Draft Study Material

MICROIRRIGATION TECHNICIAN

(Qualification Pack: Ref. Id. AGR/Q1002)

Sector: Agriculture

(Grade XII)

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION

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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

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Module 1	Layout and Installation of Microirrigation System

Module Overview

This module provides a comprehensive guide to the layout and installation of microirrigation systems, essential for efficient water management in agriculture. The module begins with Session 1, which introduces the various components of a microirrigation system, such as filters, valves, and control units, explaining their roles in distributing water effectively. Session 2, focuses on the installation of the head unit, which includes the pump and filtration systems, ensuring proper water pressure and filtration. In Session 3, you will explore the installation of the pipe network, emphasizing how to properly lay out and connect main and sub-main pipes for optimal water distribution. Session 4 covers emission devices like drippers and sprinklers, along with the fertigation system, which integrates fertilizer application into the irrigation process for efficient nutrient delivery to crops.

Learning Outcomes

After completing this unit, you will be able to:

- Recognize the components of a microirrigation system and list the necessary accessories and fittings for installation.
- Describe the procedure for installing the head unit and pipe network in a microirrigation system.
- Differentiate between the different types of filters and describe the various types of drip emitters used in microirrigation systems.
- Identify the components of a fertigation unit and describe the types of fertigation units used in microirrigation systems.

Module Structure

Session 1: Components of Microirrigation System
Session 2: Installation of Head Unit
Session 3: Installation of Pipe Network
Session 4: Emission Devices and Fertigation System

Session 1: Components of Microirrigation System

Microirrigation, also called localized irrigation, low volume irrigation, or trickle irrigation system, is an irrigation method in which water is applied to the root zone of the plants directly, with a lower pressure and flow rate than the traditional irrigation systems. A pressure piped irrigation system is a network installation consisting of pipes, fittings, and other devices properly designed and installed to supply water under pressure from the source of the water to the irrigable area. Microirrigation is broadly classified into two categories:

- Drip irrigation and
- Sprinkler Irrigation
- Other types of Microirrigation

The drip irrigation includes Surface drip irrigation, Sub-surface drip irrigation, Family drip, Online drip, and In-line drip. The Sprinkler irrigation includes Centre pivot, Towable pivot, Rain gun, Impact sprinkler, Pop-up sprinkler, and Linear move sprinkler. Bubbler irrigation and Spray Irrigation comes under other types of microirrigation.

Microirrigation is effective in saving water and increasing water use efficiency, compared to conventional surface irrigation methods. Besides, it also helps in reducing

- water consumption,
- growth of unwanted plants (weeds),
- soil erosion and
- cost of cultivation.

Microirrigation can be adopted in all kinds of land, especially when there is a problem of water scarcity or when the flooding method of irrigation is not possible. In flooding irrigation, a field is flooded with water. Flooding results in significant anaerobic conditions in the soil and around the root zone, which does not allow the supply of sufficient nutrients to the plants. It also results in a significant loss of water.
Installation of a microirrigation system is a very important aspect and needs proper planning for the effective performance of the system. Installation work is to be done as per the design, installation guidelines, and product specifications. A Microirrigation Technician should study the design sheet or drawing before starting the work.
In case of any difficulty in understanding the layout, the technician should consult the Irrigation Design Engineer for clearing the doubts.

Components of a Microirrigation System

The components of a typical microirrigation or a drip irrigation system can be broadly grouped into the following:

(i) Control head
(ii) Distribution network
(iii) Accessories and fittings

Control Head

The control head of a drip irrigation system includes a pump, filter, pressure regulating valves, pressure gauge, water meter, and fertigation equipment. This is also known as Head Control Unit (HCU) because it is the control station of a microirrigation system. A control head unit of the drip irrigation system is shown in **figure 1.1.**

Figure 1.1: Control head

The pump or an overhead tank is required to provide sufficient pressure in the system. The type and size of the pump will depend on the amount of water required, desired pressure, and the location of the pump relative to the distribution network. The installation of the pump requires appropriate power connections and matching equipment. Centrifugal pumps are usually used for low-pressure drip or trickle systems. Water meters provide information regarding water application that is essential for irrigation scheduling, and the monitoring of dripper clogging.

A water meter installed at the head of a drip irrigation system or small water meters placed at the head of selected dripper lines can help in the detection of dripper clogging. A water meter, which is installed close to a valve, elbow, or tee may not provide accurate information.

Figure 1.2: Pressure gauge

Pressure gauge, shown in **figure 1.2**, in a drip irrigation system provide vital information concerning the pressure at multiple water control accessories in a drip irrigation system. They help in the detection of leaks and clogging and in the management of filters, chemical injectors, and in keeping the system in its operating range.

One should always measure the pressure at a variety of key points along with the micro-irrigation system i.e. at the head of the system, at the head of each irrigation zone, and at the inlet and end of selected dripper lines in the field.

Filters

The source of water used for microirrigation could be either from a tank, river, canal, or tube well. Due to this, water may contain impurities, suspended particles, mineral salts, pathogenic bacteria, algae, etc. Hence, filters are used to reduce the hazard of blocking or clogging emitters due to physical, chemical, or biological reasons.

