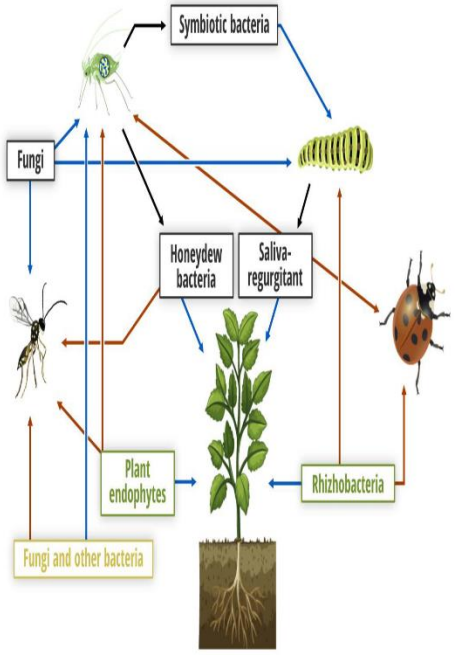
የሥራና ክህሎት ሚኒስቴር
Ministry of Labor and Skills

Crop production

Level-III



Based on April 2022, Version I Occupational standard

Module Title: - Applying Chemicals and Biological Agents for the Control of pests

LG Code: AGR CRP3 M09 LO (1-5) LG (38-42)

TTLM Code: AGR CRP3 TTLM 0523v1

May, 2023

Addis Ababa, Ethiopia

Table of Contents

Introduction to the Module

This module covers knowledge, skills and attitude to apply chemicals and biological agents for the control of weeds, pests and diseases using workplace specific application equipment. The work functions in this standard will be carried out under supervision.

LG #1	LO #1- Apply instructions and maintenance

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Carrying out pre and post operational checks
- Interpreting chemical labels
- Measuring and decanting of substances
- Following safe working practices
- Identifying and following procedures
- Preparing and adjusting application and Personnel Protective Equipment (PPE)
- Following instructions to identify and maintain damaged
- Identifying and reporting OHS hazards

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Carry out pre and post operational checks
- Interpret chemical labels
- Measure and decant of substances
- Follow safe working practices
- Identify and follow procedures
- Prepare and adjust application and Personnel Protective Equipment (PPE)
- Follow instructions to identify and maintain damaged
- Identify and report OHS hazards

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1

Definition of terminology

A pest: - is any animal, insect, weed or disease that attacks a crop.

Biological agent: - A substance that is made from a living organism or its products and is used in the prevention, diagnosis, or treatment of pest and diseases.

Chemical:-a distinct compound or substance, especially one which has been artificially prepared or purified Like fungicides, herbicide and insecticides

1.1. Carrying out pre and post operational checks

Applying chemicals on field crops is very crucial tasks that should be carried out safely. Now a day's crop failure caused by biotic factors (insects, diseases and weeds) which are a potential agent for field crops yield as well as quality redactors. Hence, we have to apply chemicals so as to curve their impact on field crops. A major concern while applying chemicals is preventing the environment from being polluted.

- Smooth delivery of material is important.
- Check the discharge material to check the air chamber and tubes for Blockages and leaks.
- Refer to your operator's manual for correct settings and adjustments on all machines so as to operate properly.

When handling chemicals, it is important to carry out pre and post operational checks to ensure that the process is safe and effective. Here are some steps you can take:

- **Pre-operational checks:**
  - ✓ Make sure you have all the necessary personal protective equipment (PPE) such as gloves, goggles, and a lab coat.
  - ✓ Ensure that all equipment used for handling the chemicals is in good working order and calibrated correctly.
  - ✓ Check the chemical storage area for any signs of leakage or spills.
  - ✓ Review the Material Safety Data Sheet (MSDS) for each chemical being used to understand their hazards, proper storage, handling, and disposal procedures**.**
- **Post-operational checks**
  - ✓ After completing the chemical application process, wash your hands thoroughly to remove any residual chemicals that may have come in contact with your skin.

- ✓ Inspect all equipment used for handling the chemicals to ensure it is properly cleaned and stored.
- ✓ Check the work area for any spills or contamination.
- ✓ Dispose of any leftover chemicals properly by following their MSDS.

Remember that proper handling, storage, and disposal of chemicals is critical to prevent accidents and protect both you and the environment.

Sprayers

Most field sprayers in use today are

- Hydraulic: -May be mounted or self-propelled models.
- Electrostatic and air-directed sprayers.
- ULV sprayer
- Boom and bloomless units to match wide range of applications.
- knapsack

The basic components are the

- Tank
- Pump
- Agitator
- Hoses
- Valves and fittings
- And nozzles.

Hoses should be oil resistant and durable. The hoses should be large enough for proper flow

Nozzles vary according to

- **Capacity**
- **Spray pattern angle**
- **And shape of spray pattern**

Drift control is an important consideration for any type of sprayer. Drift can be caused by

- Wind at or near the ground or by high nozzle pressures
- Evaporation of the liquid on hot days.
- Combination of the three is present.

Most backpack sprayers use hand pumps; however, some units have a small battery or engine-powered pumping system.

Hand-operated sprayers should have

- A comfortably located
- Reversible handle (to allow for left- or right-hand use).
- The shoulder straps should distribute the load evenly across the shoulders.
- Consider a hip belt to help carry the weight of the larger units.
- The wand should be comfortable and allow for easy use of the trigger.
- The sprayer should also have removable screens to protect the pump and nozzles.
- Should be cleaned regularly.
- The sprayer should have a stable base to hold it upright for filling and mixing.

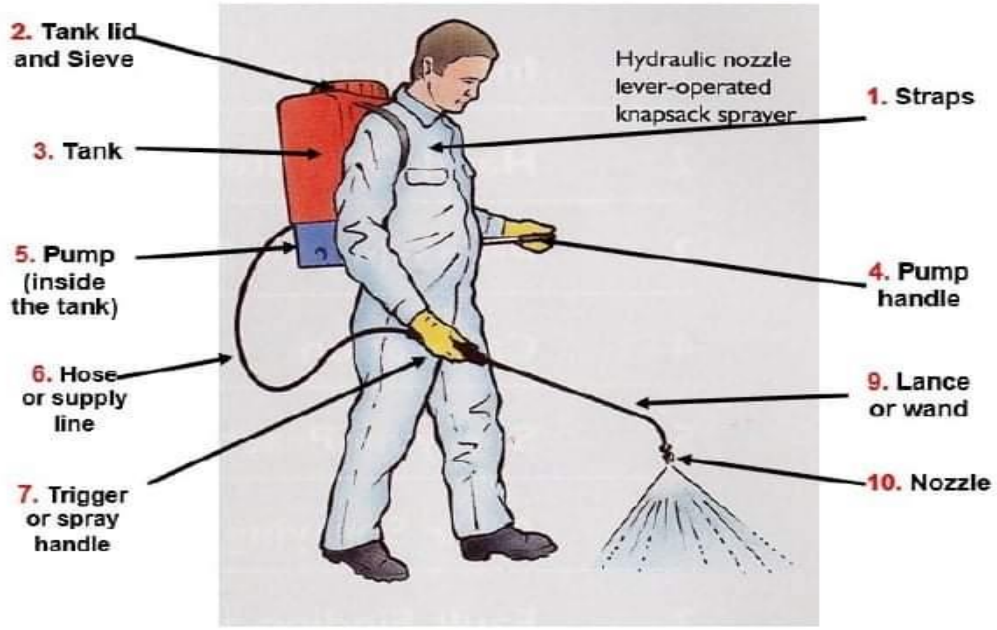


Figure 1.1. Part of knapsack sprayer

1.2. **Interpreting chemical labels**

The product Labels main function is to **explain how a product can be used** most effectively to remove a pest problem. The label also provides **enough information to make sure the product** is Used and disposed of in a safe and efficient manner. Labeling chemicals is important for several reasons. Firstly, it helps to identify the contents of a chemical container and any potential hazards associated with its use, transport or storage. This information can help ensure that the appropriate

safety measures are taken to prevent any accidents or mishandling. Additionally, labeling can also provide instructions for use, such as recommended amounts to use and proper disposal methods. This can help users apply the chemical correctly and safely. Safety Chemicals are dangerous and can cause serious injury or death when handled improperly. One should always read the label and study the Safety Data Sheet (SDS) prior to using, handling, or working with a chemical.

Labeling and relabeling

The purpose of a label is to convey a message about what the product is, who makes it and how it may be used safely and effectively.

- There should be a leaflet securely attached to, or tagged on to, the container.
- Users should always ensure that a leaflet is presented with small containers.
- Information might also include any literature provided separately in a package
- **Rules for Chemical Labels**
  - ✓ Read all labels carefully.
  - ✓ Double-check the label. Know what you are handling.
  - ✓ Do not use a chemical if it is unfamiliar to you or it has no label.
  - ✓ Ensure the chemical container has the proper label.
  - ✓ Chemical labels must be legible and prominently displayed.
  - ✓ Chemicals poured into a smaller container for daily use must be properly labeled.
  - ✓ Never obscure, deface, or remove any label.
- **What are the three most important things on a chemical label?**
  - ✓ Identity of the contents (spell out chemical names)
  - ✓ Signal word, if known or suspected (e.g., “danger”, “warning”)
  - ✓ Hazards, if known or suspected (e.g., “flammable”, “corrosive”, “irritant”)
- **How to read a Chemical Label.**
  - ✓ The Blue Section - Health Risks.
  - ✓ The Red Section - Fire Risks.
  - ✓ The Yellow Section - Reactivity Hazards.
  - ✓ The White Section - Special Hazards.

