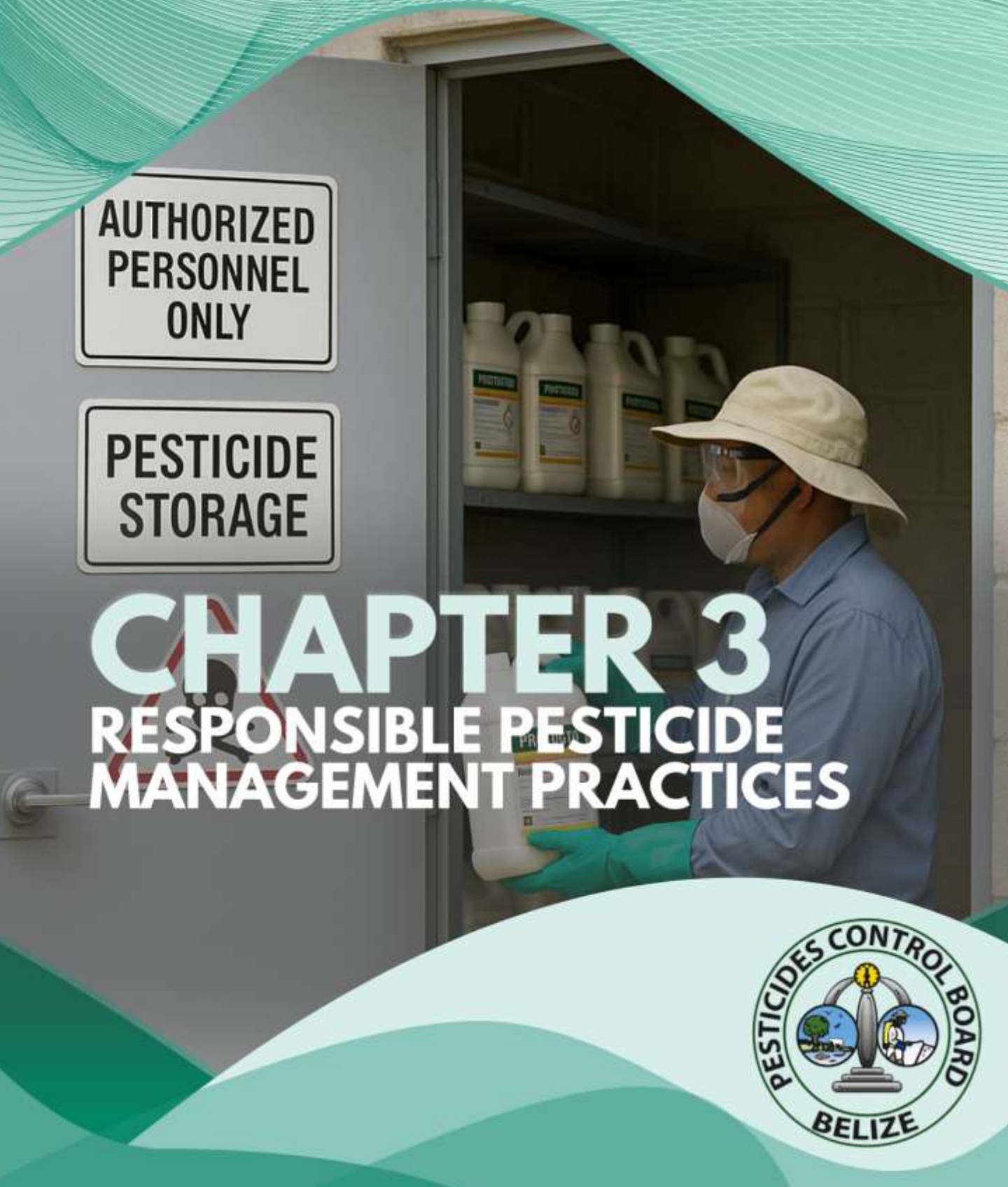


CHAPTER 3
RESPONSIBLE PESTICIDE MANAGEMENT PRACTICES

PESTICIDES CONTROL BOARD
BELIZE

CHAPTER 3: RESPONSIBLE PESTICIDE MANAGEMENT PRACTICES

Before you spray, it's important to know how to handle pesticides responsibly. This module teaches you how to protect yourself, your family, and the environment. You'll learn how to store pesticides properly, mix them properly, use the right protective gear, and clean up properly after spraying.

SESSION 3.1: Golden Rules for Responsible Pesticide Management

Box 20: The 5 Golden Rules for Handling Pesticides

Golden Rule 1:
Always read the label before using

Why: The label gives important instructions on how much to use, how to protect yourself, when to spray, and how long to wait before harvesting.

Golden Rule 2:
Wear proper protective equipment (PPE)

Why: PPE protects your skin, eyes, lungs, and body from pesticide poisoning and long-term health effects.

Golden Rule 3:
Exercise caution at all times

Why: Pesticide should be handled carefully from start to finish. Always assume that it is dangerous. Do not eat, drink, or smoke when using pesticides.

Golden Rule 4:
Practice good hygiene practices

Why: Pesticide residue on your skin or clothes can make you sick or affect others at home.

Golden Rule 5:
Repair and maintain spraying equipment in good condition

Why: A broken or leaking sprayer can harm you, waste pesticide, and damage your crops. Keeping your sprayer in good condition protects both you and your field.

SESSION 3.2: Step-by-Step Process for Responsible Pesticide Management

STEP 1: Purchasing Pesticides

- ☑ Buy only approved products from licensed suppliers.
- ☑ Choose the right product for the pest and crop (avoid guesswork).

- ☑ Ensure containers are sealed, labeled, and undamaged.
- ☑ Verify expiration dates and batch numbers.

STEP 2: Transporting Pesticides

- ☑ Transport in original containers, upright and secured.

- ☑ Do not carry pesticides with food, animal feed, or drinking water.
- ☑ Keep away from passengers and drivers if transported in shared vehicles.

STEP 3: Proper Storage Practices

- ☑ Designate a locked, well-ventilated pesticide storage area.
- ☑ Use a warning sign (“Danger – Pesticides”) on the door.
- ☑ Store away from sunlight, heat, and water sources.
- ☑ Keep empty, rinsed containers separate from full ones.

STEP 4: Personal Protective Equipment (PPE)

Always wear the correct PPE when handling or mixing pesticides.

Why it matters: PPE protects your skin, lungs, eyes, from direct splashes, spills, and spray mist.

- ☑ Wash your PPE with soap and water after every use.
- ☑ Wash separate from other clothes

- ☑ Check for holes or damage before using.
- ☑ Store PPE separate from pesticides.

❁ STEP 5: Mixing Pesticides Carefully

Mixing is the most dangerous step. Do it carefully and correctly.

STEP 5.1: Preparation Before Mixing

Task 1: Read the Label Carefully

- ☑ Ensure that it is for the approved crop and correct pest, personal protective equipment (PPE) requirements, pre-harvest interval (PHI), and re-entry interval (REI).

Task 2: Check Weather Conditions

- ☑ Always check the weather conditions before mixing. Only mix pesticides during cool, calm weather. Do not mix if it is windy, raining, or extremely hot.

Task 3: Keep Children, Workers, and Animals Far Away

- ☑ Clear the area before mixing.
- ☑ No one without PPE should be nearby.
- ☑ Set up a clear boundary and, if possible, post a sign that says, “Pesticide Mixing – Keep Away.”

Task 4: Set Up a Safe Mixing Station

- ☑ Work in a shaded, open, well-ventilated area.
- ☑ Prepare your sprayer, measuring cup, mixing stick, and clean water bucket.

Task 5: Prepare Wash Area and First Aid Supplies

- ☑ Set up clean water, soap, and towel near mixing station.
- ☑ Keep a first aid kit and a bucket of clean water nearby for emergency.

Task 6: Gather and Check Equipment

- ☑ Check that the sprayer has no leaks, the nozzle is not clogged, and the pressure system works properly.
- ☑ Test the sprayer using clean water to confirm it functions correctly.

Task 7. Collect Clean Water

- ☑ Always use clean, clear water - avoid using dirty or muddy water.
- ☑ Collect water using a clean bucket.

Task 8. Put on All Required PPE

- ☑ Before touching anything, put on gloves, a long-sleeved shirt, rubber boots, long pants. goggles, a mask or respirator, and a wide-brim hat or head covering.
- ☑ Make sure no skin is exposed.

Checklist for the Mixing Station

- ☑ Pesticide container (labeled with hazard symbols and color band)
- ☑ Clean measuring cup or graduated jug
- ☑ Stirring stick (wooden or plastic, not metal)
- ☑ Clean bucket or small mixing container
- ☑ Knapsack sprayer (with lid open)
- ☑ Bar of soap
- ☑ Bucket with clean water (for washing spills or rinsing)
- ☑ Warning sign (“No Entry” or “Mixing Area – Keep Away”)
- ☑ Disposable cloth or towel
- ☑ Clock or timer (to track mixing time if needed)

STEP 5.2: During the Mixing Process

Task 1: Add Clean Water to Half-Tank Level

- ☑ Use clean water for mixing, never use water from a contaminated source.
- ☑ Slowly pour water into the tank until it reaches the halfway mark (usually labeled).
- ☑ This reduces foaming and ensures the pesticide mixes evenly.

Task 2: Measure the Pesticide Accurately

- ☑ Read the label again to confirm the correct dose.
- ☑ Use a clean measuring cup, not caps, spoons, or guesswork.
- ☑ Never mix pesticides by eye or estimation.
- ☑ Hold the container below face level and measure carefully in a shaded, stable area.

Task 3: Add Pesticide to the Half-Tank of Water

- ☑ Slowly pour the measured pesticide into the sprayer already containing water.
- ☑ Avoid inhaling fumes while pouring.

Task 4: Top Up with Water and Mix Gently

- ☑ Fill the sprayer to the full line using the remaining clean water.
- ☑ Mix by gently shaking the sprayer or using a clean stick. Do not overfill. Leave enough air space for pressure and shaking.

STEP 5.3: After Mixing

Task 1: Clean the Mixing Area

- ☑ Wipe up any spills right away using cloth or sawdust.
- ☑ Keep pesticide away from drains, rivers, and soil.
- ☑ If it gets on your skin or clothes, wash with soap and change clothes immediately.

Task 2: Rinse All Mixing Tools and Equipment

- ☑ Triple rinse measuring cups, sticks, containers, and utensils with clean water.
- ☑ Apply rinse water on the treated crop, and never near water or animals.
- ☑ Dry and store tools in a safe place, away from food or feed.

Task 3: Safely Return the Pesticide Container to Storage

- ☑ Close the container tightly and return it to the locked shed.
- ☑ Make sure the label is readable.
- ☑ Don't leave containers near food, in the field, or living areas.

Task .4: Clean and Store PPE Properly

- ☑ Take off PPE carefully.
- ☑ Wash it separately with soap and hang it in the shade to dry.
- ☑ Never hang near food or where children play.

Check for damage before next use.