Figure 1.3: A series of filters installed for a drip irrigation

A single filter or a combination of filters in a series are used, depending upon factors like source of irrigation, level of impurities present in water, desired quality of filtered water, and the investment capacity of the farmer.

A filter is used for efficient and trouble-free operation of the microirrigation system. However, it requires frequent cleaning or flushing **(Figure 1.3)**.

Distribution Network

Distribution lines consist of a network of pipes. It consists of mainline, sub-main line, laterals, and drippers or emitters, and other accessories.

(a) **Main and sub-main line:** These are generally made of rigid PVC (Poly Vinyl Chloride) and HDPE (High-Density Polyethylene). These pipes are of 63 mm diameter and above, with a pressure rating of 4 to 8 kg/cm^2.

The exact diameter of the main and sub-main lines and pressure rating are decided in the process of drip irrigation design that mainly depends on the size of the field to be irrigated, topography, static and delivery head, etc. **(Figure 1.4).**

Figure 1.4: Main pipeline

(b) **Laterals or Lateral Pipe:** These are normally manufactured from LDPE (Low-Density Polyethylene) or LLDPE (Linear Low-Density Polyethylene) material. Generally, lateral pipes of 10, 12, and 16 mm internal diameter, with wall thickness varying from 1 to 3 mm is widely used in a drip irrigation system. Lateral pipes (Figure 1.5) generally operate at 1-2 kg/cm^2. **(Figure 1.5).**

Figure 1.5: Lateral pipe

(c) **Emitters or Drippers:** These are the main component of a drip irrigation system **(Figure 1.6)**. Emitters are made of polypropylene plastic material. Emitters are classified based on the following:

Figure 1.6: Emitter

(i) **Design geometry and working principle:** It includes orifice, long path, perforated pipe, double-wall pipe types, micro-tubes.

(ii) **Emission source :** It includes point source (generally for wide-spaced crops) and line source (for close spaced crops).

(iii) **Pressure exponent:** Pressure compensating and non-pressure compensating type.

(iv) **Method of attachment :** Inline and online.

(v) **Flow regime:** Turbulent and laminar flow.

(vi) **Discharge rates:** Low (<4 litres per hour), medium (4-10 litres per hour), and high (>10 litres per hour).

Most of the point source drippers are either online or inline drippers.

On-line emitters are fixed or fastened on the laterals after punching holes of suitable size in the lateral pipe.

In-line drippers are fixed in the lateral pipes during the manufacturing process by inserting drip emitters into the lateral pipes at evenly spaced intervals.

The most common emitters or drippers in surface drip irrigation systems are non-pressure compensating and pressure compensating types. Other types of emitting devices, like adjustable discharge types, porous pipes, or drip tapes are also being used. In the case of micro-spray, the emitters are classified as per droplet size viz., aerosol emitters, foggers, misters, mini-sprinklers, micro-sprinklers, and jets.

Accessories and Fittings

Accessories and fittings include take-off, rubber grommet, end plug, joiners, tees, reducers, elbows, connectors, gate valves, and manifolds. Sometimes silt escapes through the filters and settles in sub-mains and laterals. Also, some algae and bacteria lead to the formation of slimes or pastes in the pipe and laterals. To remove these, the sub-mains should be flushed by opening the flush valves. The lateral lines are flushed by removing the "end caps" to remove the traces of accumulated salts **(Figure 1.7)**. The flushing is stopped once the water coming out of the lateral lines are clean.

Figure 1.7: End cap

Pre-Requisites for Installation

A well-designed drip irrigation system should provide a uniform and adequate quantity of water to all plants in the field at high irrigation efficiency. The layout of the drip irrigation system is shown in **Figure 1.8**.