Before using any agrochemical, the user should read the label and discover the information. The following should be indicated:

- Hazard symbol
- Trade name of the product
- Name and quantity of active ingredient
- Purpose for which it is to be used
- Registration number when required by legislation
- Name and address of the manufacturer, distributor or agent
- Directions for use
- Safety precautions
- Warnings and statements of good practice
- First-aid instructions and advice to health personnel
- Name and quantity of any solvent or similar material classified as hazardous
- Amount by weight or volume in the container
- Identification number of the batch or consignment
- Interval between agrochemical application and harvesting
- Any matter required by national legislation such as a reference to the requirements of specific regulations

Relabeling must ensure that the contents are identified in a manner which will make known to the users:

- The hazards associated with their use
- The methods of using them safely and
- Emergency procedures

Figure: 1.1. Video how to read chemical label

https://www.youtube.com/watch?v=Ciz5xFAO4rM

Precautions

Pesticides are typically labeled with precautionary statements to indicate the level of hazard and potential risk they pose to people, animals, and the environment. These statements are required by regulation in many countries and are usually displayed prominently on the pesticide label. There are three main precautionary words or phrases that can be used on pesticide labels:

- **CAUTION**: Pesticides labeled with "CAUTION" are considered to have low toxicity, and are unlikely to cause serious harm if used as directed. However, it's still important to follow the instructions carefully to prevent accidental exposure or misuse.
- **WARNING:** Pesticides labeled with "WARNING" have a moderate level of toxicity and may pose a greater risk than those labeled with "CAUTION". Extra care should be taken when handling these pesticides to avoid accidental exposure.

- **DANGER:** Pesticides labeled with "DANGER" are highly toxic and pose a significant risk to human health, animals, and the environment. These pesticides should only be used by trained professionals who have the appropriate protective gear and equipment.

It's important to always read and understand the precautionary statements on pesticide labels before using them, and to follow all safety precautions carefully.

1.3. Measuring and decanting of substances

It's best to keep your hazardous substances in the containers they are bought in. However, many businesses purchase hazardous substances in drums or large containers and then decant smaller amounts of the substance into other containers for use. While this may seem like a simple task, it needs to be done safely to avoid accidents.

Never store hazardous substances in food or drink containers – it's just too easy for someone else to get confused about what's in the container – even if it is labeled. Too often people are seriously harmed after accidently drinking hazardous substances stored in drink containers.

When you are planning to decant a substance from one container to another, keep the following things in mind:

- Read the safety data sheet and note the hazards of the substance, particularly whether it is flammable, toxic or gives off fumes.
- Wear the recommended personal protective equipment, for example eye protection, breathing protection, gloves and overalls. Eye wash stations and/or safety showers may be needed in areas where transfers are performed in case substances spill on workers.
- Work in a well-ventilated area. This will help to prevent you from breathing in high concentrations of possibly poisonous vapours and gases and will also prevent flammable vapours building up, which could ignite causing a fire or explosion.
- Use only containers the hazardous substance can be stored in safely. Some substances can react dangerously with containers made out of different materials. For example, hydrochloric acid can react with some metals to form explosive hydrogen gas and hydrofluoric acid reacts with glass, so needs to be stored in a durable plastic container. This information is available from the safety data sheet or your hazardous substances supplier.

- Make sure the new container is clean and doesn't contain any residues of other substances that may cause a violent reaction.
- The new container must also be clearly labeled with the same information and warnings as the original container. All containers holding hazardous substances must be labeled.
- Note that flammable liquids, such as petrol and solvents, release flammable vapors so you need to avoid sources of ignition when transferring flammable substances.
- Flammable liquids may also generate static electricity that may discharge and ignite the substance so make sure metal or conductive plastic containers are earthed or bonded correctly.
- Be prepared for any spill that might occur during the transfer process. Have your spill kit ready to clean up any spill.

1.4. Following safe working practices

If you must use pesticides as part of your business or employment you must have received adequate instruction and guidance in the safe, efficient and human use of pesticides and be competent for the duties you are required to perform. Following safe working practices while applying chemicals is very important to prevent harm to yourself and the environment. Here are some guidelines to keep in mind:

Always wear personal protective equipment (PPE) such as respiratory masks, gloves, and goggles.

- Ensure that the area is well-ventilated before applying chemicals.
- Read the manufacturer's instructions and warning labels carefully before using any chemicals. 4. Store chemicals safely; keep them away from food, water sources, and heat sources.
- Avoid applying chemicals in windy conditions or near water sources where they can contaminate the environment.
- If you accidentally spill any chemicals, clean up the spill immediately and dispose of any contaminated materials safely.
- Wash your hands thoroughly after handling any chemicals. Remember, safety should always be your top priority when working with chemicals.

1.5. Identifying and following procedures

Agrochemicals such as fertilizers, dusts and granules may be supplied ready for use. Dispensing agrochemicals in this way requires particular care to ensure that it is carried out safely and efficiently. This will include:

- Reading the label
- Setting out the agrochemical
- Wearing appropriate protective clothing, particularly gloves
- Adding the dispensed agrochemical to the applicator
- Carefully emptying packs of agrochemical dusts and powders into applicators

Figure: 1.5. Mixing of chemical

1.6. Preparing and adjusting application and Personnel Protective Equipment (PPE)

Some **agrochemicals** such as **pesticides are extremely hazardou**s to

- The health of workers
- The general public
- To the environment.

Therefore, there should be strict regulations with regard to the production, sale and use of agrochemicals.

Wear protective clothing and equipment to **minimize exposure** to **pesticid**es during; -

- Mixing
- Loading
- Application and
- Clean-up.

The most vital information when we use chemicals: -

- Read the Pesticide Label
- Use Personal Protective Equipment
- Protective Clothing and Equipment
- Protect your Lungs -Respirators
- Protective Equipment for Fumigants, Smoke Bombs and Foggers
- Wash Up & Clean Protective Equipment
- Laundering Protective Clothing
- Additional Resources

Protective Clothing and Equipment

Table 1.6. Personal protective equipment's

NO	Name of equipment's	Picture	Its use
1	Boot		To protect feet from chemical spills and sharp objects.

2	Eye glass		Use safety glasses for minor splash hazards, goggles for moderate hazards, and goggles combined with a face shield for severe hazards.
3	Glove		Hand protection is indicated for the possibility of severe cuts, lacerations, or abrasions, punctures, temperature extremes, and chemical hazards.
4	Overall		Protect head from injuries and disease pathogens and any other when there is a danger of objects falling from above.
5	Helmet		Protect head from injuries and disease pathogens and any other when there is a danger of objects falling from above.

1.7. Following instructions to identify and maintain damaged

They are some general instructions for identifying and maintaining damaged areas when applying chemicals:

- Before applying any chemicals, inspect the area to identify any pre-existing damage that may be present. Make a note of these areas and address them before applying any chemicals.
- When applying chemicals, use appropriate personal protective equipment (PPE) as recommended by the manufacturer. This may include gloves, goggles, respirators, or other protective gear.
- Avoid over-saturating the area with chemicals, as this can further damage any existing damage and lead to potential safety hazards.
- After applying the chemicals, allow ample time for the area to fully dry before attempting to clean or repair it.
- Regularly maintain the affected area by checking for any new damage or wear and tear, and addressing these issues promptly to prevent further damage.

To identify and maintain damaged equipment when applying chemicals, follow these instructions:

- **Inspection:** Regularly inspect all equipment that comes in contact with chemicals for signs of damage. Check for cracks, dents, or any other abnormalities that may indicate a problem.
- **Cleaning:** Clean all equipment thoroughly after each use to prevent any damage from chemical residues.
- **Maintenance:** Regularly maintain and service equipment according to manufacturer's recommendations. This will help to prevent damage caused by wear and tear.
- **Storage:** Store all equipment in a dry, cool, and well-ventilated area away from direct sunlight and sources of heat.
- **Repair or replacement**: If any damage is found during inspection, the equipment must be repaired immediately or taken out of service until repairs can be made. If the equipment cannot be repaired, it should be replaced as soon as possible to ensure safety during chemical applications.

- **Documentation:** Document all inspections and repairs in a maintenance log or similar document. Keep records of when inspections were performed, what was discovered during inspections, and what actions were taken to resolve any issues.

1.8.Identifying and reporting OHS hazards

Identifying and reporting occupational health and safety (OHS) hazards is an important part of ensuring a safe work environment. Here are the steps you can follow:

- **Identify the hazard**: Be on the lookout for situations or activities that have the potential to cause harm. Hazards could be anything from slippery floors to unsafe equipment or procedures.
- **Assess the risk**: Evaluate the level of risk associated with the hazard. Consider how likely it is that an incident will occur, how severe the consequences might be and how many people could potentially be affected.
- **Control the hazard**: Take steps to mitigate or eliminate the hazard. This could include changing work procedures, providing personal protective equipment or modifying equipment.
- **Report the hazard**: Report the hazard to your supervisor or employer as soon as possible. Use any reporting systems that are in place, such as an incident report form or an OHS hotline.
- **Follow up**: Ensure that any corrective action has been taken and monitor the situation to ensure that the hazard has been appropriately controlled. By following these steps, you can help to create a safer work environment for yourself and others. Remember, everyone has a responsibility to identify and report OHS hazards, so speak up when you see something that could potentially cause harm.

OHS are to be in accordance with Federal and Regional Legislation and regulations, and organizational safety Policies and procedures.