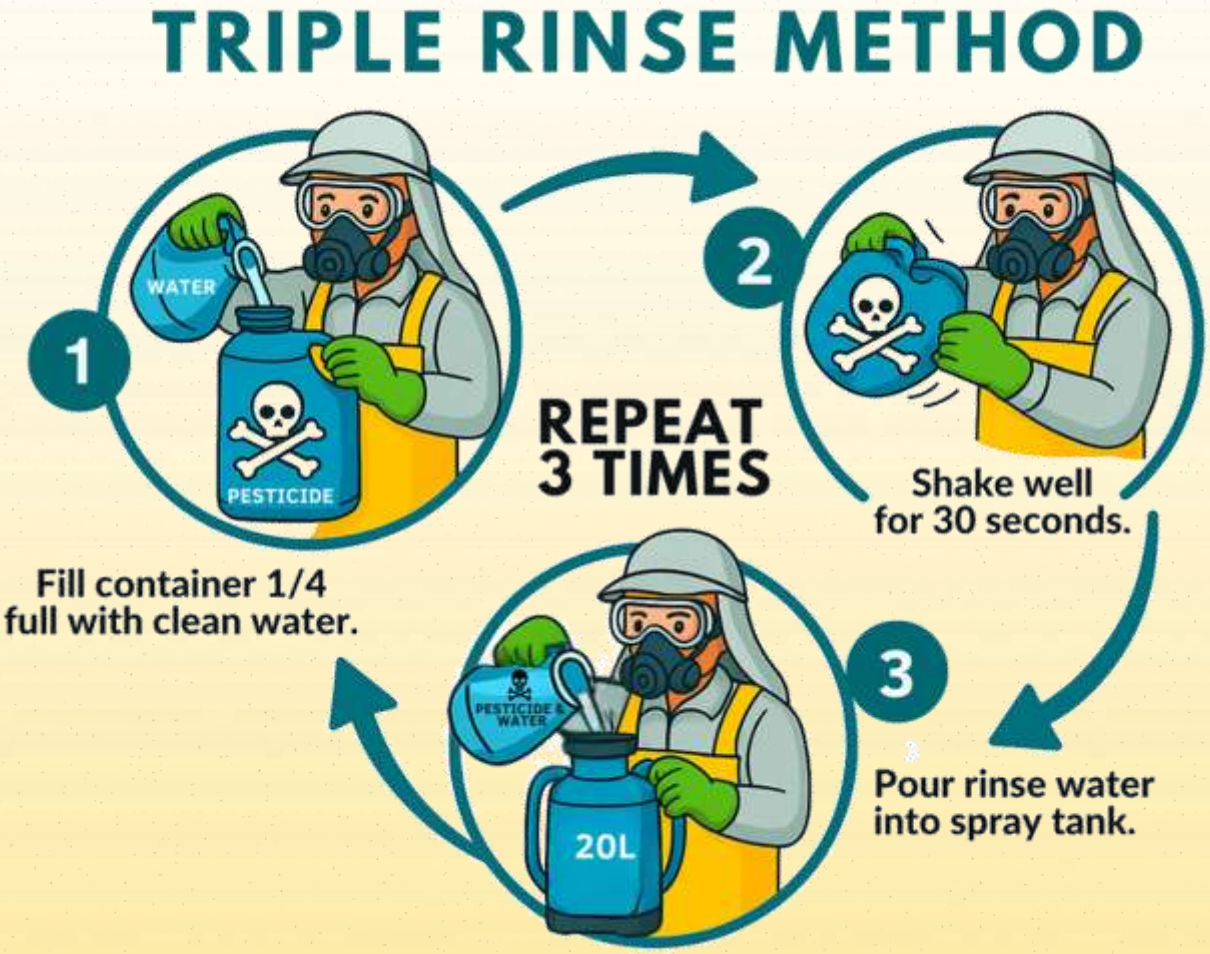
Task 5: Wash Yourself Thoroughly

- ☑ Wash your hands, face, and arms with soap and water immediately.
- ☑ Don't wait until the end of the day. Wash up right away.

Task 6: Record What You Used and When

- ☑ Write down the pesticide name, dose, date, crop, and weather.
- ☑ Use a simple notebook or wall chart.

SESSION 3.3: Triple Rinse Method



Perforate and store the rinsed pesticide containers

Use all mixed pesticide on the crop. Do not leave leftovers.

SESSION 3.4: Applying Pesticides

SPRAY WITH PRECISION


WALK STEADY & SPRAY EVENLY
SPRAY IN A CRISSCROSS PATTERN
EQUIPMENT SAFETY CHECKS
STOP & FIX
CHECK FOR LEAKY HOSE
CHECK FOR CLOG NOZZLE


EQUIPMENT SAFETY CHECKS
CHECK TANK PRESSURE
CHECK TANK STRAPS & FIT


OBSERVING THE RE-ENTRY INTERVAL
SPRAYED AREA
DO NOT ENTER
WAIT 24 HOURS
SPRAYED AREA
DO NOT ENTER
WAIT 24 HOURS

SESSION 3.5: Maintenance of Application and Protective Equipment

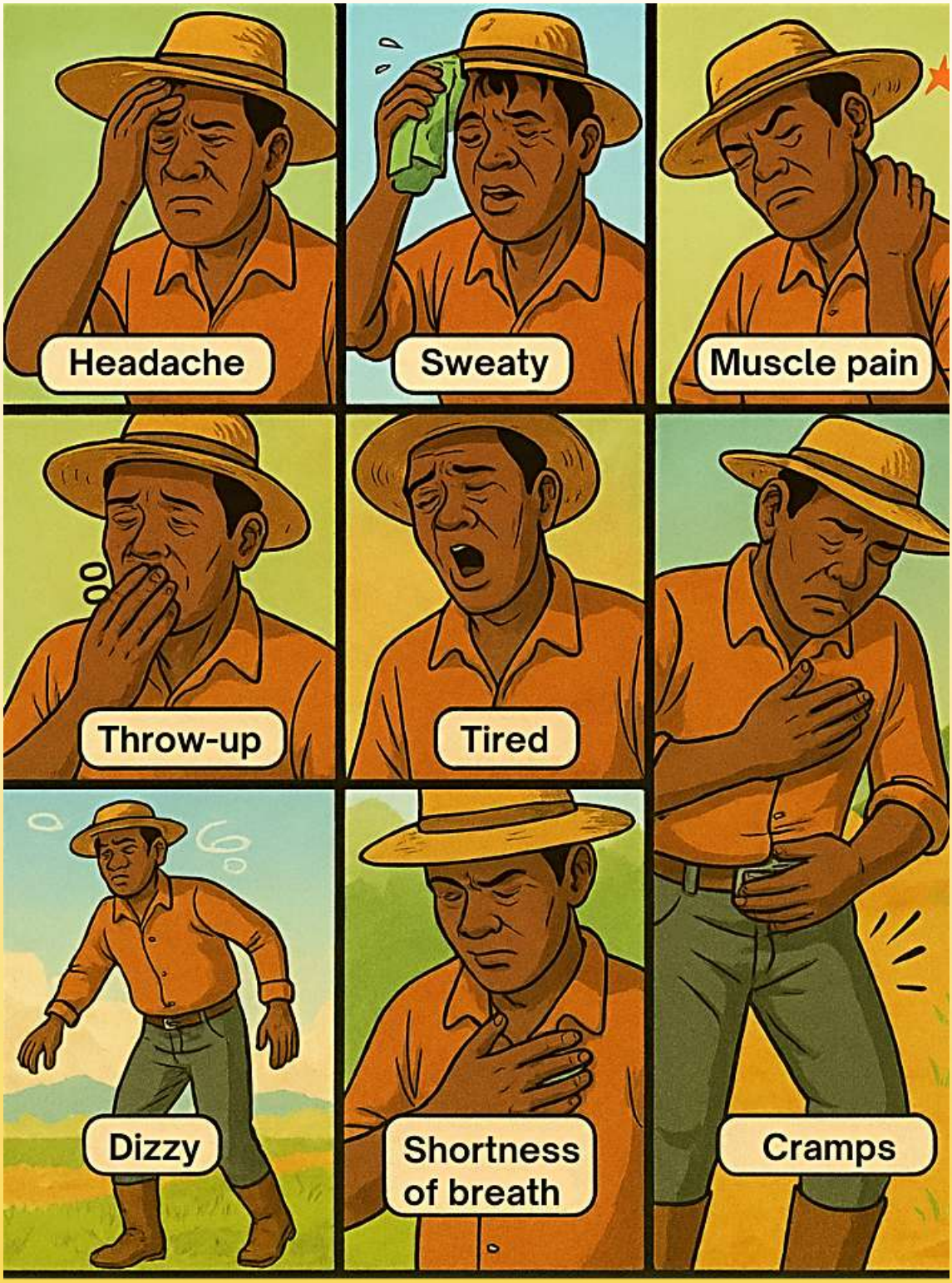
SESSION 3.6: Proper Disposal

What Not To Do

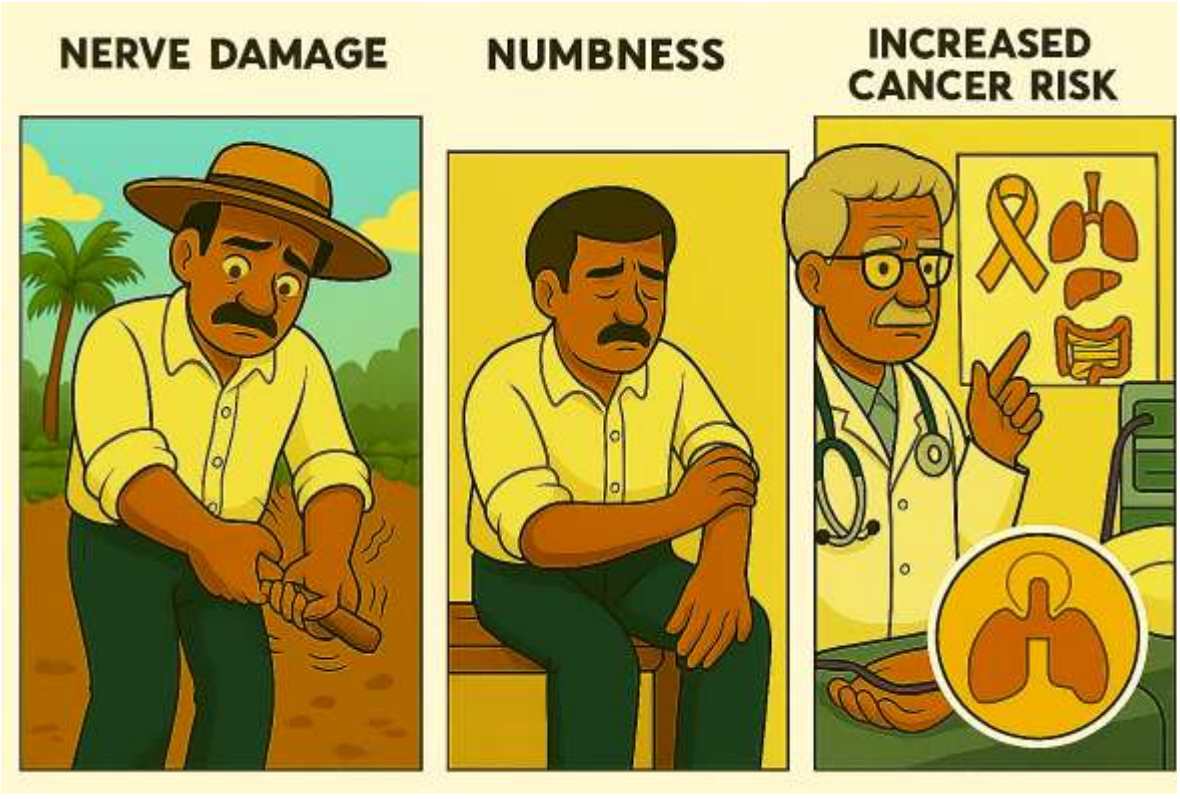

NEVER DUMP CONTAINERS
NEVER ABANDON CONTAINERS
Dumping or abandoning pesticide containers can lead to deadly accidents and environmental damage
NEVER DECANT INTO FOOD OR DRINK CONTAINERS
NEVER USE UNLABELED CONTAINERS
COOKING OIL
NEVER TRANSFER PESTICIDES INTO FOOD, DRINK, OR UNLABELED CONTAINERS – IT CAN CAUSE ACCIDENTAL POISONING.