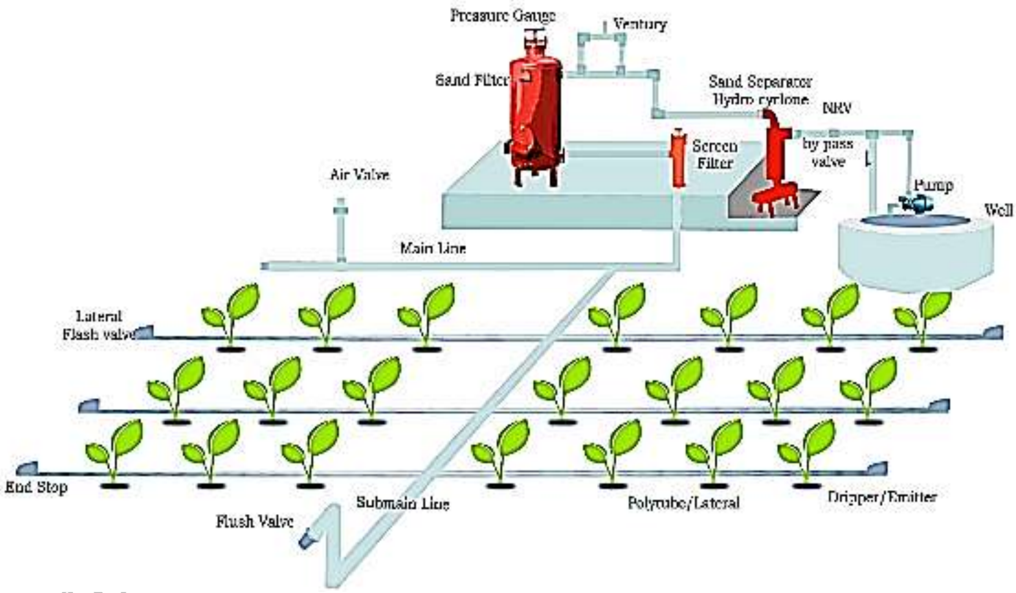


Figure 1.8: Layout of drip Irrigation system

Before designing a drip irrigation system, the following preliminary data are need to be collected at the first instance:

(i) **Water source and its location**: The source of water is usually a well or a tank storing rainwater or groundwater. The requirement of main and sub-main lines would be decided based on the location of the water source.

(ii) **Type of crop**: The general layout of a drip irrigation system depends on the type of crop, planting geometry, and root zone.

(iii) **Topographic condition**: The general relief of the land, where the drip system is to be installed, must be known which will help in determining the location of the main, sub-main, and laterals.

(iv) **Type of soil**: The type of soil and its various physical and chemical properties must be known beforehand so that the scheduling of irrigation can be done properly.

(v) **Climatic records**: The climatic records will show when and how often irrigation is needed in a cropping season.

Generally, the main and sub-main pipes are laid along the slope and the laterals are placed across the slope. Laterals may be allowed to take off directly from the main pipe in a small field. But in large fields, it may be advisable to divide it into blocks. Each block may be provided with one sub-main and a control valve. Lateral pipes are then connected with sub-mains. The layout of the drip system includes the alignment of the main pipe, sub-main pipe and lateral pipes connected to the water source.

Pre-Requisites during Installation

(i) Site Preparation

Clearing the Area: Remove any debris, rocks, or vegetation that may obstruct installation.

Levelling the Ground: Ensure the area is level or graded to facilitate even water distribution.

(ii) Component Inspection

Quality Check: Inspect all components (pipes, emitters, filters) for defects or damage before installation.

Correct Sizing: Verify that all components are the correct size and type for your system design.

(iii) Layout Implementation

Marking the Design: Clearly mark the layout of pipes and emitter placement according to the design plan.

Distance Measurement: Measure distances accurately to ensure proper spacing between emitters based on crop needs.

(iv) Installation Techniques

Pipe Laying: Lay pipes according to the marked layout, ensuring they are straight and secure.

Connections: Use appropriate fittings and connectors, ensuring they are watertight to prevent leaks.

Emitter Placement: Install emitters at designated intervals, ensuring they are positioned correctly for optimal coverage.

(v) Filtering and Pressure Regulation

Filter Installation: Install filters at the water source to remove impurities that could clog emitters.

Pressure Regulators: Ensure that pressure regulators are installed to maintain consistent pressure throughout the system.

(vi) Check Valves and Drainage
Backflow Prevention: Install check valves to prevent backflow and protect the water source.
Drainage Options: Ensure there are drainage options for the system to prevent waterlogging or freezing.

(vii) System Testing
Pressure Test: Conduct a pressure test to check for leaks and ensure the system can handle the required pressure.
Flow Rate Verification: Test the flow rate at various points to confirm that it meets design specifications.

(viii) Final Adjustments
Emitter Adjustments: Fine-tune emitter flow rates if needed to ensure uniform distribution.
System Calibration: Calibrate the system based on initial test results to optimize performance.

(ix) Documentation
Record Keeping: Document the installation process, including component specifications, layouts, and any adjustments made.

(x) Safety Measures
Personal Protective Equipment (PPE): Ensure that all personnel wear appropriate PPE during installation.
Site Safety: Maintain a safe work environment, keeping tools and materials organized to prevent accidents.

Tools, Equipment, and Materials for Installation of Microirrigation System

The following tools and equipment are required for the installation of a micro-irrigation system, besides other fittings and materials.

1. Pipe Wrench (18”, 24” or 36” size).
2. Spanner Set (preferably adjusting sly wrench)
3. Drill Machine (with drill bits of different sizes)
4. Drill Guide
5. Screw Driver and Pliers
6. Hack Saw with Blade (at least one spare blade)
7. Measuring Tape and Scale
8. Ejector Punch, Hand Punch, S-hose Pump, Plier Punch
9. Take-Off Tool
10. Solvent Cement
11. Teflon Tape
12. Jute
13. GI threaded joint’s synthetic compound

14. Pencil/Marker
15. Pressure Gauge with adopter and nozzle

Activities

Activity 1: Identification of components of the microirrigation system

Identify and name the components of the microirrigation system in the following table:

S.No.	Picture	Name of the Component
1.		
2.		
3.		
4.		