Requirements may include:

- The use of personal protective equipment and clothing
- Safety equipment
- First aid equipment

- Firefighting equipment
- Hazard and risk control
- Elimination of hazardous materials and substances
- Safe forest practices including required actions relating to forest fire
- Manual handling including shifting, lifting and carrying

Hazards arise from:

- The work environment
- The use of machinery and substances
- Poor work design
- Inappropriate systems and procedures

How dangerous substances can enter the body

The main **routes** of absorption are

- Through the **respiratory** tract (inhalation),
- Through the **skin** (dermal absorption) and
- Through the **digestive**. Tract (ingestion)

Chemical **toxicity** can be determined by: -

- Irritant
- Corrosively
- Flammability
- Explosively

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer

1. Which of the following is the most important things on a chemical label

A. Identity of the contents
B. Signal word
C. Hazards
D. All

2. Agrochemicals such as pesticides are extremely hazardous to **except**

A. The health of workers
B. The general public
C. To the environment
D. None

3. Chemical toxicity can be determined by

A. Irritant
B. Corrosively
C. Flammability
D. All

Test II: Short Answer Questions

1. List some chemical sprayers?
2. What are the mechanisms of chemical entry?
3. List some rules for Chemical Labels?

Operation Sheet -1

1.1 Techniques of maintain damaged equipment when applying chemicals

A. Tools and equipments

- PPE
- Water
- Soap
- Greese

B. Procedures/Steps/Techniques

1. Inspect all equipment that comes in contact with chemicals for signs of damage.
2. Clean all equipment thoroughly after each use
3. Maintain and service equipment according to manufacturer's recommendations.
4. Store all equipment in a dry, cool, and well-ventilated area
5. Repair or replacement the equipment
6. Document all inspections and repairs in a maintenance log

LAP TEST-1	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hours. The project is expected from each student to do it.

Task-1 Identify and maintain damaged equipment

LG #2	LO#2- Use chemical application equipment

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identification and minimization of hazards
- Selecting, using and maintaining workplace industry standard and appropriate step
- Observing safe working practices regulations and legislation
- Using application equipment accurately and effectively
- Recording details organization policy, legislative requirements and industry practice.
- Assessing weather conditions for chemical application
- Respond to emergencies and apply first aid in the event of pesticide poisoning

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and minimize of hazards
- Select, use and maintain workplace industry standard and appropriate step
- Observe safe working practices regulations and legislation
- Use application equipment accurately and effectively
- Record details organization policy, legislative requirements and industry practice.
- Assess weather conditions for chemical application
- Respond to emergencies and apply first aid in the event of pesticide poisoning

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1. Identification and minimization of hazards

The identification and minimization of hazards is an important aspect of workplace safety. Here are the steps you can follow:

- **Identify the hazards**: Conduct a comprehensive workplace inspection to identify any hazards in the workplace. This could be done in many ways, such as through periodic inspections, risk assessments, or incident reports.
- **Assess the risks:** Assess the risks associated with each identified hazard to determine the likelihood and potential severity of harm.
- **Control measures**: Identify appropriate control measures that can be implemented to eliminate or reduce the risk of harm associated with the identified hazards. It is essential to prioritize the most critical hazards according to their severity and likelihood of occurrence.
- **Implement control measures**: Implement control measures to minimize workplace hazards by, among other things, redesigning machinery and equipment, adjusting work practices, providing employee protective equipment (such as safety goggles, hard hats, etc.), or installing safety features e.g., guardrails.
- **Monitor and review**: Monitor and review implemented controls regularly to ensure that they effectively minimize the identified hazards. Moreover, continuous monitoring ensures that the controls remain effective amidst environmental or operational changes.

By following these steps, it is possible to ensure a safer workplace environment for employees and reduce the likelihood of workplace accidents or injuries. It's always better to be proactive about identifying potential risks that could lead to harm rather than waiting for an incident to occur.

During application not all pesticide droplets or particles are deposited on the crop. A large number of these fall on the ground. If the product does not break down rapidly, this may result in pollution of soil, open water wells or surface water. If spraying conditions are not optimal, some of the spray is transported by drift. Not only are the target organisms on the plant "hit", but other beneficial animals such as bees are sprayed and killed. Water organisms, birds and wildlife can be affected

as well. Try to avoid side effects as much as possible! In this section the most important side effects are discussed in more detail.

After use in the field, pesticides can end up in surface water such as ditches, pools and wells. This can happen when irrigated crops are sprayed frequently, or when it rains a lot and a crop is flooded. The pesticide is partly washed off by the rain water and runs into pools or streams. This does not immediately endanger humans; the pesticide is, after all, well diluted. However, if the water flows slowly or is stagnant in pools or wells, it can become polluted. People can then ingest the pesticide through drinking water or bathing.

Try to avoid mixing or applying agrochemicals near open water or wells; always work carefully. Spillage cannot be cleaned up and may pollute ditches or rivers. Do not wash sprayers in open water, or dump empty packages.

2.1.1. Damage to useful insects

Many insects do not cause damage, but on the contrary are most useful. Bees produce honey and are also important for the pollination of various crops, contributing to a good yield. Toxicity to bees should be indicated on the label. If a particular pesticide is known to be toxic to bees, these pesticides should not be sprayed when the bees are active in the crop at the time of day, or season, when it is flowering. Other useful insects are the so-called natural enemies of harmful insects. These are insects which feed on other insects or make them harmless in some other way. If these natural enemies are killed, a pest infestation can break out more easily. It may also happen that an insect which at first caused no trouble in the crop becomes a pest after spraying because its natural enemy was removed, even though this was not the intention. This is one more reason for not spraying more frequently than necessary

2.2.Selecting, using and maintaining workplace industry standard and appropriate step

Certainly. Selecting, using, and maintaining workplace industry standard and appropriate steps is essential to ensure safety in any workplace, especially when dealing with hazardous chemicals. Here are some steps to follow:

- **Select the appropriate PPE**: Ensure that you have the correct PPE for the specific chemical(s) being used. For example, wearing gloves made of the wrong material could lead to chemical burns or ineffective protection.

- **Properly use PPE**: Make sure that you know how to properly use PPE, including how to put it on and take it off safely.
- **Select, use, and maintain equipment**: Always use equipment that is designed for the specific chemical(s) being used. Inspect equipment regularly for any damage or defects, and address repairs or maintenance needs promptly.
- **Follow safe handling procedures**: Know how to handle and store chemicals safely, as well as how to cleanup spills or leaks.
- **Train employees**: Provide training to all employees involved in chemical handling to ensure they are aware of potential hazards and the correct measures to prevent them.
- **Have safety protocols in place**: Establish emergency protocols in case of accidental exposure or spills, including the use of first aid measures and notification procedures.

Overall, it's important to stay up-to-date with industry safety standards, regulations, and best practices to ensure that your workplace is safe and compliant with current guidelines.

2.3.Observing safe working practices regulations and legislation

This explains the following aspects of safe handling of pesticides from purchase to storage or disposal after use:

- The product labels
- Protective clothing
- Marketing, transport and storage
- Precautionary measures on the farm
- Dealing with pesticide spills

2.3.1 Product label

The label is the most important source of information on the pesticide, so read it fully and carefully before use, and ask for explanation, if needed. Here we give the types of information that a label on a crop protection product should give.

- **Trade name (brand name, commercial name): -** This is the most prominent name on the label. Pesticides with different commercial, brand or trade names can contain the same active ingredient, depending on the producer/manufacturer

- **Common or chemical name:** -The use of the agreed common name of the active ingredient is preferred over the full chemical name.
- **Product composition or ingredient statement:** - Every label must list the active ingredients present in the product, preferably on the front panel directly below the brand name. The concentration of each active ingredient may be given in several forms: as a percentage, as grams per litre, or as pounds per gallon. The active ingredient should be listed by its common name, if one has been agreed upon. Otherwise, it can be identified by its complex chemical name. Inert ingredients need not be named, but the label must state their weight or volume percentage.
- **Type of formulation:** -The label must indicate what type of formulation the package contains as a same pesticide may be sold in various forms, such as powder (WP) or liquid concentrate (EC or SC), which require different methods of handling.
- **Name and address:** - The manufacturer, formulator or distributor must put the name and address of the company on the label to enable inspection and complaints.
- **Registration/authorization or license number:** - This number must appear on the front panel of the pesticide label. It shows that the product has been registered with the Government.
- **Net content:** -The net content shows how much product is in the container expressed either in liquid measures (litres, pints, gallons) or dry weights (grams, pounds) or in local units.
- **Warning with signal words, symbols and colour codes per toxicity class:** - every label should carry a warning that the product is hazardous and the words "KEEP OUT OF REACH OF CHILDREN".
- **Statement of practical treatment:** - The label indicates what practical first aid measures are prescribed in case of poisoning from ingestion (intake by mouth), inhalation (breathing), and skin or eye contact. It must also indicate when medical treatment is needed and what antidote is recommended.
- **Pictograms:** - for precautionary safety measures. These are precautionary statements indicating in which way the product may be poisonous to man and animal. Words, symbols or pictograms are used to indicate what special measures are needed, such as the wearing of protective clothing equipment and decontamination.

- **Environmental hazards.** The label should contain environmental precautions, such as: 'This product is highly toxic to bees exposed to direct treatment or pesticide residues on crops' or 'Toxic to fish, do not contaminate bodies of water while spraying, cleaning sprayer or when disposing of leftover or waste materials.
- **Physical or chemical hazards.** This section uses words or pictograms to warn for special fire, explosion or chemical hazard posed by a highly inflammable, corrosive or gaseous product.
- **Misuse statement** This is a reminder not to use a product on a crop or pest that is not listed on the label. Do not use it at a rate higher than the recommended dosage rate.
- **Re-entry statement** the re-entry statement indicates how much time must pass before a pesticide-treated plot is safe for entry by a person not wearing protective clothing.
- **Storage and disposal directions** These guidelines tell how to store and dispose of the product as well as the empty containers.
- **Use areas** This section lists the crops, animals or other targets of application on which the product can be used.
- **Directions for use** These important instructions indicate: pests for which the product is registered to control, crops or animals on which the product can be used, form in which the product should be applied, how much to use; dosage or concentration, and
- **Harvesting statement** as toxic residues on the crop take time to break down, some product labels give a specific number of days before the crop can be cut, harvested or consumed by man or animal.
- **Warranty statement** Each product label specifies to what degree the manufacturer or distributor limit their warranty and liability.