SESSION 3.7: First Aid Measures

SYMPTOMS OF ACUTE POISONING (within 24 hrs)



LONG-TERM HEALTH EFFECTS OF PESTICIDE EXPOSURE



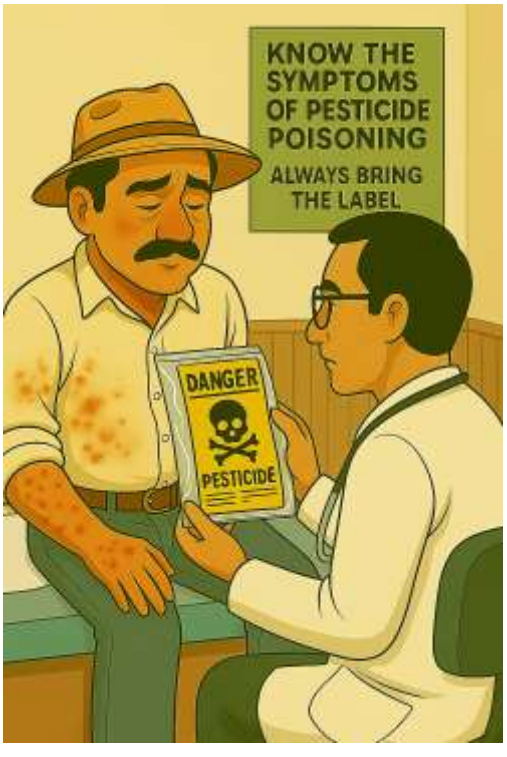
Notes:

KEY FIRST-AID MEASURES

CALL FOR HELP

GO TO EMERGENCY CLINIC

KNOW THE SYMPTOMS



WASH IMMEDIATELY

WASH EYES WITH CLEAN WATER FOR 15-20 MINUTES

PREGNANT WOMEN SHOULD SEEK MEDICAL HELP IMMEDIATELY

GET FRESH AIR OR DO CPR ON PERSON

ALWAYS MONITOR FOR SYMPTOMS FROM EXPOSURE

Review Activity: Responsible Management of Pesticides

Section 1: Is the Farmer handling pesticide responsibly?

BEFORE

OR

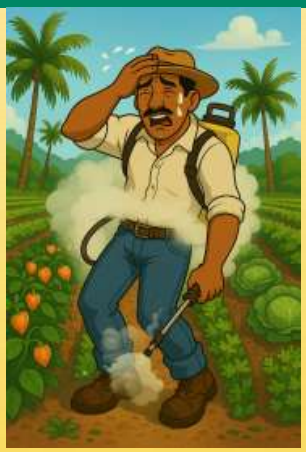
OR

DURING MIXING

OR

OR

DURING SPRAYING



OR

OR

AFTER SPRAYING

OR

OR

Section 2. Multiple Choice (Choose the correct answer):

1. **Where should pesticides be stored?**
   a) Near food in the kitchen
   b) In a locked, dry storage area away from unauthorized people.
   c) In an open container near a water tank
   d) Under the bed

2. **What should you wear when mixing pesticides?**
   a) Gloves, goggles, long sleeve shirt, long pants, mask & boots
   b) Clean but casual clothes
   c) Short pants and sandals
   d) Hat and sneakers only

3. **How should you dispose of empty pesticide containers?**
   a) Reuse them to store water
   b) Burn them
   c) Triple rinse and puncture, then dispose safely
   d) Throw them in the river

4. **How should you wash your PPE?**
   a) With other family clothes
   b) Never wash it
   c) Wash it separately with soap and water
   d) Throw it in the river

Section 3. True or False:

5. It's okay to store pesticide containers along with animal feed.
   ○ True ○ False

6. You should always read the label before using a pesticide, even if you used it before.
   ○ True ○ False

7. PPE protects your body from pesticide exposure.
   ○ True ○ False

8. It's safe to store leftover pesticides in soda bottles.
   ○ True ○ False

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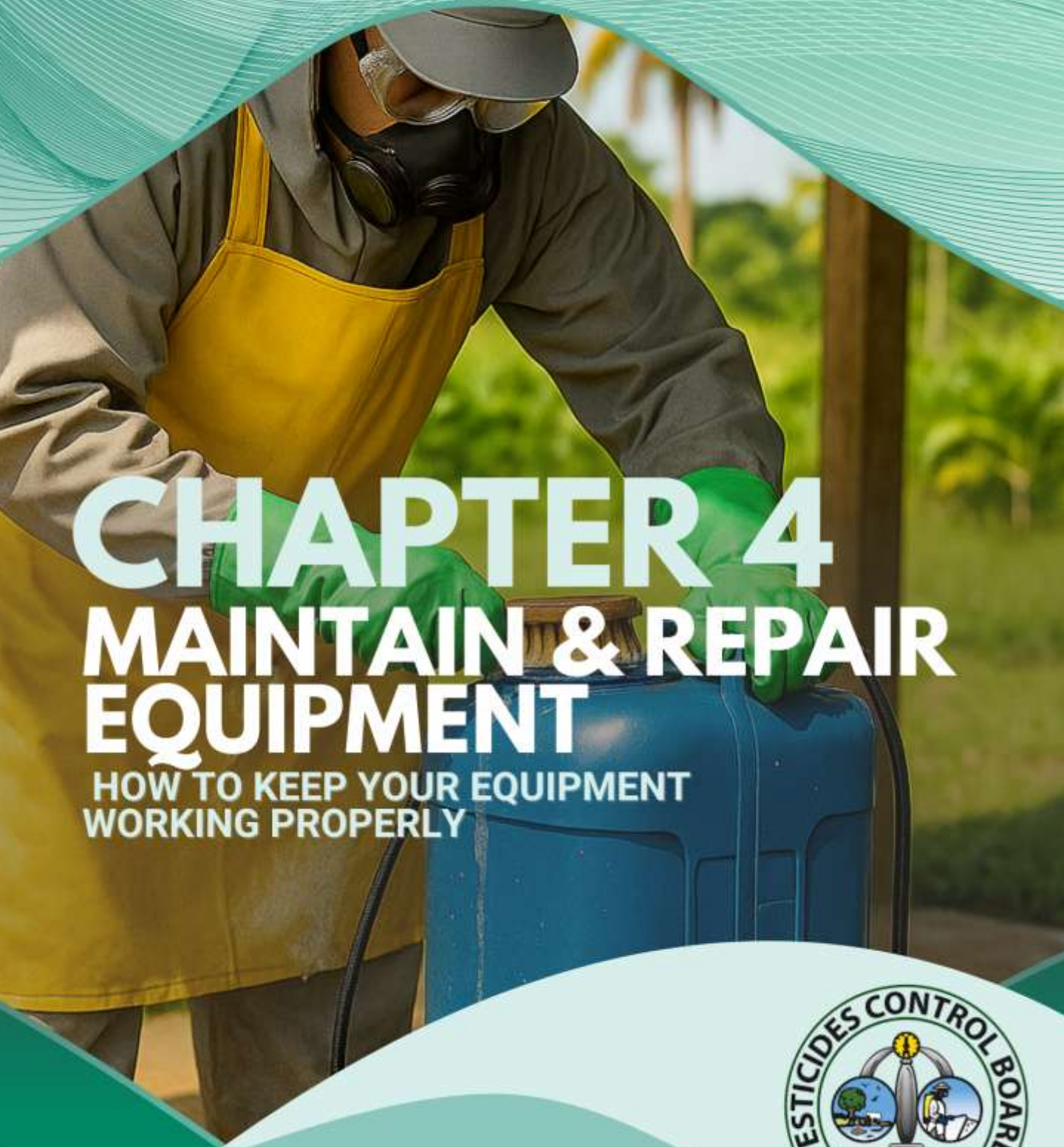

CHAPTER 4
MAINTAIN & REPAIR EQUIPMENT

HOW TO KEEP YOUR EQUIPMENT WORKING PROPERLY

PESTICIDES CONTROL BOARD
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CHAPTER 4: MAINTAIN AND REPAIR EQUIPMENT

Knowing Your Sprayer & Nozzles

Your sprayer is your main tool for applying pesticides. If it's not working well, your spray won't be either. This module helps you understand the parts of your sprayer, how to choose the right nozzle, and how to check for problems like leaks, clogs, or uneven spraying. A well-maintained sprayer saves you money and improves results.

Why it Matters:

SESSION 4.1: Know Basic Parts of Your Sprayer

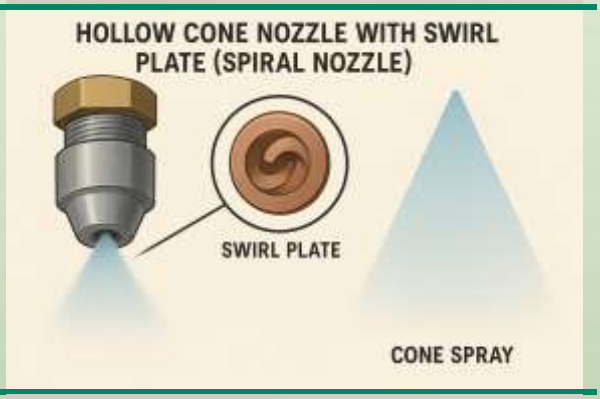
Parts of the Basic Sprayer

Box 21: Parts of the Basic Sprayer

List of Parts to Basic Sprayer:

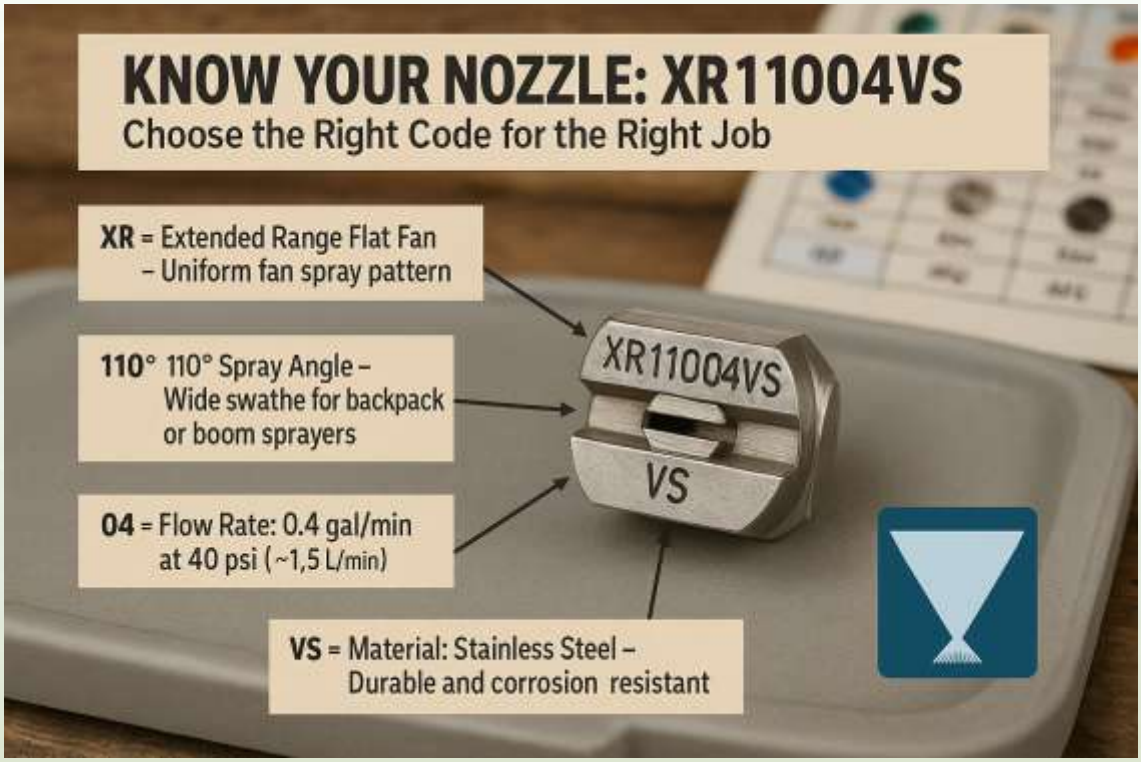
1. **Nozzle:** Releases the spray in a fine mist or stream onto crops.
2. **Filter:** Prevents dirt or debris from clogging the nozzle and lance.
3. **Lance:** A long tube that directs the spray from the tank to the nozzle.
4. **Tank:** Main container that holds the spray liquid (pesticide, fertilizer).
5. **Tank Cover:** a lid that seals the tank opening to prevent spills and contamination.
6. **Bumper:** Protects the spray handle and valve from damage.
7. **Cut-off Valve:** Controls the flow of liquid from the tank to the nozzle; can stop or start spraying.
8. **Hose:** Carries the liquid from the tank to the lance and nozzle.
9. **Hose Connector:** Joins the hose to the tank or pump assembly.
10. **Pressure Gauge:** Shows the spray pressure to help apply the correct amount.
11. **Handle:** Used to hold or operate the sprayer comfortably.
12. **Plunger Rod:** Part of the pump that pressurizes the liquid in the tank.
13. **Bracket and Cup:** Holds the pump assembly securely in place.
14. **Lock:** Secures parts together or holds the pump in position.