5.		

Check Your Progress

A. Fill in the Blanks

1. The medium ________________ rate of an emitter typically ranges from 2 to 8 litres per hour (lph).
2. Emitters are classified according to the flow regime as ________________flow emitters and turbulent flow emitters.
3. The lateral pipe size commonly available ranges between ______ mm to 32 mm.

B. Multiple Choice Questions

1. Which among the following is not a commonly available size of drip lateral?
   (a) 10 mm
   (b) 12 mm
   (c) 16 mm
   (d) 20 mm
2. Generally, laterals are laid____________.
   (a) Along the slope
   (b) Across the slope
   (c) Diagonal to slope
   (d) Perpendicular to the slope
3. Which among the following are **not required** while designing a drip irrigation system?
   (a) Type of crop
   (b) Topography
   (c) Water source
   (d) Wind velocity

C. Subjective Questions

1. List any three-equipment required for installing a drip irrigation system in the field.
2. Write a short note (50 words) on the following:
   (i)Laterals

(ii) Main and sub-main line
(ii) Emitters

3. What is the role of the mainline in a microirrigation system?
4. What is a lateral in microirrigation system?
5. What is the role of emitters in drip irrigation?
6. What is the function of a filter in a microirrigation system?
7. What is a pressure regulator used for in microirrigation?
8. What does a backflow preventer do in microirrigation?
9. What is a drip tape?
10. What is the purpose of a control valve in microirrigation?

Session 2: Installation of Head Unit

To install the head unit of a microirrigation system, first gather all necessary materials, including the water source, filters, pressure regulators, flow meters (if applicable), valves, and possibly a fertilizer injector.

Select an accessible and stable location near the water source, ensuring it is clear of debris and level. Begin by connecting the head unit to the water source using appropriate fittings, ensuring all connections are secure and leak-free.

Position the filter immediately after the mainline connection, followed by the pressure regulators, making sure they are oriented correctly for water flow. If using flow meters, place them between the pressure regulator and the distribution lines. Install valves for flow control, ensuring they are easily accessible. If incorporating a fertilizer injector, place it after the pressure regulator and before the distribution lines, following the manufacturer's instructions for connection.

Connect the distribution lines securely to the head unit, then test the system for leaks and check flow rates. Finally, secure all components, label them for easy identification, and document the installation for future reference. This organized approach will help ensure an efficient and effective Microirrigation setup.

Components of Head Control Unit

The Head Control Unit of microirrigation system includes a pump, air release valve, vacuum gauge, pressure gauge, filtration unit, fertigation unit, throttle valve, water meter, fittings and accessories. A typical head control unit consists of the following components:

1. Water Pump: The water pump is used to create the desired water pressure and also to deliver the desired water discharge for the operation of the microirrigation system.

Pumps can broadly be classified into two types — positive displacement and non-positive displacement pumps.

1.1 Positive displacement pumps

Positive displacement pumps make water move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe. Pumping takes place by to and fro motion of the piston or diaphragm in the cylinder.

Positive displacement pumps can be further classified based on mechanical operation and working principles. Based on mechanical operation, positive displacement pumps are of three types — piston pump, diaphragm pump, and plunger pump.

(a) Piston pump: In the 'piston pump', the high-pressure seal reciprocates with the piston. The pump has a piston-cylinder arrangement. As the piston goes away after the delivery stroke, low pressure is created in the cylinder, which opens the suction valve. On forward stroke, the water trapped inside the cylinder is compressed, which in turn opens the delivery valve.

(b) Diaphragm pump: This pump uses a combination of the reciprocating action of a rubber, thermoplastic or Teflon diaphragm, and non-return check valves to pump water.

(c) Plunger pump: A 'plunger pump' is one, in which there is a high-pressure stationary seal and a smooth cylindrical plunger, which slides through the seal.

2. Non-positive displacement pumps

In non-positive displacement pumps, water is pressurised by the rotation of the propeller and the water pressure is proportional to the speed of the rotor. These pumps provide a smooth and continuous flow of water.

(a) Centrifugal pump: A centrifugal pump operates when water is drawn into the central chamber of a spinning impeller **(Figure 1.9)**. It is, then, engaged by the vanes that drive the water outside the pump volute casing. This process transforms the kinetic energy of the impeller into the pressure head used to discharge water from sprinklers or emitters located in the area to be irrigated.

One of the limitations of a centrifugal pump is that the impeller casing and intake (suction) pipe must be filled with water before starting. This process is called 'priming'.

When the pump is turned "ON," a differential pressure is formed that is required to draw water into the pump. As the water flows from the impeller to the delivery system, an area of low pressure is created at the impeller centre. This draws a continuous stream of water from the source into the impeller.