2.4. Using application equipment accurately and effectively

Using application equipment accurately and effectively is crucial for ensuring that pesticides and other chemicals are applied correctly and safely. Here are some tips to help you achieve this:

- **Choose the right equipment for the job.** There are many different types of application equipment available to suit different needs, such as backpack sprayers, handheld sprayers, and mist blowers. Make sure you select the appropriate equipment that is designed for the specific task that you need to perform.

- **Read the instructions carefully before use**. Each type of application equipment will have its own set of instructions and guidelines that you need to follow to operate it safely and effectively.
- **Calibrate your equipment before use**. Calibration is the process of setting your equipment correctly so that it applies the appropriate amount of chemical per unit area. This is important for ensuring effective pest control while minimizing waste and avoiding over-application.
- **Ensure that your equipment is well-maintained**. Regular maintenance, such as cleaning and replacing worn parts, will help to ensure that your equipment operates effectively and safely.
- **Follow all safety guidelines when using application equipment**, such as wearing protective clothing, using appropriate ventilation, and avoiding direct contact with the chemicals.

Effective application meets the following conditions:

- The right choice of crop protection product
- Applied in the right dosage at the right time
- Using an appropriate technique.

Correct dosage is not only dependent on pest level, but also on potential crop damage or expected harvest loss, and also on economic costs and benefits of crop protection. Potential damage to the crop may justify the application of the pesticide, but this must always do in accordance with the instructions on the label. Application is economically efficient if the avoided damage and crop loss justifies application. A farmer should therefore estimate and compare the cost of applying pesticides with the rate of loss in yield or quality that (s)he finds acceptable

2.5. Recording details organization policy, legislative requirements and industry practice.

The records of implementation in chemical storage and use must be comply with legalization and regulation written on instruction label. Records can help you remember what happened in previous crops (what worked well/badly).

Policy - All employees must ensure that they record the following details when using chemical application equipment:

- Date and time of use
- Type of equipment used

- Type of chemical applied
- Location where equipment was used
- Amount of chemical applied
- Weather conditions during use
- All records must be kept for a minimum of three years.
- All records must be accurate and legible.
- Employees must report any accidents or incidents related to the use of chemical application equipment to their supervisor immediately.

Legislative Requirements: - Employees must comply with all relevant legislation and regulations related to the use of chemical application equipment.

Industry Practice: - Employees must comply with established industry practices related to the use of chemical application equipment.

2.6.Assessing weather conditions for chemical application

If possible, spray at the time of the day when the harmful organism is most active. The measure is then most likely to be effective. If you do not know about the insect's behavior, consult an agricultural extension officer. Keep an eye on the wind. Never spray against the wind; you will then be constantly walking in the spray mist and thus poison yourself. If at all possible, spray either in the morning or the evening, as it is usually less windy and the spray solution is less likely to evaporate.

If there is a strong wind, do not spray because the wind will cause the spray to drift onto yourself, another crop, or animals, people, soil and surface water in the vicinity. Do not spray during rain, or if rain is expected. A shower of rain immediately after applying a pesticide promptly washes it off the plants. This reduces the effect of the pesticide to a minimum and pollutes the environment. If this nevertheless happens, it may be necessary to repeat the treatment.

A little rain or drizzle does not pose a problem in the case of herbicides or nematicides which need to be applied to the ground. In fact, it helps to wash the pesticide into the soil. Do not spray if there is no wind at all, or a very hard wind. When spraying a canopy crop, a very gentle wind will disperse the spray mist over the crop. If possible, spray either in the morning or in the late afternoon, as it is generally less windy then, and the spray solution evaporates less.

The weather should be: -

- Not sunny day
- Not rainy
- Cloudy
- Early morning
- Late after noon

Here are some guidelines for assessing weather conditions before applying chemicals:

A. **Temperature:** Check the temperature range specified on the chemical's label to ensure conditions are appropriate for application. Certain chemicals may work best within a specific temperature range. Use of chemicals outside of their designated temperature range can result in poor efficacy, safety hazards, and reduced product longevity.

B. **Windy Conditions**: Be mindful of direction and speed of wind during chemical application, as high winds can cause drift that can result in damage to crops and soil, undermine the efficacy of the chemicals, and pose serious risks to human health. If it is too windy, it may be unwise to apply chemicals at all; if not, consider using wind barriers or other forms of protection.

C. **Rain and Humidity**: Some chemicals may require specific conditions for optimum effectiveness. Rain and high humidity can interfere with the optimal application of certain chemicals, rendering them ineffective. Always consult the chemical label included with the product and avoid spraying when heavy rain is forecasted or during periods of high humidity.

D. **Precipitation:** Avoid chemical application in areas prone to flooding or heavy precipitation as it can unintentionally cause harm to the environment or lead to reduced efficacy of the chemical product.

E. **Sunny Conditions**: Beware of applying chemicals in direct sunlight as it is known to reduce the efficacy of some chemicals.

By following these guidelines when assessing weather conditions, you can better plan your chemical applications for optimal results while ensuring safety for both human beings and the environment.

2.7.Respond to emergencies and apply first aid in the event of pesticide poisoning

In the event of pesticide poisoning, it is important to respond quickly and appropriately to minimize the damage done. Here are the steps to take:

- Remove the person from the source of the poison and move them to a well-ventilated area.
- Call for emergency medical assistance immediately. Let the operator know that you suspect pesticide poisoning so that they can direct the paramedics to bring the appropriate equipment.
- Check the person's breathing and pulse. If they are not breathing or do not have a pulse, begin CPR immediately.
- Try to identify the pesticide that caused the poisoning. This will help medical professionals to provide appropriate treatment.
- If the poison is on the person's skin, remove any contaminated clothing and wash the affected area with soap and water.
- If the person has ingested the poison, do not induce vomiting unless instructed to do so by medical professionals.
- Stay with the person until medical help arrives, monitoring their breathing and pulse and keeping them calm and comfortable. Remember, prevention is always better than cure when it comes to pesticide poisoning. Follow all safety guidelines when handling pesticides, including wearing protective clothing and using appropriate equipment.

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Multiple choice

1. Which one of the following is **mismatched**
   A. Apply chemical------early morning
   B. Apply chemical------late afternoon
   C. Apply chemical------at sunny day
   D. Apply chemical------not rainy
2. Types of information that a label on a crop protection product
   A. Use area
   B. Direction of use
   C. Warranty
   D. All

Test II: Short Answer Questions

1. List some guidelines for assessing weather condition before applying chemical?
2. List steps of identification and minimization of hazards to make work place safety?
3. List some tips helps to achieve using application equipment accurately and effectively
4. Explain how respond to emergencies and apply first aid in the event of pesticide poisoning

Operation Sheet -2

2.1. Techniques of wear personal protective equipments and personal hygiene

A. Tools and equipment's

- Boots
- Overalls
- Gloves
- Respirator
- Facemask
- Sunscreen
- Hat
- goggles

B. Procedures/Steps/Techniques

1. Identify chemical which needs protective equipment and which does not need
2. Identify different types of protective equipment
3. Carry out how to wear protective equipments and clothing, never wear leather products which absorbs chemicals
4. Mix one of the chemical and apply
5. In case of a pesticides spill or splash at work site, wash your body immediately after contact.
6. Clean protective equipments and clothing after application
7. Wash your hands or take shower at the end of the application.

LAP TEST-2	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hours. The project is expected from each student to do it.

Task-1 Perform Select personal protective equipments and personal hygiene

LG #3 LO #3- Apply chemicals & bio-agents

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Interpretation of chemical labels
- Recognizing and identifying hazards
- Following requirements for application equipment and calibration.
- Assessing suitable weather conditions.
- Following safe working practices
- Classification of pesticides
- Paths of entry of poisons into the body and methods of limiting exposure
- Following equipment, cleanup methods and instructions

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Interpret of chemical labels
- Recognize and identifying hazards
- Follow requirements for application equipment and calibration.
- Assess suitable weather conditions.
- Follow safe working practices
- Classify of pesticides
- Paths of entry of poisons into the body and methods of limiting exposure
- Follow equipment, cleanup methods and instructions

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

3.1 **Interpretation of chemical labels**

Interpreting chemical labels is essential to understand the hazards associated with the chemicals being used. Here's what to look for when interpreting chemical labels:

- **Hazard statements:** These provide information on the immediate or long-term hazards associated with the use of the chemical.
- **Precautionary statements**: These provide guidance on how to prevent exposure to the compound and minimize risks associated with its use.
- **Signal words**: Indicate the severity of the hazards - either "danger" or "warning."
- **Pictograms**: Provide a visual representation of the hazard type, such as corrosive or toxic.
- **First aid instructions**: Provide guidance on what to do if exposure or ingestion occurs.
- **Chemical ingredients:** Identify what chemicals are present in the product.

It's also essential to note any specific warnings related to transportation, storage, handling, disposal, or any legal requirements associated with the use of the product. It's crucial to carefully read and understand all label information before using chemicals and following any associated instructions and safety precautions.

3.2 **Recognizing and identifying hazards**

Recognizing and identifying hazards is an important part of ensuring safety in various different areas, from workplaces and public spaces to natural environments and beyond. The first step in identifying different types of hazards is to understand what "hazard" means in this context. A hazard is generally defined as anything that has the potential to cause harm or injury to people or damage to property or the environment. There are many different types of hazards to be aware of, but some of the most common include the following:

A. **Physical hazards**: These are tangible objects or conditions that can harm people, such as sharp edges, electrical power sources, and unsafe equipment.