SESSION 4.2: Types of Nozzles & their Characteristics

Nozzle Type	Features	Best Used For	Illustration
Flat Fan Nozzle Thin, flat fan (sheet spray)	**Nozzle hole:** 0.5–1.2 mm **Flow:** 0.6–1.5 L/min **Swathe:** 50–80 cm Droplet: Medium–Fine	Herbicides for row or band application	
Hollow Cone Nozzle Circular ring with open center	**Nozzle hole:** 0.7–1.0 mm **Flow:** 0.5–1.2 L/min **Swathe:** 40–60 cm - Droplet: Fine	Fungicides and insecticides	
Hollow Cone with Swirl Plate	**Nozzle size:** 0.7–1.0 mm **Flow rate:** 0.5–1.2 L/min **Swathe:** 40–60 cm - Droplet size: Fine	Fine mist application of fungicides and insecticides	
Full Cone Nozzle Solid circular coverage	**Nozzle hole:** 1.0–1.5 mm **Flow:** 1.0–2.0 L/min **Swathe:** 50–80 cm **Droplet:** Medium–Large	Insecticides	

Nozzle Type	Features	Best Used For	Illustration
Adjustable (Variable) Nozzle Stream to mist (adjustable)	**Nozzle hole:** Variable hole size **Flow:** Adjustable (0.3–1.5 L/min) **Swathe**: 20–60 cm **Droplet:** Fine–Coarse	Spot spraying, seedlings, or home gardens	
Flood Nozzle Wide, coarse fan at low pressure	**Nozzle hole:** 1.5–2.5 mm **Flow:** 2.0–3.5 L/min **Swathe:** 80–100 cm **Droplet:** Coarse	Pre-emergent herbicides on soil	
Twin Flat Fan Nozzle	**Nozzle size:** 0.5–1.0 mm **Flow rate:** 0.6–1.5 L/min **Swathe width:** 60–80 cm **Droplet size:** Medium	Spraying herbicides in both directions (front & back) for row crops; improved leaf contact	
Boom Sprayer Nozzle Assembly Multiple nozzles (usually flat fan or air-induction) -	**Flow rate:** 1.0–2.5 L/min/nozzle **Swathe width:** Up to 8–12 meters - **Droplet size:** Medium–Coarse	Large-scale field spraying using tractor-mounted or towed boom sprayers	

SESSION 4.3: What the Nozzle Code Means



Typical Format of a Nozzle Code: Example: XR 110 04 VS

1. Spray Pattern Type

(Letters at the Start)

Code	Meaning
XR	Extended Range (flat fan)
TT	Turbo TeeJet (low drift fan)
TX	Hollow Cone
AD	Air-Induction/Drift Reduction
OC	Off-Center
FL	Flood Nozzle

2. Spray Angle

(First 2–3 Numbers)

Code	Spray Angle
80	80-degree angle
110	110-degree angle (most common)

3. Flow Rate

(Next 2 Digits)

Code	Flow at 40 psi (US gallons/min)
01	0.1 gal/min (0.38 L/min)
02	0.2 gal/min (0.76 L/min)
04	0.4 gal/min (1.5 L/min)
08	0.8 gal/min (3.0 L/min)

4. Material Code

(End Letters)

Code	Material Type
VS	Stainless Steel
VP	Plastic (Polymer)
VK	Ceramic
VL	Brass

SESSION 4.4: Troubleshooting Abnormal Spray Problems

WORN OR CLOGGED NOZZLES

- ☑ Remove nozzle, soak in warm soapy water, brush clean.
- ☑ Use a brush or straw to clear debris from nozzle tip.
- ☑ Refit nozzle and test for even spray.

LEAKING HOSES OR CONNECTIONS

- ☑ Replace damaged hoses or connectors.
- ☑ Wrap plumber's tape on threads for a better seal.
- ☑ Tighten loose hose fittings.

DIRTY SPRAY FILTERS

- ☑ Remove filter from housing and rinse under clean running water.
- ☑ Brush gently to remove stuck dirt or residue.
- ☑ Replace filter if damaged or too clogged to clean.

WORN OR DAMAGED DIAPHRAGM

- ☑ Open pump housing and inspect diaphragm for cracks or wear.
- ☑ Replace with a new diaphragm that matches the sprayer model.
- ☑ Reassemble pump securely and test spray output.

WORN OR DAMAGED VALVES

- ☑ Remove pump assembly to access valves.
- ☑ Clean valve seats and replace worn or cracked valves.
- ☑ Refit parts, ensuring a tight seal to restore pressure.

Notes:

Review Activity: Handling Your Sprayer Responsibly

Section 1: Name the Parts of the Sprayer Tank

Instructions:

- ☑ Look at the sprayer tank illustration.
- ☑ Each numbered arrow points to a different part of the sprayer.
- ☑ Write the correct name of the part in the space provided on your answer sheet (or directly beside the number if space is available).

01_____
02_____
03_____
04_____
05_____
06_____
07_____
08_____
09_____
10_____
11_____
12_____
13_____
14_____

Section 2: Multiple Choice- select best answer

1. **What part of the sprayer controls the spray pattern?**
   a) Strap
   b) Tank lid
   c) Nozzle
   d) Pump handle

2. **Which nozzle is best for applying herbicide?**
   a) Hollow cone
   b) Flat fan
   c) Full cone
   d) Mist blower

3. **If your nozzle is clogged, what should you do?**
   a) Shake the sprayer
   b) Blow into it with your mouth
   c) Remove and clean it with a brush or straw
   d) Spray harder

4. **What happens if you use a worn-out nozzle?**
   a) It saves pesticide
   b) It sprays too much or too little
   c) It gives better results
   d) Nothing changes

5. **What is a key sign of a leaking sprayer hose?**
   a) Your back feels cold
   b) You see mist in the air
   c) Pressure is steady
   d) The spray is perfect

Section 3 True or False

6. All nozzles spray the same way.
○ **True or** ○ **False**

7. You should check your sprayer for leaks before each use.
○ **True or** ○ **False**

8. Cleaning the filter helps prevent nozzle clogs.
○ **True or** ○ **False**

9. If a sprayer drips when you stop spraying, the trigger valve may be worn.
○ **True or** ○ **False**

10. You should change your sprayer tank diaphragm when worn.
○ **True or** ○ **False**

Section 4: Fix Sprayer
What's Wrong With My Sprayer?

Goal: Learn how to spot sprayer problems and choose the correct fix.

Instructions:

1. **Look at each picture (Questions 1-6)**
   Each shows a common problem farmers face with their sprayer.
2. **Look at the three choices (A, B, C)**
   Each option shows a possible cause or solution.

What's Wrong With My Sprayer?

Look at each picture. Choose the correct fix!

Question 1
Weak Spray Output

A. Tank too full
B. Wrong nozzle color
C. Pump Seal worn

Question 2
White Crystals inside Spray tank

A. Overused pesticide
B. Tank not rinsed properly
C. Used hot water to mix

Question 3
Nozzle keeps dripping

A. Not enough pumping
B. loose or cracked nozzle
C. Spray rod too long

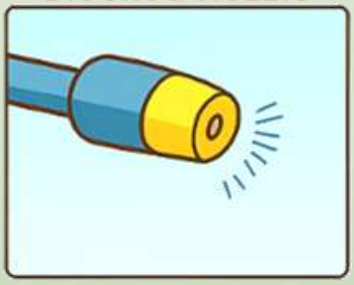
Question 4
Spray Blowing Away

A. Spray harder
B. Use bigger droplets
C. Use smaller nozzle

Question 5
Leak Around Lid

A. Tank too light
B. Lid seal missing
C. Hose is dirty

Question 6
Blocked Nozzle



A. Clean with nail
B. Use plastic straw or brush
C. Blow it out with mouth

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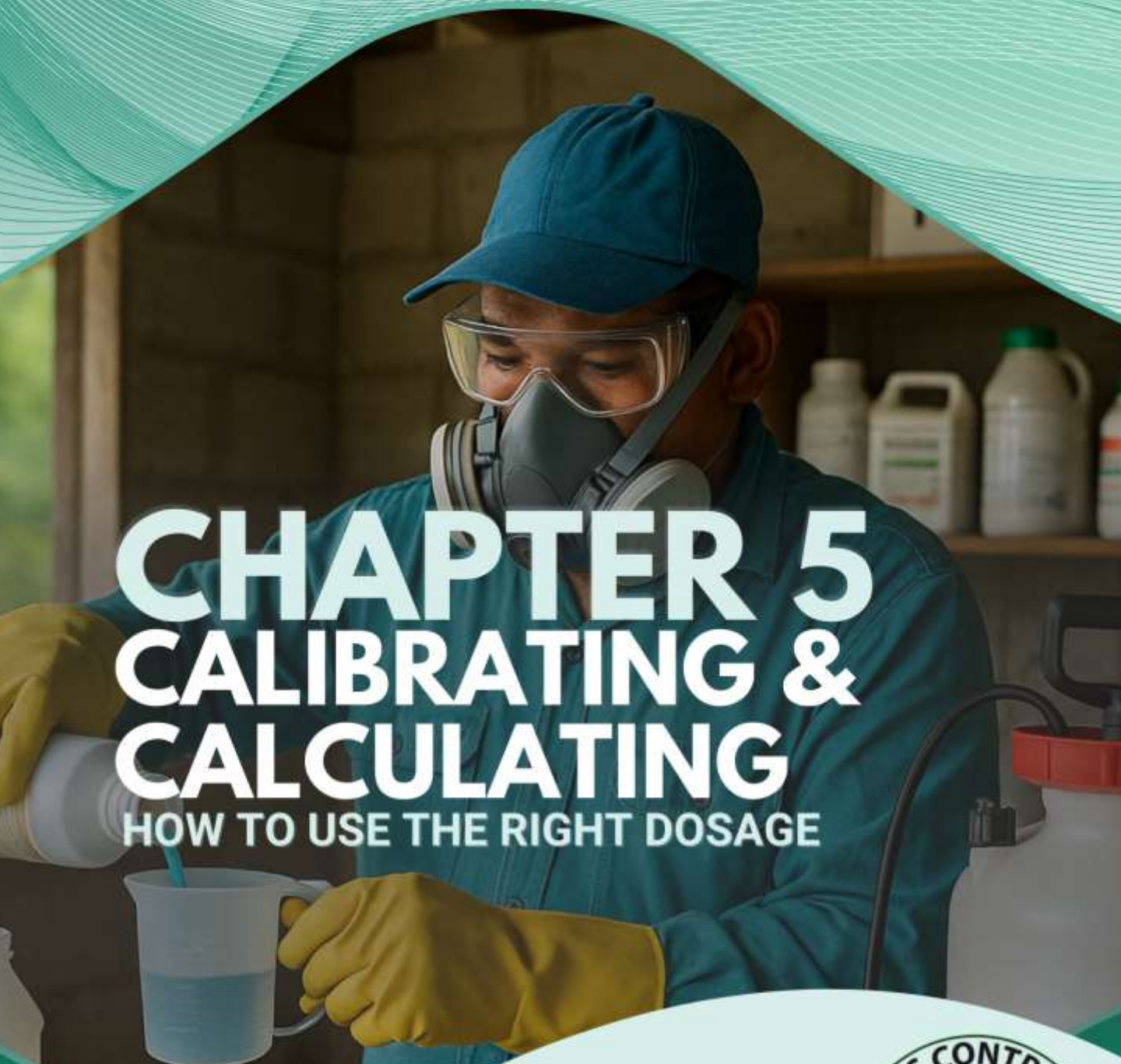


CHAPTER 5
CALIBRATING & CALCULATING
HOW TO USE THE RIGHT DOSAGE

PESTICIDES CONTROL BOARD
BELIZE

CHAPTER 5: CALIBRATION AND CALCULATION

This module shows you how to find out exactly how much spray your sprayer puts out, and how to calculate the right amount of pesticide to mix. You'll learn how to match your sprayer to the label instructions so that you use just enough; not too much or too little. This protects your crops, your health, your livelihood and the environment.