Figure 1.9: Centrifugal pump

Centrifugal pump performance capacity can be calculated in the following way.

$$Q = b_1 \cdot (\pi \cdot D_1 - \delta \cdot Z) \cdot C_1 = b_2 \cdot (\pi \cdot D_2 - \delta \cdot Z) \cdot C_2$$

Where,

Q = centrifugal pump performance capacity, m^3/s

$b_{1,2}$ = widths of impeller pass through diameters D_1 and D_2, m

$D_{1,2}$ = inlet external diameter (1) and impeller external diameter (2), m

δ = the thickness of blades, m

Z = number of blades

$C_{1,2}$ = radial components of absolute velocities at impeller inlet (1) and its outlet (2), m/s

Installation of centrifugal pump

Centrifugal pumps must be installed and operated according to guidelines that address electrical connection requirements: the foundation on which the pump is installed, the number of bends on the delivery, the suction side, and the shelter that protects the pump from various weather conditions.

A centrifugal pump is installed close to a water source. It must be located at an accessible place in a clean, dry, and ventilated area. To ensure the maximum utilisation of the pump's capacity, the site selected must permit the use of the shortest and most direct suction and discharge pipes. The pump is installed on a concrete foundation to tolerate vibrations. It must have minimum plumbing fittings to avoid friction losses. Bends, elbows, tees and other fittings' usage must be kept to a minimum to reduce heat loss in the discharge line. The current carrying capacity of wires used in pump installation needs to be sufficient to avoid excessive heating of wires and hazards like fire.

Operation of centrifugal pump

If one is starting the pump for the first time, attention must be paid to the following:

- Check the alignment of the pump. Any misalignment is to be corrected by placing shims under the pump or driver.
- Make sure that the engine or motor drives the pump in the direction indicated on the pump body.
- It must be ensured that the gland is tightly and evenly adjusted, and the pump shaft revolves freely when turned by hand.
- Check for airtightness of the suction pipe and leakage in the foot valve.
- Fill the suction line and pump with water and remove air from the pump casing.
- Attend to lubrication requirements.

Types of valves

Valves are an important component of drip irrigation systems and play key roles in controlling pressure, flow, and distribution under different conditions to optimize performance, facilitate the management, and reduce maintenance requirements. Generally, bypass/pressure regulating valves, non-return valves, and pressure release valves are used in drip irrigation systems. A Polypropylene ball valve is depicted in **figure 1.10.**

(i) **Bypass valve/pressure regulating valve:** A pressure regulating valve controls the pressure of a fluid or water to the desired value. These valves may be installed at any point where the possibility exists for excessively high pressures. A Pressure Reducing Valve (PRV) reduces higher upstream pressure to lower constant downstream pressure regardless of fluctuating demand and opens fully upon line pressure drop. A back-pressure regulator is a control valve that maintains the set pressure at its inlet side by opening to allow flow when the inlet pressure exceeds the set value. It differs from an over-pressure relief valve because the over-pressure valve is only intended to be open when the contained pressure is excessive and it is not required to keep upstream pressure constant. A bypass arrangement is the simplest and most cost-effective means to avoid problems of high pressure instead of using costly pressure relief valves.

(ii) **Non-return valve:** Check valves, also called non-return valves, permit flow in one direction only and prevent reversal flow in piping using an automatic check mechanism. This valve prevents the backward flow of water that may contain fertiliser and/or other chemicals, into the main supply system.

Figure 1.10: Polypropylene Ball valve

Non-return valves come in two basic types:

(i) The swing check, which can be installed in horizontal or vertical piping; and

(ii) The lift check, which is used in horizontal lines only. Water flow keeps the check valves open, and the gravity and reversal of flow close them automatically. They are placed in-line at the head control unit i.e. immediately after the pump.

Air Release valve: This valve is provided at the highest point in the mainline to release entrapped air during the start of the system and break the vacuum during shut-off. The purpose of an air release valve is to prevent air from being sucked in the main sub-main pipes, laterals, and emitters when the system is turned off **(Figure 1.11).**

Figure 1.11: Air release valve

Types of Filters

Filters: The hazard of blocking or clogging necessitates the use of filters for efficient and trouble-free operation of the micro-irrigation system. The design of a filtration system involves the selection of filter type and filter size (capacity) depending on the water source and the amounts of particulate matter, nutrients, carbonates, and iron present in the water supply.

The selection of one or more filters mainly depends on the quality of irrigation water available. The different types of filters used in Microirrigation systems are available in 5, 10, 20, 40, and 50 m^3/hr filtration capacities.

Most drip irrigation systems require filtration of 125 microns (120 mesh) or higher. The types of filters used in drip irrigation systems are as follows:

Centrifugal or hydrocyclonic filter: Centrifugal filters, as shown in **Figure 1.12**, also called as pre-filters, are effective in filtering sand, fine gravel, and other high-density materials from open wells or river water.

Water is introduced tangentially at the top of a cone and creates a circular motion resulting in a centrifugal force, which throws the heavy suspended particles against the walls.

The separated particles are collected in the narrow collecting vessel at the bottom. These filters are particularly effective for primary filtering of irrigation water and should be installed before the media or screen filters.