The physical hazards can be:

Noise: absorbed through the ear:

Noise from farm tools and machinery can cause permanent hearing loss. Hearing loss may be temporary at first, but repeated exposure will lead to permanent damage

Vibration: In fact, **high frequency, low amplitude vibration** is absorbed and damped by the layers of muscle that envelop the skeleton.

Heat: The ill effects of work in a hot climate are associated with the deficiency or exhaustion of the thermoregulatory mechanisms. In a hot climate, beside the heat resulting from metabolic processes, the organism has to get rid of heat from the environment also.

B. **Chemical hazards**: These involve exposure to toxic substances, such as chemicals, gases, and heavy metals.

Chemical hazards include the followings; -

Dusts: Are substances consisting of **solid particles** that has been reduced to small size by some mechanical process. E.g., silica, coal, asbestos, lead cotton, wood, cement.

Mist: Suspension in air of very small drops usually formed by mechanical means E.g., acid mists

Gases: Substance that will diffuse to evenly occupy the space in which it is enclosed. A gas does not appear in the solid state or liquid state at standard temperature and pressure.

Fumes: Substances composed of solid particles formed by condensation from a gaseous state, these particles are microscopically small (odorous) E.g., smoke

Vapors: Gaseous form of a substance that is normally a liquid, or solid. E.g., alcohols

C. **Biological hazards**: These are organisms or substances that can cause infectious diseases, such as bacteria or viruses.
D. **Ergonomic hazards**: These involve physical factors in the workplace environment that can lead to discomfort or injury, such as repetitive motions, awkward positions, and heavy lifting.
E. **Psychosocial hazards**: These involve stressors in the workplace, such as bullying, harassment, and violence.

When it comes to recognizing and identifying hazards, it's important to be vigilant and observant. Employers and employees alike should be aware of potential hazards and take steps to prevent

them from causing harm. This may involve conducting regular safety inspections, providing appropriate protective gear, ensuring employees are properly trained, and taking steps to mitigate risks where possible.

Precautions

Pesticides are typically labeled with precautionary statements to indicate the level of hazard and potential risk they pose to people, animals, and the environment. These statements are required by regulation in many countries and are usually displayed prominently on the pesticide label. There are three main precautionary words or phrases that can be used on pesticide labels:

- **CAUTION**: Pesticides labeled with "CAUTION" are considered to have low toxicity, and are unlikely to cause serious harm if used as directed. However, it's still important to follow the instructions carefully to prevent accidental exposure or misuse.
- **WARNING**: Pesticides labeled with "WARNING" have a moderate level of toxicity and may pose a greater risk than those labeled with "CAUTION". Extra care should be taken when handling these pesticides to avoid accidental exposure.
- **DANGER**: Pesticides labeled with "DANGER" are highly toxic and pose a significant risk to human health, animals, and the environment. These pesticides should only be used by trained professionals who have the appropriate protective gear and equipment.

Signal Word	Degree of Hazard
DANGER	Highest degree of hazard (Red Text)
WARNING	Intermediate degree of hazard (Orange Text)
CAUTION	Lowest degree of hazard (Yellow Text)

It's important to always read and understand the precautionary statements on pesticide labels before using them, and to follow all safety precautions carefully.

3.3. Following requirements for application equipment and calibration.

Calibration refers to the process of adjusting or verifying the accuracy and precision of a measuring instrument or test equipment. This is done by comparing the performance of the device being calibrated with that of a reference standard with known accuracy, typically traceable back to a national or international standard.

Following the requirements for application equipment and calibration is crucial to ensure that chemicals are applied accurately and effectively. Here are some guidelines to keep in mind:

- Choose the appropriate application equipment for the specific chemical being applied. Different chemicals may require different types of equipment for proper application.
- Calibrate the equipment before each use. Calibration ensures that the equipment is accurate and that the correct amount of chemical is being applied per unit area.
- Follow the manufacturer's guidelines for calibration procedures and frequency. Calibration procedures will vary depending on the type of equipment used, and it's essential to follow the manufacturer's instructions.
- Keep records of equipment calibration dates, calibration procedures, and any adjustments made to ensure accuracy. These records help demonstrate compliance with guidelines and can also help troubleshoot any issues that arise.

Following these requirements will help ensure that chemicals are applied accurately and at the correct rates, reducing the risk of over-application or under-application and providing effective results while minimizing environmental impact.

Why calibrate?

- Enables the accurate calculation of how much product to add per tank and that product‘s optimal safe use. Under-dosing can lead to product failure, over dosing can lead to un-acceptable crop residues and other risks.
- Both under-dosing and over-dosing lead to wasted product and wasted money.
- To determine the required amount of water and chemicals
- To know materials weather, they are functional or not functional.

I. Calibration of chemicals

Careful and accurate control of ground speed is important for any type of chemical application procedure. From large self-propelled sprayers and spreaders to small walk-behind or backpack units, precise ground speed is a key for success. Ground speed can be determined by one of two methods.

The first method requires a test course and stopwatch. For this procedure, measure a suitable test course in the field and record the time it takes to cover the course with the equipment. The course should be between 100 and 300 feet long. Drive or walk the course at least twice, once in each direction, and average the times for greater accuracy.

The second method is to use a true ground speed indicator such as a tractor-mounted radar or similar system. Do not rely on transmission speed charts and engine tachometers. They are not accurate enough for calibration.

Factors affecting application volume -

- Forward speed
- Nozzle size, type and condition
- Sprayer pressure
- Operator accuracy

Calibration process

- Fill the knapsacks spray tank to maximum rated capacity with clean water.
- Set the correct operating pressure.
- Spray holding the nozzle at the required height and measure the swath width.

Procedures of calibration;

- Measure the small area Final out its area is sqm (L*W) = a sqm
- Pour measured quantity of water in tank of sprayer (water) = V1 liter
- Spray the area uniformly with pump and nozzle tube used for spray
- Measure the leftover water in tank (water) = V2 liter

The formula for sprayers' calibration is;

$$\mathbf{Q} = \frac{(\mathbf{V1} - \mathbf{V2}) \times \mathbf{A}}{\mathbf{a}}$$

Where;

Q = Quantity of water required (L/ha)

V1 = volume of water (L) in the sprayer before spray

V2 = Volume of water (L) in the sprayer after spray

A = one hectare (10000m^2)

a = measured area of spray (m^2)

Area covered per unit hour can be calculated using formula given below.

$$\text{Area (ha)} = \frac{\text{Walking speed } \left(\frac{\text{m}}{\text{hr}}\right) \times \text{Spray width (w)}}{10000\text{m2}}$$

Example: A person walks with speed of 1km/hr covers swath of 0.5mwide. How much area he will be cover in one hour?

Solution:

$$\text{Area (ha)} = \frac{1000\ (\text{m/hr}) \times\ 0.5\text{m}}{10000\text{m2}} = 0.05\text{ha/h}$$

II. Calibration of sprayer equipment

For calibration to be successful, several items need to be taken care of before going to the field. Calibration will not be worthwhile if the equipment is not properly prepared. Whenever possible, calibration should be performed using water only.

Follow the steps outlined below to prepare spraying equipment for calibration.

- Inspect the sprayer.
- Be sure all components are in good working order and undamaged.
- Check the label of the product or products to be applied
- Next, determine some information about the sprayer and how it is to be operated
- Choose an appropriate nozzle or nozzles from the manufacturer's charts and install on the sprayer.
- Fill the tank half full of water and adjust the nozzle pressure to the recommended setting.
- Whenever possible, calibrate with water instead of spray solution.

3.4. Assessing suitable weather conditions.

Assessing suitable weather conditions is critical when applying chemicals to ensure they are effective and do not pose a risk to human health or the environment. Here are some factors to consider when assessing weather conditions for chemical application:

- **Wind speed and direction**: Wind speed and direction will affect the spread and drift of chemical sprays. You should monitor wind conditions and check that they are within safe limits before applying chemicals.
- **Temperature and humidity**: High temperatures and low humidity may cause chemicals to evaporate too quickly or be less effective. Low temperatures and high humidity may cause chemicals to linger in the air longer than intended. Therefore, it is important to check the recommended temperature and humidity range for each chemical being used before application.
- **Precipitation**: Rain or dew can affect the effectiveness of chemicals, causing them to be washed away or diluted. Avoid applying chemicals during rainy or wet conditions.
- **Time of day**: When applying chemicals, early morning or late afternoon is often best because the sun's intensity is lower, reducing the chances of rapid evaporation.
- **Local weather forecasts**: Check local weather forecasts regularly and avoid applying chemicals during adverse weather events like storms, heavy winds, and high temperatures. By considering these factors and checking the recommended weather criteria for each specific chemical being used, you can help ensure that chemicals are applied safely and effectively in suitable weather conditions.

3.5. Following safe working practices

Following safe working practices while applying chemicals is very important to prevent harm to yourself and the environment. Here are some guidelines to keep in mind:

- Always wear personal protective equipment (PPE) such as respiratory masks, gloves, and goggles.
- Ensure that the area is well-ventilated before applying chemicals.
- Read the manufacturer's instructions and warning labels carefully before using any chemicals.

- Store chemicals safely; keep them away from food, water sources, and heat sources.
- Avoid applying chemicals in windy conditions or near water sources where they can contaminate the environment.
- If you accidentally spill any chemicals, clean up the spill immediately and dispose of any contaminated materials safely.
- Wash your hands thoroughly after handling any chemicals. Remember, safety should always be your top priority when working with chemicals.