SESSION 5.1: Knowing Calibration and Calculation

(1) What is Calibration?

It is an exercise done to find out how much water you will need to spray your area.

(2) Why is Calibration Important?

(3) When and Why to Calibrate

Before Using New Equipment

After Repairs or Changing Parts

At the Start of a New Season or Crop Cycle

SESSION 5.2: Getting Ready
(Tools and Pre-Checks)

MEASURING JUG

SPRAYER

WATER CONTAINER

STOPWATCH

MEASURING TAPE

COLLECTION CUP

PPE

NOTEBOOK

SESSION 5.3: Calibrating Your Sprayer (Hands-On Method)

STEP 1 Select the Right Nozzle and Pressure

(1) Choose the correct nozzle type for your crop and desired spray pattern.

(2) Set the sprayer to the recommended pressure for that nozzle.

STEP 2 Test the Nozzle Spray Pattern

(1) Fill the sprayer tank with clean water.

(2) Spray to check for even coverage and correct pressure.

(3) Empty the tank after testing.

STEP 3 Mark Out the Test Area

(1) Prepare a "Test Area".

(2) Measure a 10 m × 10 m plot (100 m^2) in your crop field.

(3) Mark the plot clearly using measuring tape and rope.

STEP 4 Spray the Test Area with Measured Water

Measure and pour exactly 10 liters of clean water into the sprayer tank.

Spray the marked plot as you would when applying pesticide (keep a steady pace and correct nozzle height).

After spraying, pour the leftover water from the tank into a measuring container.

Calculate water used:

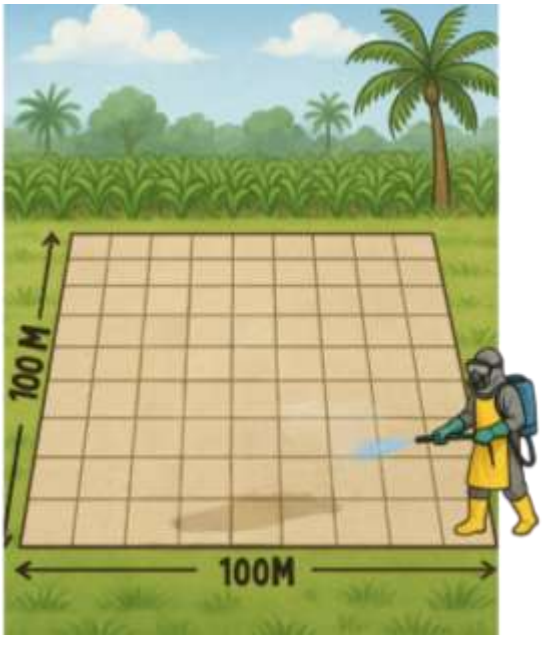
1) *You started with 10 liters (10L) of water*

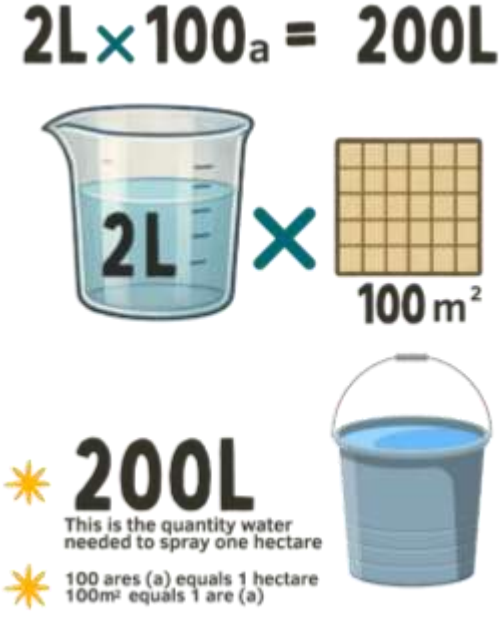
2) After spraying the test area, you were left with 8L

3) Therefore the quantity of water used to spray the test area is 2L

STEP 5 Calculate Water Needed for 1 Hectare

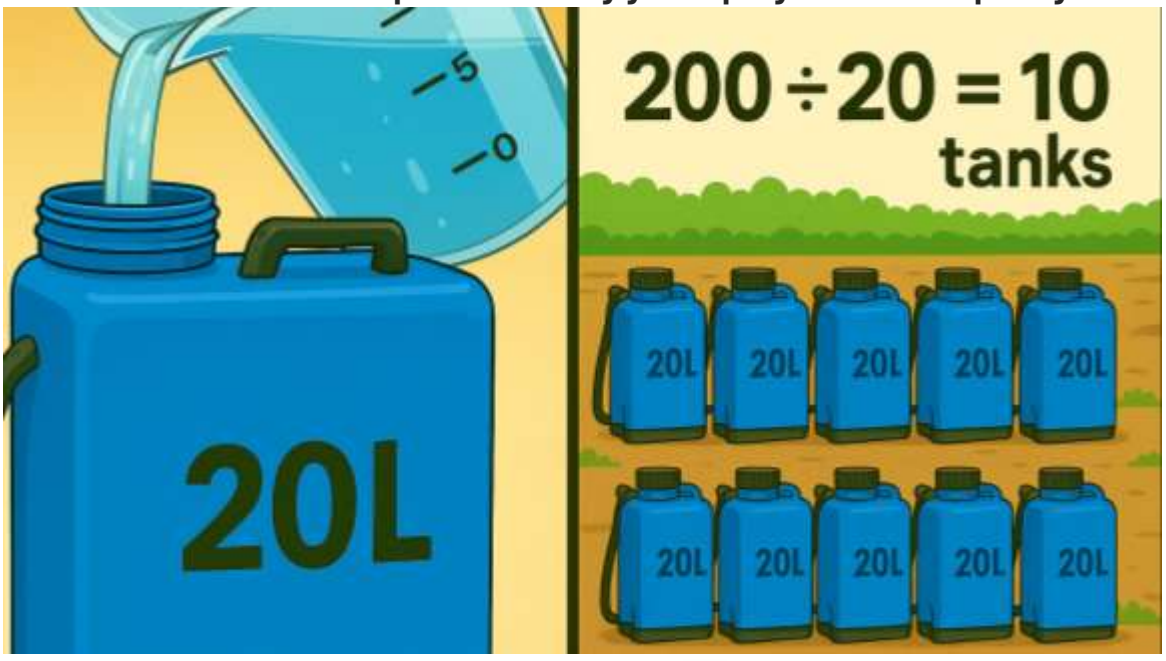
Multiply the amount of water used for 100 m^2 by 100 to get the total for 1 hectare. 1 hectare = 10,000 m^2.





STEP 6 Calculate Number of Tanks Per Hectare

Divide the water needed per hectare by your sprayer's tank capacity.



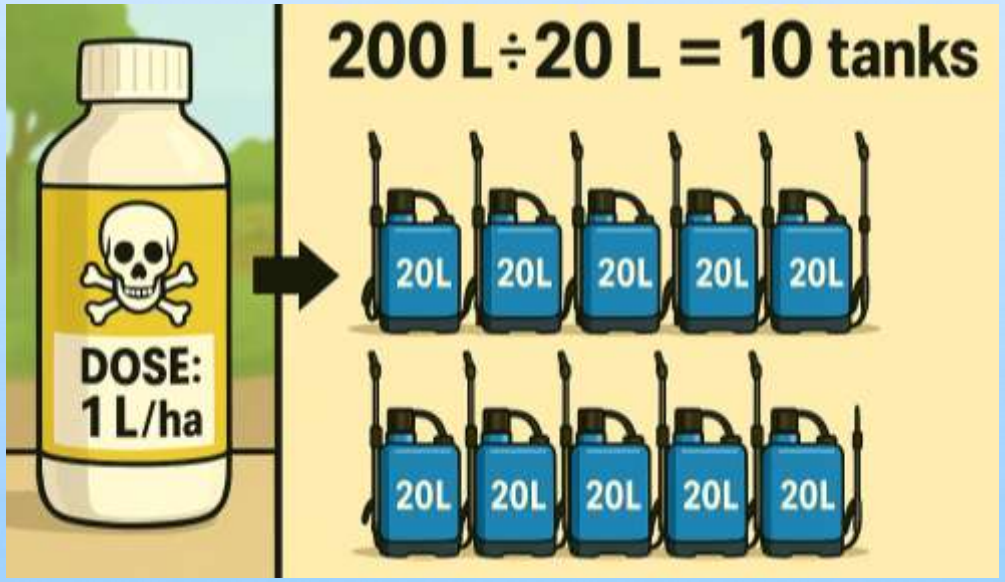
SESSION 5.4. Calculating the Right Dose

STEP 1 Read the Label

1) Read the pesticide label and pamphlet.
2) Take note of the safety warnings.
3) Check the dosage recommendation.