Figure 1.12: Hydrocyclone filter

Gravel or media filter: Media filters consist of fine gravel or coarse quartz sand of selected sizes (usually 1.5 – 4 mm in diameter), free of calcium carbonate placed in a cylindrical tank. These filters are effective in removing light-suspended materials, such as algae and other organic materials, fine sand, and silt particles. This type of filtration is essential for the primary filtration of irrigation water obtained from open water reservoirs, canals, or reservoirs. Water is introduced at the top, while a layer of coarse gravel is put near the outlet bottom. Reversing the direction of flow and opening the water drainage valve cleans the filter. Pressure gauges are placed at the inlet and at the outlet ends of the filter to measure the head loss across the filter. If the head loss in the media filter is about 2 m, it means the filter is clean. However, the filter needs backwashing if the head loss exceeds more than 0.5 kg/cm^2.

Figure 1.13: Screen filter

Screen filter: Screen filters are the most commonly used filter in microirrigation systems **(Figure 1.13)**. This filter consists of a cylindrical screen that removes suspended particles like fine sand, dust, etc. present in the irrigation water. The material used for the screen is generally nylon, polyester, or stainless steel. The size of filter perforation is expressed either in mesh or micron (1/1000 mm). Mesh size represents the number of pores (openings) per linear inch (typically 40-200) but does not represent the size of each pore.

Various mesh sizes are available in the screen filter, ranging between 20 – 200 mesh. In a micro-sprinkler system, a 70 mesh filter, and in the drip irrigation system, 100 mesh or 150 microns are generally recommended to remove most clogging materials. Screen filters can be cleaned either by flushing or manually cleaning due to their easier opening feature. The self-cleaning screen filter is one of the most common types of filter used in drip irrigation systems.

Disc filter: Disc filters are an improved form of screen and sand media filters **(Figure 1.14)** . They are used with surface water systems, wells, or municipal water sources. These filters are comprised of a series of grooved plastic discs stacked together with a total equivalent screen size ranging from 40 to 400 mesh. The disc captures debris and is very effective in the filtration of organic material and algae. During the filtration mode, the discs are pressed together. There is an angle in the alignment of two adjacent discs, resulting in cavities of varying size and partly turbulent flow.

Figure 1.14: Disc filter

The sizes of the groove determine the filtration grade. Disc filters are available in a wide size range (25-400 microns). Back flushing can clean disc filters. However, they require back flushing pressure as high as 2 to 3 kg/cm^2. Discs can be separated and snagged debris can be cleaned by flushing or hand cleaning.

Sand filter: The sand filter should be installed on a levelled and hard surface to avoid mishaps **(Figure 1.15)**. To install the sand filter, a platform of cement concrete is constructed for the filter station, which is usually done as per the dimensions and the location finalised by the engineer.

Figure 1.15: Sand Filter

The size of the platform depends on the size of the sand filter and its multiple tanks. For 1.5” sand filter, the minimum platform size should be 5′ x 3′, whereas for 2” and 3” sand filters, it should be 6′ x 4′ and 6′ x 5′, respectively. If a fertilizer tank is to be provided, then the platform size will have to be increased accordingly.

A filtration system should be planned to filter water at two stages: (i) Primary and (ii) Secondary. The primary stage is responsible for filtering relatively large size particles near the water source. It is generally comprised of a media or disc filter.

A hydrocyclone sand separator should be placed before the main filter in cases where sand or other heavy particles (50 microns or bigger) are present in the water source. In the secondary stage, filtering of relatively small particles remaining after the primary stage filtration takes place **(Figure 1.16).** Screen and disc filters can be used for secondary filtration.

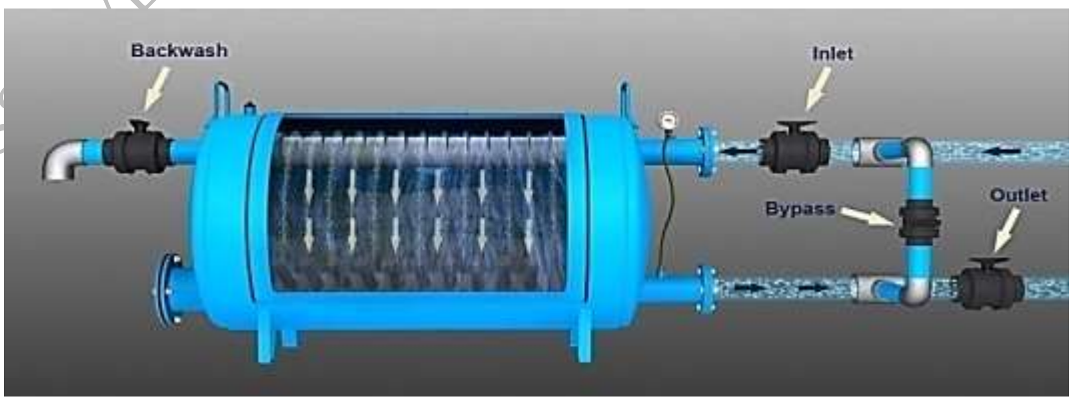


Figure 1.16: Cross section view of sand filter with filtration mechanism

Pressure gauge: Pressure gauges are used to observe the operating pressure of Microirrigation system **(Figure 1.17)**. It is installed at inlet and outlet points of the filters and other components of the microirrigation system where the pressure is to be recorded. It also indicates the level of filter clogging so that filters can be cleaned from time to time during the operation.