Any union strategy to protect workers against chemical hazards should try to create a working environment where it is safe for **all workers** — the average worker (male or female) and even vulnerable workers — to work without the job affecting their health. Regular medical examinations must never be used by the employer to eliminate "vulnerable" workers, such as women of childbearing age.

Personal hygiene rules for workers.

- Worker handling chemical pesticides perform with great care, special attention and Precision.
- Strictly observe the instruction and personal hygiene rules.
- Do not drink, eat or smoke while handling or working with pesticides or in the chemical Stores and premises.
- The person dealing with chemical should eat food that is rich in protein, vitamins, starch, and gelatin to diminish irritating action of chemicals.
- Take food before beginning work with toxicants. This reduces the harmful effects of chemical substances that may enter the blood system. The breakfast and lunch should contain an adequate amount of liquid (soup, milk, stewed fruit, and tea) and not very salty food. Avoid fats and spicy foods. Use foods in animal proteins (meat, cheese, fish), calcium salt, and vitamin B2(riboflavin), vegetables, fruits, sugar, honey, beef, green, porridge and vitamin C and etc.

N.B .The kinds of food to take or avoid depends on the types of toxicants.

- Person working with toxicants must wash their hands and face with soap and rinse their mouths before eating after finishing works, they must take shower.

3.6. Classification of pesticides

Pesticides can be classified in different ways, but a commonly used classification system is based on the type of pest they target and the mode of action by which they control the pest. Here are some of the most common classifications:

- **Insecticides**: these are pesticides that target insects, such as flies, mosquitoes, and ants.
- **Herbicides**: these are pesticides that target weeds and other unwanted plants. Such as glyphosate, 2,4-D, and atrazine. 3. Fungicides
- **Fungicides**: these are pesticides that target fungi, such as molds and mildews.
- **Rodenticides**: these are pesticides that target rodents, such as rats and mice.
- **Nematicides:** these are pesticides that target nematodes, which are worms that can damage crops.
- **Miticides**: these are pesticides that target mites, which are small arachnids that can damage plants.
- **Bactericides**: these are pesticides that target bacteria, such as those that cause plant diseases.
- **Virucides**: these are pesticides that target viruses, such as those that infect crops. It's important to note that certain pesticides can have multiple modes of action and may target more than one type of pest.

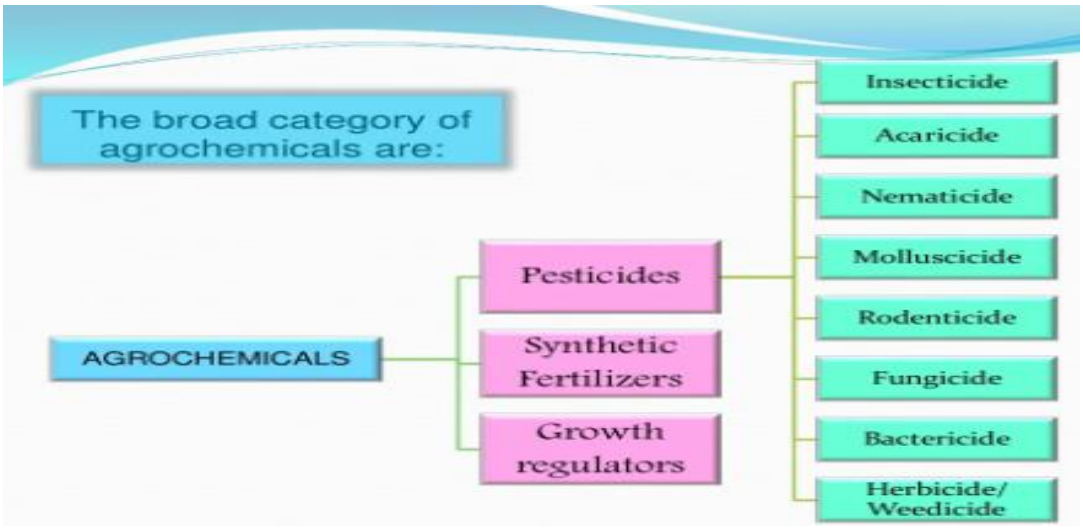


Figure: 3.6. Classification of pesticide

3.6.1. Time of chemical application

1. Pre-emergence
2. Post-emergence

Pre-emergence and post-emergence are two different methods of applying herbicides or other chemicals to control weeds or pathogens in crops.

- **Pre-emergence** application refers to applying a chemical before the target plants have emerged from the soil. The goal of this method is to create a barrier in the soil that prevents weed seeds from germinating and emerging, or to kill the young seedlings as they emerge. Pre-emergence herbicides are usually applied to the soil surface shortly after planting, before the first irrigation or rainfall, to ensure that the chemical stays in the top layer of soil where the target weed seeds are likely to germinate.
- **Post-emergence** application refers to applying a chemical after the target plants have emerged from the soil and developed leaves. This often involves spraying herbicides directly onto the foliage of the target plants. The goal of this method is to kill existing weeds or pathogens in crops, without harming desirable plants which have already established themselves. The timing and frequency of post-emergence applications can vary depending on factors such as weed type, crop type, and environmental conditions.

3.6.2. Mode of action of chemical

Chemical pesticides can be broadly categorized based on their mode of action - in other words, how they work to kill or control pests.

A. **Selective pesticides:** These are chemicals that have been manufactured to target specific types of pests, leaving non-target species and beneficial insects unharmed. For example, a pesticide that targets only aphids would be considered selective, since it wouldn't harm ladybugs or other beneficial predators.

B. **Nonselective pesticides**: In contrast to selective chemicals, nonselective pesticides are broad-spectrum and can kill or harm a wide range of pests and organisms. Glyphosate, a herbicide used to kill weeds, is one example of a nonselective chemical which can also be harmful to some crops and potentially toxic to humans.

C. **Contact pesticides**: These chemicals work by coming into direct contact with the target pest, either through physical means (such as by sticking to the surface of the pest's body)

or through inhalation or ingestion. Examples of contact pesticides include insecticides like pyrethroids and organophosphates.

D. **Systemic pesticides**: Systemic pesticides are absorbed by a plant's roots or leaves and then travel throughout the plant's vascular system, making all parts of the plant toxic to pests that feed on it. This makes systemic pesticides particularly effective against pests such as aphids or beetles that feed on the leaves or stems of a plant. However, systemic pesticides can also pose a risk to non-target species if they consume parts of the treated plant or if runoff from the pesticide contaminates nearby waterways.

E. **Stomach poisons**: This mode of action involves pesticide chemicals that must be ingested by the target pest in order to be effective. Once ingested, stomach poison chemicals disrupt the pest's digestive system and cause it to stop feeding and ultimately die. Rodenticides, which are used to control rats and mice, are an example of stomach poison pesticides.

Advantages of chemical pest control

- Chemical pesticides tend to work quickly and can provide immediate control of the pest population in the targeted area.
- They tend to be more cost-effective compared to other methods of pest control.
- Chemicals can be applied directly, even in hard-to-reach areas, and can offer a broad-spectrum solution to a variety of pests.
- They can also increase crop yields and lead to higher quality crops.

Disadvantages of chemical pest control

- Pesticides may harm non-target organisms, such as beneficial insects and wildlife.
- Overuse and misuse of pesticides can lead to pesticide resistance and residues that may persist in the environment for a long time.
- These chemicals can also have harmful effects on human health, ranging from minor allergic reactions to serious long-term health issues like cancer, fertility problems or neurological damage.
- Pesticides can also contaminate water sources and negatively impact the water ecosystem.

3.6.3**. Biological agent for pest control**

Biological control is the use of living organisms to suppress pest populations, making them less damaging than they would otherwise be. Natural enemies of insects play an important role in limiting the densities of potential pests.

Biological control agents are organisms that are used to control pests by targeting their natural enemies. These agents can be classified into three main categories based on their mode of action:

- **Predators** - Predators are organisms that feed on pest insects and mites. Examples of predators used in biological control include ladybugs, lacewings, and mites.
- **Parasitoids** - A parasitoid is an insect that lays its eggs inside the body of a pest insect. The parasitoid larva then feeds on the pest insect, killing it. Examples of parasitoids used in biological control include wasps and flies.
- **Pathogens** - Pathogens are microorganisms that cause disease in pest insects. Examples of pathogens used in biological control include bacteria, viruses, and fungi.
    - ✓ **Bacteria:** Certain types of bacteria can be used to control pests. For example, Bacillus thuringiensis (Bt) is a soil-dwelling bacterium that produces toxins that target specific insect pests.
    - ✓ **Fungi:** Some species of fungi can also control pests. For example, the fungus Metarhizium anisopliae is used to control beetles and other pests.
    - ✓ **Viruses:** Certain viruses can be used as biological agents to control pests. The nucleopolyhedrosis virus (NPV) is one such virus that affects certain insect pests.
    - ✓ **Nematodes:** Certain types of nematodes, which are microscopic worms, can be used for controlling pests in the soil. These are just a few examples of biological agents for pest control. Each has its own advantages and disadvantages, and the choice of agent will depend on the type of pest being controlled and the specific situation.

Biological control agents are often used in combination with other pest control methods such as cultural practices, chemical pesticides, and genetic control methods to create an integrated pest management (IPM) program. When used effectively, biological control can be a safe and effective method of controlling pests without harming non-target organisms or the environment.

Advantage of biological pest control

- It is a natural method of controlling pests, which means it does not use any harmful chemicals that could harm other organisms in the ecosystem.
- Biological control can be highly effective when done correctly.
- It provides long-term control as it may take some time for the natural predators to establish themselves, but once they do, they can keep the pest population under control for years.