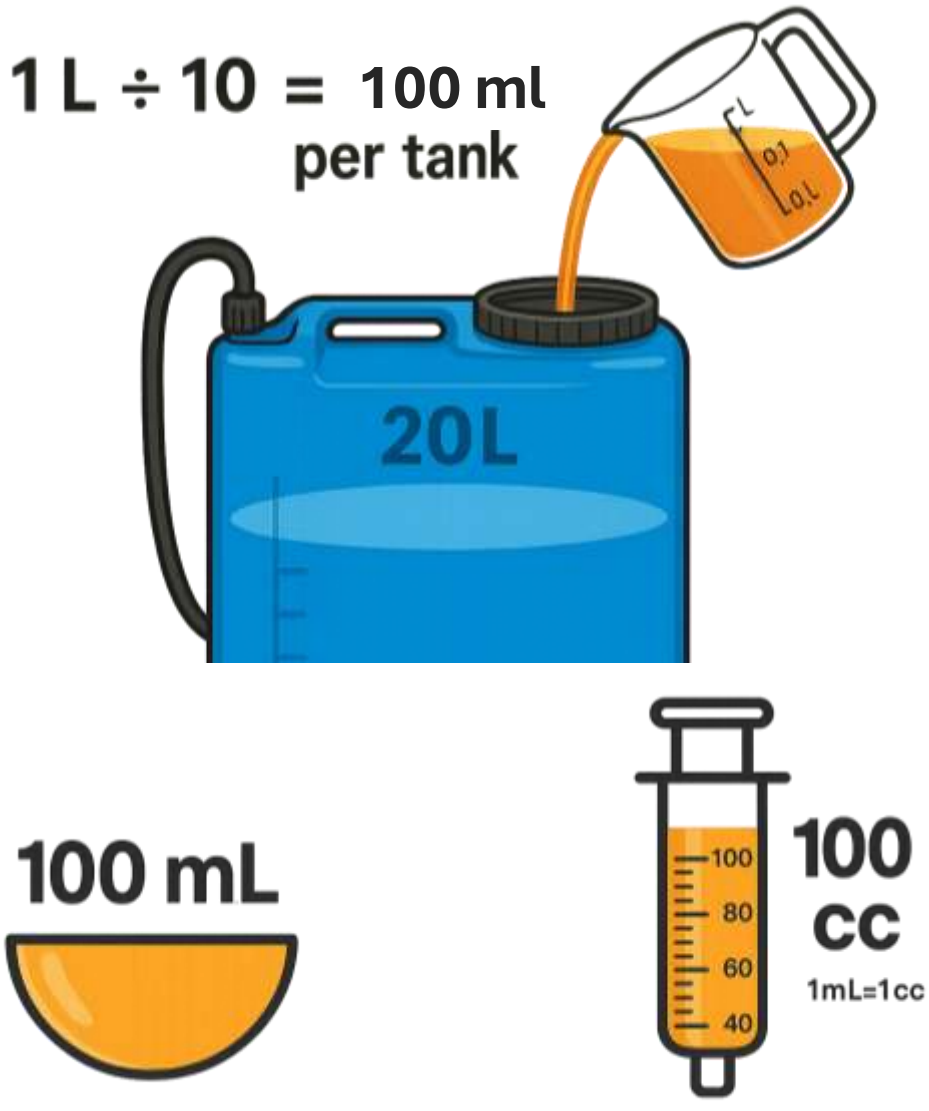
STEP 2 Calculate Tanks required for Area

Based on your previous calculation, know the number of tanks needed for one hectare.



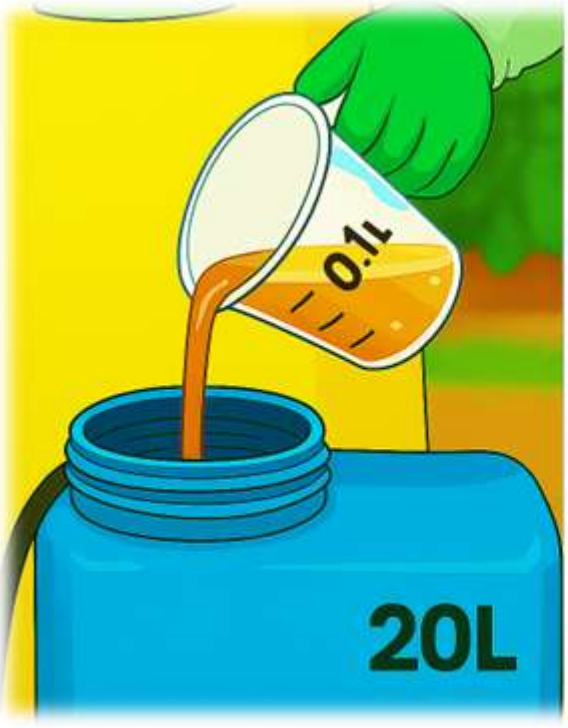
STEP 3 Calculate Dose per Tank

1) Take the total pesticide amount per hectare from the label.
2) Divide this by the number of tanks needed for one hectare.
3) This gives you the amount of pesticide for one tank.



STEP 4 Measure and Pour in Tank

Measure the pesticide amount for one tank using a measuring jug. Pour the measured pesticide into the sprayer tank partly filled with water.



SESSION 5.5. Recordkeeping

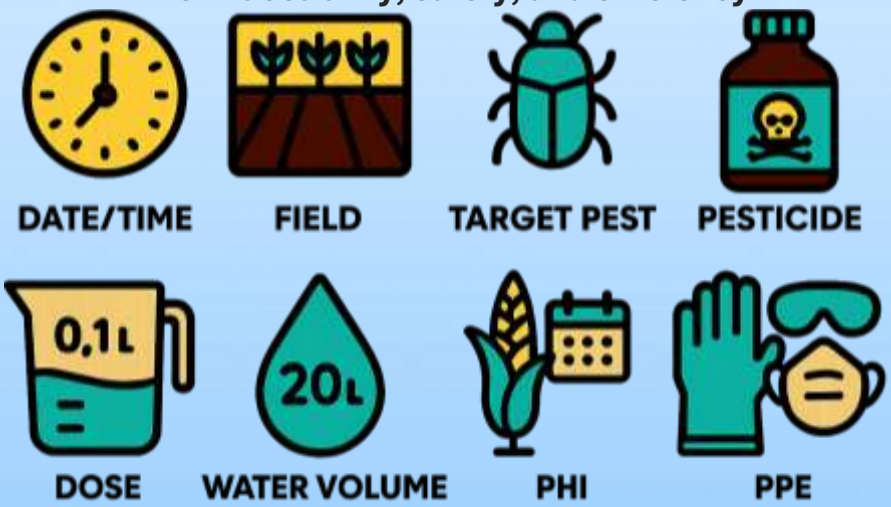
Proper calibration and dosage calculation go hand-in-hand with good practices in recordkeeping and safety. This final section covers how to keep track of your pesticide use and ensure you and your environment stay safe while spraying.

SET 1 Calibration & Calculation Records

Here are some basic records that should be kept when doing calibration, calculations, and pesticide use.

SET 2 Pesticide Use Records

These are simple records that are very important for traceability, safety, and efficiency



Review Activity: Calibration and Calculation

Section 1: Multiple Choice

1. What is calibration used for?
   a) To clean your sprayer
   b) To find out how much water to spray
   c) To guess the field size
   d) To paint the sprayer

2. If your sprayer uses 200 L per hectare and your tank is 20 L, what area does it cover?
   a) 1 ha
   b) 0.5 ha
   c) 0.1 ha
   d) 2 ha

3. The label says use 2 L per hectare. You're spraying 0.1 ha. How much product do you need?
   a) 1.5 L
   b) 0.2 L
   c) 2.0 L
   d) 0.5 L

4. What is 0.2 L in milliliters?
   a) 2 mL
   b) 200 mL
   c) 20 mL
   d) 2,000 mL

5. Why is it bad to guess the dose without calculating?
   a) It takes too long
   b) It wastes fuel
   c) You may over- or under-dose and harm your crop or yourself
   d) No reason

Section 2: True or False:

6. Calibration helps you mix just the right amount of product.
   ○ True ○ False

7. You can skip calibration if your tank looks full.
   ○ True ○ False

8. Measuring water used on 100 m^2 helps calculate liters per hectare.
   ○ True ○ False

9. If you change your walking speed, your calibration stays the same.
   ○ True ○ False

10. Doing the calculation protects your health, crop, and budget.
    ○ True ○ False

Section C: Discussion

11. What would happen if you guessed instead of calculating?
12. Why is it important to match the label dose to your tank and spray area?
13. How can you keep track of this in your notebook?

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Glossary of Terms

This glossary follows FAO/WHO's Code of Conduct on Pesticide Management and related guidance.

Term	Definition
Active Ingredient (AI)	The chemical that actually controls the pest.
Acute toxicity	Harm from a single or short exposure.
Adjuvant / Surfactant	Adjuvant: substance added to a product or tank mix to improve performance or physical properties; surfactants are a type that improves spreading/wetting.
Agitation	Keeping the mix uniformly suspended in the tank.
Application rate	Amount of product per area (e.g., mL or g per 20 L, or per ha).
Buffer zone / no-spray zone	A no-application strip next to water bodies, homes, beehives, or sensitive areas to reduce drift and runoff; width set by label or authority.
Calibration	The measured process to set a sprayer so it delivers the intended dose and spray volume uniformly over a known area.
Carrier	The liquid used to dilute the product (usually water).
Check valve	One-way valve preventing backflow.
Chronic toxicity	Harm after repeated or long-term exposure.
Colour/Color band	Label colour bands indicate acute hazard classes (e.g., red for Ia/Ib, yellow for II, blue for III, green for U) where national systems use them. They supplement, but do not replace, GHS.
Compatibility test (jar test)	Small-scale mix test before tank mixing.
Container management	Approved collection and disposal of rinsed, punctured empties.
CS (Capsule Suspension)	Micro-encapsulated AI in liquid.
Droplet size (VMD)	Typical droplet diameter from a nozzle.
EC (Emulsifiable Concentrate)	Oil-based liquid that emulsifies in water.
Exposure routes	Ways pesticide enters body: skin, breathing, swallowing, eyes.
Filter/Strainer	Screen in tank, line or nozzle to trap debris.
First-aid (pesticide)	Immediate steps on exposure based on label/SDS.
Flat-fan nozzle	Produces a flat sheet pattern.
Foaming	Excess bubbles in tank when mixing.
Formulation	The final product you buy: AI(s) plus inert ingredient(s).

Term	Definition
GAP (Good Agricultural Practice)	Recommended production and protection practices, including label-approved uses and PHIs.
GHS pictograms	Standard hazard symbols on labels.
Granules (GR)	Dry particles applied to soil.
Highly Hazardous Pesticide (HHP)	Pesticides known to present particularly high acute or chronic hazards to health or the environment (e.g., WHO Class Ia/Ib or GHS Category 1 for health or environment), or linked to severe/irreversible impacts in country experience.
Hollow-cone nozzle	Ring pattern with fine droplets.
Inert Ingredient	any component of a formulation other than the active ingredient (e.g., solvents, stabilizers) that helps with product performance or handling.
Integrated Pest Management (IPM)	Combines all suitable control methods to keep pests below damaging levels while minimizing risks to people and the environment. Using prevention, monitoring, thresholds and selective controls (incl. biocontrol), with pesticides as last resort.
Knapsack sprayer	Backpack hand-pump sprayer used by smallholders.
Label	Legal instructions for safe and effective use.
Lance/Wand	Rigid tube that holds the nozzle.
Maximum Residue Limit (MRL)	The highest residue level of a pesticide legally permitted in food or feed, based on Codex risk assessment and GAP.
Mixing/loading area	Designated shaded spot for filling tanks.
Mode of Action (MoA)	How a pesticide affects a pest (e.g., nerve, growth).
Nozzle	Spray tip that shapes spray pattern and droplet size.
Obsolete pesticide	Products that can no longer be used for their intended purpose (outdated, deteriorated, banned or unknown) and require disposal.
Pesticide	Any substance or mixture used to prevent, destroy, repel or control a pest.
PPE (Personal Protective Equipment)	Gloves, goggles, respirator, apron, boots, long sleeves/pants.
Pre-harvest interval (PHI)	Time that must pass between the last application and harvest so residues decline to permitted levels. Always follow the days stated on the label.
Pressure (bar/psi)	Force that drives flow through the nozzle.
Puncture / Render unusable	Pierce a rinsed empty container.
Record-keeping	Date, field, crop, product, rate, volume, weather, operator.
Re-entry interval (REI)	Minimum time after application before people may re-enter the treated area without PPE, to reduce exposure risk. Value is set on the label.
Resistance management	Planning sprays to avoid repeated use of the same MoA.