Figure 1.17: (a) Pressure gauge, (b) Pressure gauge installed on a screen filter

Commercially glycerine-filled pressure gauges are available for accurate measurement and trouble-free operation.

Activities

Activity 2: Identify and name the connectors and accessories of drip irrigation in the following table:

S. No.	Picture	Name of the accessories
1.		
2.		

3.		
4.		
5.		

Check Your Progress

A. Fill in the Blanks

1. In a drip irrigation system, a ________________ valve is used to regulate the flow of water to different sections of the irrigation network?
2. The no-return valve permits the flow of water in __________ direction and prevents reversal flow in piping using an automatic check mechanism.
3. _______valves come in two basic types: (i) the swing check and (ii) the lift check.
4. The _______valve releases the entrapped air from the mainline during the start of the system and breaks the vacuum during shut off.

B. Multiple Choice Questions

1. Which among the following filter is used for sand separation?
   (a) Screen
   (b) Gravel
   (c) Hydrocyclone

(d) None of these

2. Selection of one or more than one filters mainly depends on the quality of _______________.
   (a) Irrigation water
   (b) particulate matter
   (c) Nutrients present in the water
   (d) None of the above

3. Mesh size of 100 is equal to ________ microns.
   (a) 50
   (b) 75
   (c) 100
   (d) 150

C. Match the Columns

S. No.	Column A	S. No.	Column B
1.	Hydrocyclone filter	(a)	Filtration of organic material and Algae
2.	Gravel filter	(b)	Pre-filters
3.	Screen filter	(c)	Primary filtration
4.	Disc filter	(d)	Effective in filtering out debris and particles from water

D. Subjective Questions

1. Where should the filter be installed in a Head Unit?
2. What is the role of the pressure regulator in the Head Unit?
3. Which location is the best for installation of the Head Unit?

Session 3: Installation of Pipe Network

Irrigation water needs to be distributed evenly to each plant in a field so that every plant should receive a similar amount of water. If the irrigation is uneven, certain areas will receive excessive water while others will not get enough. In this scenario, pipe network plays an important role in water distribution and delivery. The uniformity of water application from a micro-irrigation system is affected both by the water pressure distribution in the pipe network and by the hydraulic properties of the emitters used. The emitter hydraulic properties include the effects of emitter design, water quality, water temperature, system pressure, and other factors on emitter flow rate. Factors, such as emitter plugging and wear and tear of emitter components will affect water distribution. **Figure 1.18** depicts a simple pipe distribution system.

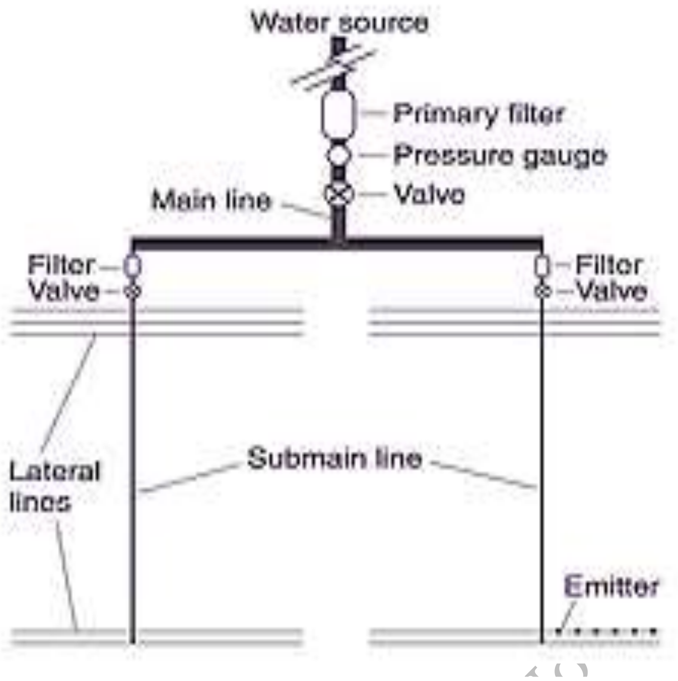


Figure 1.18: A simple pipe distribution system

Water distribution pipes network consists of main, sub-main, and laterals. In a microirrigation system, irrigation water is carried from the source (well or tank) to a large number of application points through a network of different pipes. The role of the pipe distribution system is to convey water from the source to the field. Distribution systems may be above ground (easily movable) or underground (less likely to be damaged). When water flows through a pipe network, pressure losses occur because of friction losses in the pipes and fittings. Pressure changes also occur as the water flows uphill (pressure loss) or downhill (pressure gain) in a pipe network. If a microirrigation system is poorly designed or improperly installed, pressure losses may be high. Water application uniformity may be greatly affected by the design of the pipe network.