Disadvantages of biological pest control

- One disadvantage is that it may take a longer amount of time for the predator or parasite to control the pest population than it would with chemicals - and sometimes the pest population might not be fully eradicated.
- There is also no guarantee that the biological control will work

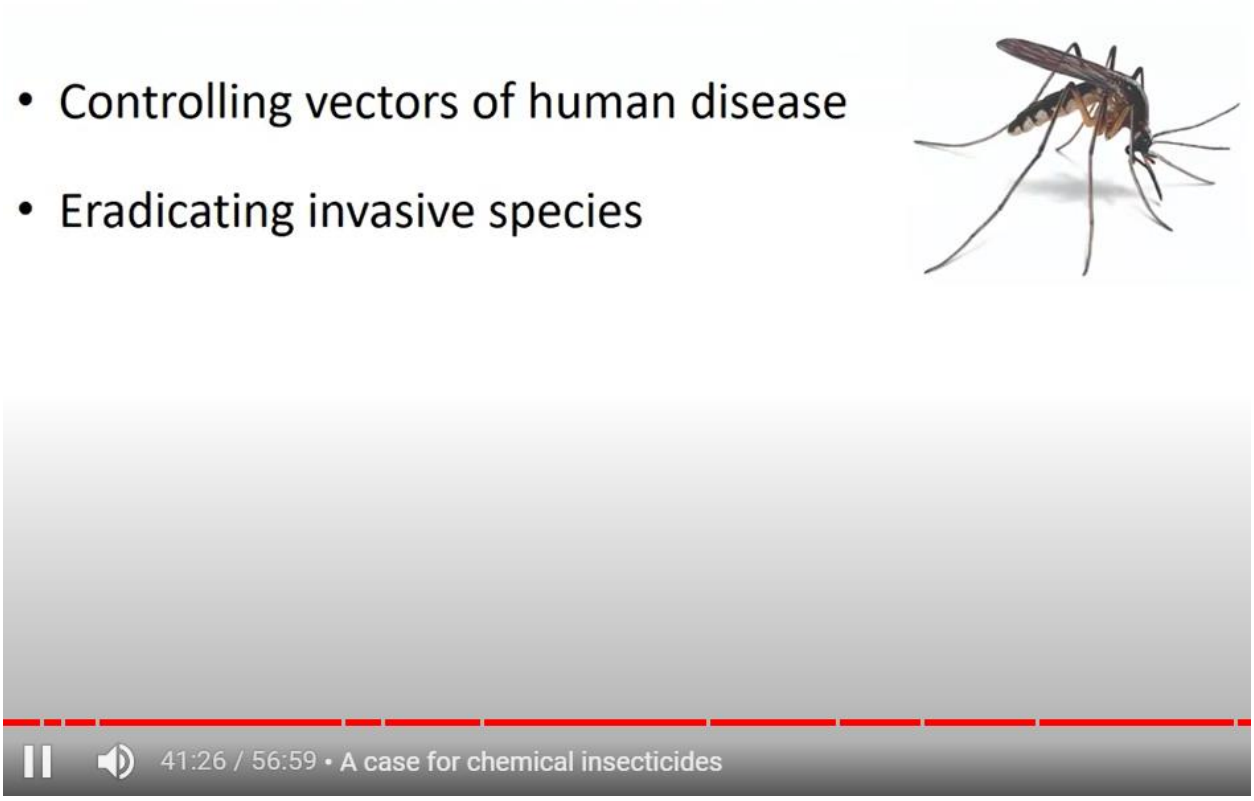


Figure:3.7.Video of principle of biological control

https://www.google.com/search?q=apply+chemicals+%26+bio-agents(video)

3.7.Paths of entry of poisons into the body and methods of limiting exposure

There are several paths of entry of poisons into the body. These include:

- **Inhalation:** Poisons can enter the body through inhaling gases, vapors, or dust particles that contain toxic substances.
- **Ingestion**: Poisons can enter the body through ingestion of contaminated food or water or through accidental ingestion of poisonous substances such as cleaning products.
- **Absorption:** Poisons can enter the body through the skin or mucous membranes, such as in the case of exposure to toxic chemicals or pesticides.
- **Injection**: Poisons can enter the body through injection, such as in the case of drug abuse or accidental needle sticks.

To limit exposure to poisons, there are several methods that can be used:

- **Engineering controls:** This includes modifying the workplace environment to limit exposure to toxic substances, such as maintaining proper ventilation and using protective barriers.
- **Administrative controls**: This includes implementing policies and procedures to limit exposure to toxic substances, such as providing proper training to workers and enforcing safety regulations.
- **Personal protective equipment**: This includes wearing appropriate protective clothing and gear, such as gloves, respirators, and safety goggles, to prevent exposure to toxic substances.
- **Proper handling and disposal**: This include properly handling and disposing of toxic substances according to environmental regulations and using proper labeling and warning signs. By implementing these measures, it is possible to limit exposure to poisons and protect the health and safety of workers and the general public.

3.8.Following equipment, cleanup methods and instructions

- Mixing, loading, and application equipment must be cleaned as soon as they are finished being used.
- Cleaning should be done in a special area that has a wash rack or concrete

- The best way to dispose of wash water containing a registered chemical is to use it as directed on the label.
- Collect the contaminated water and use it to dilute the chemical or a compatible chemical if possible.
- Waste from equipment cleanup must be kept out of water supplies and streams.
- It is extremely important for chemical equipment to be properly cleaned between applications.
- Be sure to clean the inside and outside of the equipment, including the nozzles.
- The outside of the equipment should be washed so that people touching it will not be exposed to chemicals.
- The inside must also be cleaned so that dangerous chemical mixing does not occur.
- At the end of each day the person applying chemicals must take a shower.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Multiple choice

1. Chemical used to weed control

   A. Insecticide
   B. Herbicide
   C. Fungicide
   D. Bactericide

2. Which of the following is correctly matched with their level of toxicity

   A. Caution----moderate toxic
   B. Danger----low toxic
   C. Warning---high toxic
   D. Danger----high toxic

Test II: Short Answer Questions

1. List some of paths of entry of poisons into the body?
2. Write advantage and disadvantage of biological pest control?
3. Write three main categories of biological agents used for pest control?
4. List Factors affecting application volume?

Operation Sheet -3

3.1. Techniques of calibration of equipment

A. Tools and equipments

- Sprayer(knapsack)
- Water
- Water container
- PPE

B. Procedures/Steps/Techniques

1. Select PPE
2. Fill the sprayer with clean water
3. Apply the water with normal technique
4. Check for leaks if there is leakage, pinpoint where it is and repair or replace the parts.
5. Check for any coarse particle blocking/interfering the flow of water through the pipes to the nozzle.
6. Check your nozzle give a uniform output, if not change it.

3.2. Techniques of calibration of chemical

A. Tools and equipment's Materials

- Knapsack
- Meter
- Water
- PPE
- Measuring cylinders

B. Procedures/Steps/Techniques

Method 1

1. Measure and mark out an area of crop 10 m x10m ($100m^{2)}$.
2. Fill the sprayer with clean water
3. Spray the measured area with normal spraying technique.
4. Find out how much you have used by measuring the amount of water needed to refill the sprayer, or checking the liquid level against the markings on the tank.
5. Use the following formula to calculate the volume application rate. (VAR in liters/hectare)

Vol. App. Rate (liters/hectare) =volume used (litres) x10,000m^2

Area Sprayed (m^2

Method 2

1. Determine swath width.

- Partly fill the sprayer with water and attach the appropriate nozzle.
- Select a dry target area e.g., concrete ground, holding the nozzle at the correct height spray stationary.
- Measure the wetted area, which area, which shows a uniform dark band, repeat three times.
- Calculate the average swath in meters (m).

2. Determine walking speed.

- Mark out a line at least 100m long and put a stake at each end.
- Start spraying and walk at comfortable speed along the line while spraying correctly.
- Measure the distance walked in exactly one minute.
- Repeat the operation and calculate the average walking speed in meters per minute (m/min).

3. Determine sprayer output.

- Adjust the pressure at the required level and
- pump the sprayer using steady strokes and
- Collect the spray in dry bucket, or other container, for exactly one minute, measure the water collected in the bucket.
- Repeat the operation and
- Calculate the average output in liters per minute (1/min) using the following formula.

Vol. App. Rate (lit/ha) = spray output (lit/min) =spray output (lit /min) x 10,000m^2

Walking speed (m/min) x swath width (m)

LAP TEST-3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **4** hours. The project is expected from each student to do it.

Task 1-perform calibration of sprayer (knapsack)

Task2- perform calibration of chemical

LG #4	LO #4- Complete application and record keeping

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identification of instructions
- Recording chemical inventory
- Reporting chemical application

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify of instructions
- Record chemical inventory
- Report chemical application

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -4

4.1 Identification of instructions

After a chemical application has been completed, there are several steps that should be taken to ensure safe and effective use of the chemicals. Here are some identifications of instructions that can be followed after completing a chemical application:

- Wait for the recommended amount of time before entering the treated area - this will vary depending on the chemical being used and the conditions of the application.
- Keep pets and children away from the treated area for the recommended period of time after application.
- Remove any protective gear used during the application and wash hands and exposed skin thoroughly with soap and water.
- Properly dispose of any unused chemical product and empty containers according to local regulations.
- If any adverse reactions occur, seek medical attention immediately.
- Monitor the treated area for any signs of damage to plants or other non-target organisms.
- Record details of the application, such as the date, type of chemical used, dosage, and any adverse effects observed.

Following this identification of instructions should help ensure safe and effective use of chemicals after their application.