Term	Definition
Safety Data Sheet (SDS)	Technical sheet with detailed hazard and safety information for workers and emergency responders; must match the approved label.
Secondary containment	A tray or berm under containers to catch spills.
Signal word	Under GHS there are only two signal words on labels: Danger (more severe) or Warning (less severe). Some products may have no signal word if hazards are low.
SL (Soluble Liquid)	Liquid that dissolves fully in water.
Spill kit	Materials to absorb/contain spills (sawdust, sand, bags, soap, PPE).
Spray drift	Movement of droplets or vapour off target during or just after spraying; reduced by correct nozzles, pressure, boom height and weather checks.
Spray volume (L/ha)	Total water delivered per hectare.
Storage (general)	Store locked, ventilated, cool and dry, away from food, feed, seed, children and animals; never decant into food/drink containers.
Suspension Concentrate (SC)	Fine solid particles suspended in liquid.
Tank mix	Two or more products mixed for one application.
Trigger/Valve	Hand control that starts/stops the spray.
Triple rinse	Immediately after emptying pesticide bottle: (step 1) fill container with water to approximately 20%, (step 2) shake and drain into sprayer tank; (step 3) repeat three times, then puncture so it cannot be reused.
ULV (Ultra-Low Volume)	Very low spray volume application.
WG/DF (Water-dispersible Granule / Dry Flowable)	Granules that disperse to form a suspension.
WHO hazard class	Acute toxicity classes (Ia, Ib, II, III, IV) based on LD_{50}/LC_{50}.
WP (Wettable Powder)	Powder that forms a suspension in water.

Belize
National Pesticides Training and Certification Program

QUICK REFERENCES

KEY RESOURCES

PESTICIDES CONTROL BOARD
BELIZE

Quick References

Quick Reference 1: Homemade Pest Control Remedies

Recipe Name	Ingredients	Method of Preparation	Pests Controlled
Neem Spray	100g fresh neem leaves or 30ml neem oil 1Liter water Few drops of soap	Crush leaves or mix neem oil with water and soap. Let it sit for 12 hrs. Strain and spray early morning.	Aphids, whiteflies, caterpillars, mealybugs
Garlic-Chili Spray	5 garlic cloves or 1 tbsp garlic powder 2 hot peppers 1L water Soap drops	Blend or mix ingredients. Steep overnight. Strain and spray.	Aphids, beetles, caterpillars, thrips
Onion-Garlic Spray	1 onion bulb 4 garlic cloves 1L water Few drops of soap	Blend onion and garlic in water. Let it sit for 12–24 hrs. Strain and spray on plant leaves.	Soft-bodied insects, mites, leafminers
Soap Spray (Insecticidal Soap)	2 tbsp mild dish soap (non-scented) 1L water	Mix gently (avoid foam). Spray directly on pests, not during hot sun.	Aphids, mites, whiteflies, scales
Ash Barrier	Clean dry wood ash	Sprinkle around plant base or directly on pests when leaves are dry.	Slugs, snails, cutworms
Papaya Leaf Extract	5 fresh papaya leaves 1L water	Crush or blend leaves with water. Steep for a few hours. Strain and spray.	Leafhoppers, mealybugs, fungal leaf spots
Banana Peel Trap	1 ripe banana peel 1 container (with small holes)	Place peel in container near plants. Replace every 2–3 days.	Fruit flies, beetles
Molasses Ant Bait	1 tbsp molasses 1 tbsp sugar ½ cup water	Mix and place in shallow dishes near ant trails.	Ants
Madre de Cacao (Gliricidia) Extract	10–15 fresh leaves 1L water	Crush or blend leaves with water. Let it sit for 24 hours. Strain and spray directly on crops.	Aphids, beetles, fungal diseases, nematodes (soil drench)
Onion-Salt Spray (Fungal control)	1 onion 1L water 1 tsp salt	Blend onion and water. Add salt. Let sit for 6–8 hours. Strain and spray infected leaves.	Fungal leaf spots, mildew

Quick Reference 2: Types of Pests and Non-Chemical Control Methods

Table 6: Types of Pests and Non-Chemical Control Methods

Types of Pests and Non-Chemical Control Methods			
Type	**What It Is (Description & Characteristics)**	**Local Examples**	**Non-Chemical Control Methods**
Insects	• **Insects** • Small animals with 6 legs. Some fly, others crawl. They can chew, suck sap, or lay eggs inside fruits or stems. Many spread diseases like viruses. Found on leaves, stems, fruits, and flowers. Multiply quickly in warm weather.	• Fall Armyworm (*Spodoptera frugiperda*) • Aphids (*Aphis gossypii*) • Whiteflies (*Bemisia tabaci*) • Thrips (*Scirtothrips dorsalis*) • Bean Pod Borer (*Maruca vitrata*) • Pepper Weevil (*Anthonomus eugenii*)	• Hand-picking • Neem oil spray • Yellow or blue sticky traps • Use resistant crop varieties • Encourage ladybugs, lacewings • Keep field clean and weed-free
Mites	• **Mites** • Tiny spider-like creatures that are not insects. Usually live under leaves and suck sap. Thrive in hot, dry weather. Too small to see easily. May leave webbing. Cause bronzing or curling of leaves.	• Red Spider Mite (*Tetranychus urticae*) • Broad Mite (*Polyphagotarsonemus latus*) • Two-spotted Mite (*Tetranychus spp.*)	• Spray leaves with water or neem • Use soap-based sprays • Remove and destroy affected leaves • Maintain humidity and reduce plant stress
Weeds	• **Weeds** • Unwanted plants that grow among crops. They compete for water, light, and nutrients, and can host pests or diseases. Many grow faster than crops. Some produce many seeds or underground tubers.	• Pigweed (*Amaranthus spp.*) • Jungle Rice (*Echinochloa colona*) • Purple Nutsedge (*Cyperus rotundus*) • Goosegrass (*Eleusine indica*) • Spiny Amaranth (*Amaranthus spinosus*)	• Hand weeding • Mulching (with straw, grass, or plastic) • Crop rotation • Cover crops • Timely land preparation and hoeing
Fungi	**Fungi** • Microscopic organisms that cause disease, especially in wet, warm, or shaded areas. Spread by wind, water, or on tools. Appear as spots, molds, rots, or wilts. Damage starts on leaves, stems, or fruits.	• Powdery Mildew (*Oidium spp.*) • Early Blight (*Alternaria solani*) • Damping Off (*Pythium spp.*, *Rhizoctonia spp.*) • Anthracnose (*Colletotrichum spp.*) • Downy Mildew (*Peronospora spp.*)	• Space plants properly • Improve drainage • Avoid overhead watering • Remove infected plant parts • Use resistant or tolerant varieties

Types of Pests and Non-Chemical Control Methods

Type	What It Is (Description & Characteristics)	Local Examples	Non-Chemical Control Methods
Bacteria	**Bacteria** • Very microscopic organisms that live in soil and water and enter plants through wounds, rain splash, or insects. Spread fast in warm, humid conditions. Appear as water-soaked spots or stem cracks. Some cause wilting.	• Bacterial Spot (*Xanthomonas spp.*) • Bacterial Wilt (*Ralstonia solanacearum*) • Bacterial Blight (*Xanthomonas oryzae*)- Soft Rot (*Erwinia spp.*)	• Remove and burn infected plants • Use clean tools and planting material • Avoid working in fields when wet • Avoid overhead watering • Use crop rotation
Viruses	**Viruses** • Invisible disease agents that cannot be cured, only prevented. Usually spread by insect pests like whiteflies, leafhoppers, and aphids. Cause yellowing, curling, or deformation.	• Tomato Yellow Leaf Curl Virus • Maize Streak Virus • Papaya Ringspot Virus • Cucumber Mosaic Virus	• Control insect vectors • Remove and burn infected plants- Use virus-resistant seeds • Eliminate weedy borders • Keep nurseries pest-free
Nematodes	**Nematodes** • Microscopic worms that live in the soil and feed on plant roots. Cause root galls or knots. Make plants weak, especially during dry periods. Damage often goes unseen until it's too late.	• Root-knot Nematode (*Meloidogyne spp.*) • Reniform Nematode (*Rotylenchulus reniformis*) • Lesion Nematode (*Pratylenchus spp.*)	• Crop rotation (non-host crops like corn) • Soil solarization • Add organic matter or compost • Plant resistant varieties • Avoid infested nursery soil
Molluscs	**Molluscs** • Soft-bodied animals like snails and slugs. Mostly active at night or after rain. Chew large holes in leaves, stems, and fruits. Leave slimy trails. Hide under mulch, debris, or dense weeds.	• Garden Slug (*Deroceras spp.*) • Field Slug (*Lehmannia spp.*)	• Hand-pick in early morning or evening • Use lime, ash, or sand barriers • Clean up weeds and trash piles • Keep field edges trimmed

Quick Reference 3: Understanding the Key Types of Pest Control Methods in IPM

Table 7: Comparison of IPM Pest Control Methods for Farmers in Belize

Pest Control Method	Type of Action	Main Purpose	Timing of Use	Tools or Inputs Needed	Cost	Examples (Belize)
Cultural Control	Based on farming practices and crop management	Prevent pest outbreaks before they start	Before pests appear (preventive)	Crop rotation, early planting, spacing, field sanitation	Low -uses on-farm knowledge	Rotating tomato with corn, cleaning weeds and old plants before replanting
Mechanical Or Physical Control	Based on tools or physical actions	Remove, block, or trap pests without chemicals	When pests appear (reactive or preventive)	Hand-picking, sticky traps, row covers, soil solarization	Low to medium - depends on tools	Hand-picking caterpillars, using sticky traps for whiteflies, plastic mulching
Biological Control	Based on use of natural enemies (beneficial insects/fungi)	Reduce pest numbers naturally	Preventive or reactive, depending on pests	Ladybugs, parasitic wasps, beneficial fungi, flowering borders	Low to medium - some may require habitat	Ladybugs on peppers, parasitic wasps on armyworm
Chemical Control	Use of pesticides	Kill or control pests when other methods fail	Last resort – when pest levels are high	Registered pesticides, PPE, sprayer, label guidance	Medium to high - product cost + PPE	Insecticides for whiteflies in tomato, fungicides for early blight
Genetic Control	Use of resistant crop varieties	Reduce pest impact using strong plants	Planned at planting stage	Resistant seeds, certified planting material	Medium -cost of resistant seed	Tomato varieties resistant to TYLCV, beans tolerant to rust, nematode-resistant okra
Behavioral Control	Use of pest behavior to trap or confuse	Interrupt pest feeding or reproduction	During pest mating or active feeding times	Pheromone traps, attract-and-kill lures, reflective mulch	Low to medium - depends on material used	Pheromone traps for moths, reflective mulch in peppers, fruit fly bait stations
Legal or Regulatory Control	Government laws and regulations	Stop serious pests and protect national agriculture	Ongoing, as regulated by authorities	Quarantine zones, destruction orders, registered product lists	No direct cost unless in violation	Citrus greening quarantine, PCB pesticide registration, medfly control laws

Quick Reference 4: Register of Pesticides (RoP) approved for use in Belize

The Register of Pesticides (RoP) is the official list of pesticides approved by the Pesticides Control Board (PCB) for use in Belize. Updated quarterly, it reflects new approvals, voluntary withdrawals, and changes to registration categories and conditions.

The RoP is now a searchable database on the PCB website- https://pcbelize.com/.

Farmers can consult it to find duly registered pesticides and related substances, with their approved uses and other information for effective pest and disease control.
Access the RoP by scanning the QR Code below.

Crop	Common Pest or Disease	Common Pesticide Type Used
Tomato	Whiteflies, fruit worms, early blight, late blight	Insecticide, Fungicide
Sweet Pepper	Aphids, broad mites, powdery mildew, bacterial spot	Insecticide, Miticide, Fungicide, Bactericide
Hot Pepper (Habanero)	Thrips, aphids, anthracnose, bacterial leaf spot	Insecticide, Fungicide, Bactericide
Beans	Leafhoppers, bean rust, anthracnose	Insecticide, Fungicide
Cabbage	Diamondback moth, aphids, black rot	Insecticide, Fungicide, Bactericide
Corn (Maize)	Fall armyworm, corn earworm, maize streak virus	Insecticide, Seed treatment,
Sugarcane	Sugarcane borer, froghopper, smut disease, mosaic virus	Insecticide, Fungicide
Banana	Banana weevil, nematodes, Black Sigatoka (fungal leaf spot)	Insecticide, Nematicide, Fungicide

"Search the Register of Pesticides online to find approved products and their uses- scan the QR code to access."

Quick Reference 5: Conversion Table for Pesticide Use, Mixing, and Field Measurement

Units of Measurement

Core volume and mass

Symbol	Unit name	What it measures	Quick equivalence
L	Litre	Liquid volume	1 L = 1000 mL = 1000 cc
mL	Millilitre	Small liquid volumes	1 mL = 1 cc = 0.001 L
cc	Cubic centimetre	Small liquid volumes	1 cc = 1 mL
g	Gram	Mass/weight	1000 g = 1 kg
oz	Ounce	Mass / weight	1 ounce = 28.4 g
kg	Kilogram	Mass/weight	1 kg ≈ 2.2 lb (approx.)

Area and length

Symbol	Unit name	What it measures	Quick equivalence
ha	Hectare	Area	1 ha = 10,000 m^2 = 2.471 acres
	Task	Area	1 task = 25 x 25 yards
			1 hectare = 20 task
	Manzana	Area	1 manzana = 16 task
ac	Acre	Area	1 acre = 8 task
a	Are	Area	1 are = 100 m^2

Concentration and application rate

Symbol	Unit name	What it measures	Quick equivalence
mL/L	Millilitres per litre	Mix concentration	e.g., 2 mL/L = 0.2% v/v
g/L	Grams per litre	Mix concentration (solids)	—
L/ha	Litres per hectare	Spray volume per area	e.g., 200 L/ha
%	Percent	Concentration	1% = 10 mL/L
ppm	Parts per million	Very low concentration	1 ppm ≈ 1 mg/L

Pressure and temperature

Symbol	Unit name	What it measures	Quick equivalence
bar	Bar	Spray pressure	1 bar ≈ 14.5 psi
psi	Pounds per square inch	Spray pressure	30 psi ≈ 2.07 bar
°C	Degrees Celsius	Temperature	25–30°C common field range

Occasional field units (for reference)

Symbol	Unit name	What it measures	Quick equivalence
gal (US)	US gallon	Liquid volume	1 gal = 3.785 L
fl oz (US)	US fluid ounce	Small liquid volumes	1 fl oz = 29.57 mL
acre	Acre	Field area	1 acre = 0.405 ha

Conversion Tables

Note: Use the tables below to calculate area, volume, mixing ratios, and spray amounts. Follow FAO-aligned practices for safe and accurate application.

A. Area Measurement

From	To	Multiply By	Use Case Example
Square meters (m^2)	Hectares (ha)	0.0001	500 m^2 × 0.0001 = 0.05 ha
Hectares (ha)	Square meters (m^2)	10,000	1 ha × 10,000 = 10,000 m^2
Acres	Square meters (m^2)	4,047	1 acre × 4,047 = 4,047 m^2
Acres	Hectares (ha)	0.4047	2 acres × 0.4047 = 0.81 ha
Hectares (ha)	Acres	2.471	1 ha × 2.471 = 2.47 acres
10 m × 10 m plot	Hectares	0.01	100 m^2 = 1/100 ha (used for calibration)
Number of 10 × 10 m plots	Hectare	Divide by 100	25 plots = 25 ÷ 100 = 0.25 ha

B. Liquid Volume and Mixing

From	To	Multiply By	Use Case Example
Liters (L)	Milliliters (mL)	1,000	1 L = 1,000 mL. Used for mixing small doses into tank.
Milliliters (mL)	Liters (L)	0.001	250 mL × 0.001 = 0.25 L
Gallons (US)	Liters (L)	3.785	1 gallon = 3.785 L (used for older spray tanks)
Liters (L)	Gallons (US)	0.2642	20 L tank × 0.2642 = 5.28 gallons
Tablespoons (tbsp)	Milliliters (mL)	15	2 tbsp = 30 mL (for measuring small pesticide amounts)
Teaspoons (tsp)	Milliliters (mL)	5	3 tsp = 15 mL (for insecticides or fungicides in small packs)
Knapsack tank (L)	Total volume needed	Divide into total mix required	For 60 L needed and 15 L sprayer: 60 ÷ 15 = 4 tanks

C. Spray Volume and Calibration

Description	Formula or Tip	Use Case
Spray Volume per Hectare (L/ha)	Water used on 100 m^2 × 100	If 2 L used on 100 m^2 → 2 × 100 = 200 L/ha
Total Spray Volume Needed for a Plot	Field area (ha) × Spray volume (L/ha)	0.5 ha × 200 L/ha = 100 L total spray mix
Number of Knapsack Tanks Needed	Total volume ÷ tank size (L)	100 L ÷ 15 L = 6.7 tanks (round up to 7)
Mix per Tank (based on label dose)	Label dose ÷ number of tanks	For 400 mL per ha over 100 L → 400 ÷ 100 = 4 mL per L, so 60 mL for 15 L tank
Spray Coverage per Tank (area treated)	Tank size ÷ L/ha	15 L ÷ 200 L/ha = 0.075 ha or 750 m^2 covered per tank
1 Hectare	100 plots of 10 × 10 m	Use for calibration with clean water

Quick Reference 6: Common Abnormal Spray Problems

Table 8: List of Common Abnormal Spray Problems

Problem	Possible Cause	How to Check	What to Do (Basic Solution)
No spray or blocked spray	○ Clogged nozzle ○ Clogged internal filter	○ Remove nozzle and filter, ○ Check for dirt or particles	○ Rinse both in clean water. ○ Use a soft brush or straw to clean.
Dripping from nozzle	○ Worn-out nozzle tip ○ Loose nozzle fitting	○ Look for uneven wear or cracks ○ Check nozzle connection	○ Replace nozzle. ○ Tighten nozzle or use thread tape.
Very weak spray pressure	○ Worn or cracked piston seal ○ Air leakage	○ Pump repeatedly and check if pressure builds ○ Look for hissing	○ Replace piston seal. ○ Apply oil to plunger seal if dry.
No pressure build-up	○ Worn-out diaphragm ○ Loose tank lid or leaking gasket	○ Check pump movement and listen for air Inspect diaphragm (if accessible)	○ Replace diaphragm or gasket. ○ Tighten lid or replace rubber ring.
Spray stops during use	○ Trigger valve seal worn or stuck ○ Clogged hose	○ Open trigger, observe flow ○ Check hose for blockage or kinks	○ Replace trigger valve seal or clean valve ○ Unclog or replace hose
Inconsistent or patchy spray	○ Partially blocked nozzle or filter ○ Walking too fast	○ Test spray on dry surface ○ Observe walking speed	○ Clean nozzle/filter. ○ Maintain steady pace and spray overlap.
Overspray or waste	○ Overlapping rows ○ Spraying too high above crop	○ Observe wet areas or spray going beyond row	○ Walk evenly, spray 18–20 inches above plants. Avoid double-spraying.
Spray drift (blowing away)	○ Windy weather ○ Droplets too fine	○ Watch mist direction. ○ Test for drift.	○ Spray early morning/evening. ○ Use correct nozzle (coarse droplet).
Crop damage (burned leaves)	○ Overdose ○ Wrong pesticide ○ Spraying during hot sun	○ Check label dose Look for leaf burn at edges or tips	○ Use correct dose. Spray early/late. ○ Don't spray in hot sun.
Liquid leaking from pump handle	○ Worn piston or plunger seal	○ Pump and observe under handle for leaks	○ Replace the seal or lubricate with oil.
Liquid leaking from trigger	○ Cracked trigger valve or seal	○ Pull trigger and observe for leaks	○ Replace trigger or internal O-ring/seal.
Sprayer leaks from tank lid	○ Worn-out or missing lid gasket/seal	○ Close lid, tilt tank, and observe for leakage	○ Replace lid gasket or apply tape until new one is available.
White residue or crystals in tank	○ Not cleaned after last use ○ Hard water deposits	○ Open tank and inspect inside walls	○ Triple rinse after every use. ○ Use clean water for mixing.

Quick Reference 7: PCB CONTACT INFORMATION

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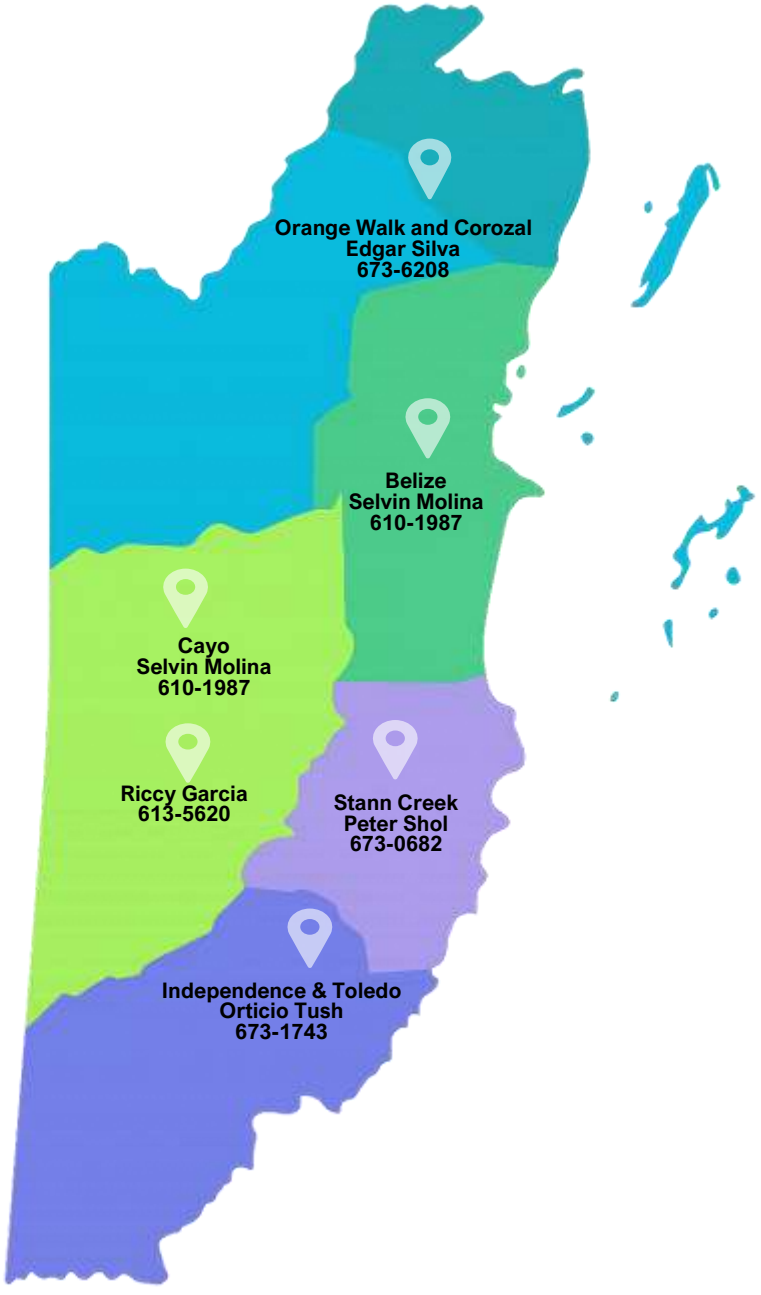

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