4.2 Recording chemical inventory

Recording chemical inventory refers to the process of tracking and documenting all chemicals that are stored, used, or disposed of in a facility or workplace. The purpose of maintaining a chemical inventory is to promote safety, facilitate compliance with regulations, and generally provide better oversight of chemical use and handling. To record a chemical inventory, you should begin by identifying all of the chemicals in the facility. This may include cleaning agents, laboratory reagents, pesticides, herbicides, and other hazardous materials

Information needed

- Time of day and date of application
- Crop or target
- Pest, weed and diseases
- Equipment used
- Agrochemical used
- Common name
- Trade name
- Formulation and % active ingredient
- Lot number (in case of cross-contamination or failure to control)
- Total formulation added to tank or hopper
- Amount of mixture used
- Amount or numbers treated (hectares, buildings, sheep, etc.)

Additional comments

- Location
- Weather
- Applicator
- Severity of infestation

4.3 Reporting chemical application

Reporting chemical application involves documenting the use of chemicals, including what was applied, when it was applied, and where it was applied. This information is important for ensuring that chemicals are being used safely and effectively, and for complying with regulations that require the reporting of chemical use. The specific requirements for reporting chemical applications will vary depending on the regulatory framework in place in your region or industry. Generally, you will need to document the following information:

- The name and description of the chemical(s) applied
- The date and time of application
- The location of application
- The dose or concentration of the chemical applied
- The application method used (e.g., spraying, injection)

- Any precautions taken to prevent exposure to non-target organisms or bystanders
- Any observed effects of the chemical application
- The name of the person(s) who applied the chemical

You may also need to provide additional information, such as the reason for the application (e.g., pest control, weed control), the type of equipment used for application, and the certification or training held by the applicator. It's important to record all of this information accurately and in a timely manner. This will help ensure that the chemical is being used safely and effectively, and can help in identifying any problems or concerns that need to be addressed. By reporting chemical applications, stakeholders can more effectively manage occupational health risks associated with workplace exposure to chemicals; regulatory compliance; reducing over-ordering/stockpiling of chemicals

Self-Check – 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Write information needed while recording chemical inventory
2. Write some identifications of instructions that can be followed after completing a chemical application

Test II: Write true or false

1. Reporting chemical application involves documenting the use of chemicals
2. Recording chemical inventory refers to the process of tracking and documenting all chemicals that are stored, used, or disposed

LG #5	LO #5- Transport, handle, store chemicals & bio-agents

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Recognizing and following transport, handle and storage requirements
- Recognizing and following requirements for storage of chemicals &bio-agents

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Recognize and follow transport, handle and storage requirements
- Recognize and follow requirements for storage of chemicals &bio-agents

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -5

5.1 Recognizing and following transport, handle and storage requirements

Transporting: Safe transport should ensure that:

- Only products in good-quality containers are accepted from the supplier
- Any vehicle transporting a product will not damage the container.
- Sharp edges on vehicle sides or nails which have worked upwards from floorboards should be hammered down or otherwise removed;
- A package or container is handled in a manner to avoid unnecessary collisions
- Any information provided with the agrochemicals such as labeling, accompanying information or data sheets is transported with it;
- Random stacking is avoided during transport
- Agrochemicals are isolated from other materials transported on the same vehicle;
- Paper, cardboard or water-soluble packages are protected from rain or bad weather
- Agrochemicals are not carried alongside the driver in either a vehicle or a tractor cab;
- Drivers take extra care

Safe handling and use

This major section deals with packaging, transport, transfer, storage, dispensing, pesticide application, other agrochemical applications, spillage and disposal of containers and waste.

As pesticide application is a major activity in the use of agrochemicals and also the most hazardous, precautions to be taken before, during and after application are treated separately.

Storage, management of spills and disposal are also hazardous operations. Precautions to **be taken, both** for the safety of users as well as the **general** public and the environment, are described.

Packaging

Agrochemicals are usually supplied in packages. These may vary greatly in size, from a small bottle or box to a large metal or plastic drum. Packages are made of glass, metal, plastic or paper. In some cases, they are subject to high internal pressures. Liquefied gases such as methyl bromide

or anhydrous ammonia could evaporate inside the container to exert pressures on its walls. Packages need to be resistant to these pressures or the corrosive action of chemicals

Storage

In general, safe and secure storage should ensure correct sitting to allow easy access for the delivery of agrochemicals and transfer to farm vehicles. If the store is within a general-purpose building it should be separated from other stocks such as flammable materials. The location of the store should also take account of possible pollution risks from leaks and spillages. It should be situated away from living accommodation and surface waters such as rivers, streams and reservoirs used for the supply of drinking or irrigation water.

Stores should not be located:

- In areas liable to flooding or with a potential for the pollution of underground water supply sources such as wells and boreholes or
- In upstream catchment areas for water supply or
- In environmentally sensitive areas

There should be adequate capacity for storing the maximum amount of agrochemicals and provision for secure stacking and easy access.

5.2 Recognizing and following requirements for storage of chemicals &bio-agents

- Water supply
- Records
- First aid.
- Fire precautions.
- Washing facilities.
- Protective-clothing accommodation.
- Storage for empty containers and solid agrochemical waste.
- Preparation areas

Self-Check – 5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

3. Write some guidelines to safe transport of chemical
4. Write some guidelines to safe storage of chemical

Test II: Write true or false

1. Stores should be located in areas liable to flooding
2. Agrochemicals are usually supplied in packages
3. Only products in good-quality containers are accepted from the supplier

Operation Sheet -5

5.1. Techniques of Site selection, handling and storage of chemicals

A. Tools and equipments

- PPE
- Water
- Soap
- Marker
- Notebook
- Store
- Pesticides/ chemicals

B. Procedures/Steps/Techniques

1. Select the site that separated from other equipments and storage facilities and far from flood plain
2. Select materials for construction
3. Construct a simple storage house
4. Make ventilation, spill and drainage and have sources of heat and water be fireproof
5. Make a secure locking system
6. Mark the building with placards indicating the presence of pesticide inside the house
7. Store the pesticides
8. Separate each pesticides class for storage on its own shelf
9. Keep the product off the floor
10. Practice a good housekeeping or lock the house

LAP TEST-5	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hours. The project is expected from each student to do it.

Task-1. Perform proper site selection and store chemical

Reference Materials

Books:

Biological Control (1996) Roy G. Van Driesche, Thomas S. Bellows Jr.

Biological Control of Insect Pests Using Egg Parasitoids (2013) S. Sithanantham, Chandish R. Ballal, S. K. Jalali

Code of practice for the safe use and storage of chemicals (including pesticides and herbicides)

Department of Entomology, Soils, and Plant Sciences, South Carolina May 1992

Revised 2nd edition 2006

Handbook of Pesticide Toxicology, Volume 3:

Guidance Document on Pesticide Analytical Methods for Risk Assessment and Post-approval Control and Monitoring Purposes SANTE/2020/12830, Rev.1 24. February 2021

International code of conduct on pesticide management Guidelines for personal protection when handling and applying pesticides; Food and Agriculture Organization of the United Nations World Health Organization Rome, 2020

Web addresses

https://www.garri.ai/app/chat#:~:text=Calibration%20refers%20to,accurate%20and%20reliable.(access 19/05/2023)

https://www.garri.ai/app/chat#:~:text=Sure%2C%20here%20are,type%20of%20chemical.(access date,18/05/2023

https://www.garri.ai/app/chat#:~:text=To%20identify%20and%20maintain%20damaged%20equipment%20when,working%20condition%20and%20is%20safe%20for%20use.(access date,19/05/2023)

https://www.garri.ai/app/chat#:~:text=Certainly.%20Selecting%2C%20using,with%20current%20guidelines. (Access date, 19/05/2023)

https://www.garri.ai/app/chat#:~:text=Policy%0A%2D%20All%20employees%20must%20ensure%20that%20they%20record%20the,practices%20related%20to%20the%20use%20of%20chemical%20application%20equipment. (Access date, 20/05/2023)

https://www.garri.ai/app/chat#:~:text=Certainly%2C%20here%27s%20a%20draft%20of%20a%20policy%20document%20for,requirements%20and%20best%20practices%20for%20your%20industry%20and%20region. (Access date, 18/05/2023)

https://www.garri.ai/app/chat#:~:text=When%20handling%20and,like%20to%20know%3F (access date,19/05/2023)

https://www.garri.ai/app/chat#:~:text=Herbicides%20%2D%20Herbicides%20are,phosphide%2C%20or%20diphacinone. (Access date,20/05/2023)

https://www.garri.ai/app/chat#:~:text=Sure!%20Here%20are,the%20water%20ecosystem.(access 20/05/2023)

https://www.garri.ai/app/chat#:~:text=Sure%2C%20I%20can,hope%20that%20helps!(access date, 18/05/2023)

AKNOWLEDGEMENT

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

The experts who developed the learning guide

No	Name	Qualification	Educational Level	Region (College)	Phone number	E-mail
1	Mulugeta Alemu	Horticulture	A	Nefas Silk Polytechnic College, Addis Ababa	09 25322650	mulugetaalex44@gmail.com
2	Michael Zigder	Horticulture	B	Agarfa ATVET college Oromia Region	0941977555	mikytube1987@gmail.com
3	Girum Fisseha	Horticulture	A	Wereta ATVET College, Amhara Region	0911773323	girum.fis@gmail.com
4	Haile Terefe	Plant Science	B	Gewanie ATVET College, Afar Region	0940243855	haileterefe21@gmail.com
5	**Bayisa Abeshu**	**Agronomy**	**A**	**Mizan ATVET College, South West Ethiopia Region**	**0921434086**	**bayo@gmail.com**
6	Samson Seifu	Agronomy	A	Alage ATVET college Oromia Region	0911469872	samiseifu@gmail.com