Pipes used for water distribution are most commonly made of Polyvinyl Chloride (PVC) or other polyethylene (HDPE) plastics material **(Figure 1.19 a and b)**. The size and shape of the distribution system may vary widely from field to field and from farm to farm. Pipe network optimization is generally directly or indirectly related to the total cost of the pipe network. The total cost of the pipe network is a function of pipe materials, lengths, and diameters.

The description and function of different components of a water distribution network in a micro-irrigation system, such as main pipe, submain pipe, and fittings of main and sub-main pipe, laterals and fittings of lateral pipe are as follows:

Microirrigation Pipes

Main Pipe: Rigid Poly Vinyl Chloride (PVC) and High-Density Polyethylene (HDPE) pipes are normally used as main pipes to minimize corrosion and clogging. Pipes of 63 mm diameter and above with a pressure of 4 to 8 kg/cm^2 are recommended for main pipes.

Function: Main pipes supply water from the main source to the sub-main lines of the Microirrigation system. It is the primary artery of a drip system, usually laid along the length of the field, which serves as a conveyance system for delivering the total amount of water to the sub-mains at the required water pressure. The main pipe is normally buried at about 45 - 60 cm below the soil surface.

Submain Pipe: Submain pipes are made up of light PVC or HDPE or LLDPE material. Pipes having an outer diameter, ranging from 32 mm to 75 mm with a pressure rating of 2.5-6.0 kg/cm^2 are used. The diameter of main and submain pipes depends on the water requirement of the crop and the size of the field. Both main and submain lines are provided with the flush valve at the outlets to occasionally flush the pipes for removal of sediments from the pipes.

Function: The submain unit is a function of hydraulic design, which runs perpendicular to the lateral and delivers water to the lateral on one or both sides.

Figure 1.19 (a): PVC pipes

Figure 1.19 (b): HDPE pipes

Lateral Pipe: Laterals are the tubes on which emitters are mounted or within which they are inserted or cast at the time of extrusion. Laterals are usually made of LDPE or HDPE material, ranging from 10 mm to 20 mm in diameter, with a wall thickness varying from 1 to 3 mm and a pressure rating of 2.5 kg/cm^2. Lateral pipes are usually flexible, non-corrodible, and resistive to solar radiation and temperature fluctuations. Laterals are usually black.

Function: The laterals carry a uniform supply of water through the emitters. In drip laterals, the pressure drop between the lateral lines must not exceed 20 percent of the emitter operating pressure. Each lateral is connected to either the main or sub-main pipe. Water flow in each lateral depends upon the number of drippers on that lateral.

Fittings and Accessories

During the installation of the drip irrigation system, some fittings and accessories are required for the proper installation and functioning of the system. The details of the commonly used fittings and accessories are as follows:

Tee: Tee is a joint which used to connect the main and sub-main pipe longitudinally. It is made of PVC plastic **(Figure 1.20)**.	 **Figure 1.20 Tee**
Elbow: Elbows are used to change the direction perpendicular to the main and sub-main pipe, as per the layout of the system and field boundaries. Elbows are made of PVC plastic **(Figure 1.21)**.	 **Figure 1.21: Elbow**
Socket: A socket is used to connect the same sizes of main and sub-main pipes **(Figure 1.22)**.	 **Figure 1.22: Socket**
Flow control valve: A flow control valve is used to control (to allow or cut off the water supply to main/ sub mainline) the flow of water **(Figure 1.23)**.	 **Figure 1.23: Flow control**
Reducer: Reducers are used to connect the large diameter pipe with the smaller diameter pipe or vice versa. A reducer is made of PVC plastic **(Figure 1.24)**.	 **Figure 1.24: Reducer**
Rubber grommet: A rubber grommet is used to hold the take-off tightly with the lateral line during the operation of the irrigation system **(Figure 1.25)**.	 **Figure 1.25: Rubber**
Take-off: A grommet take-off is used to connect lateral with sub-main lines **(Figure 1.26)**.	 **Figure 1.26: Grommet take off**

Teflon tape: Teflon tape is used to prevent the leakages of threaded components **(Figure 1.27)**.	 **Figure 1.27: Teflon tape**
Solvent cement: Solvent cement is synthetic glue used to make water-tight joints for two different PVC components **(Figure 1.28)**.	 **Figure 1.28: Solvent cement**
Male Threaded Adapter: A male threaded adapter is the adapter used to couple with the female threaded component **(Figure 1.29)**.	 **Figure 1.29: Male threaded adapter**
Female Threaded Adapter: A female threaded adapter is the adapter used to couple with the male threaded component **(Figure 1.30)**.	 **Figure 1.30: Female threaded adapter**
Lateral End Cap: The lateral end cap is connected at the end of the lateral for ease in flushing, as well as to maintain the pressure in the lateral pipes **(Figure 1.31)**.	 **Figure 1.31: Lateral end cap**
Flush Valve: A flush valve is connected at the end of the main or sub-main lines for flushing. It is made up of PVC plastic material **(Figure 1.32)**.	 **Figure 1.32: Flush valve**
Poly Joiner: A poly joiner is used to connect or join the polytube or laterals. It is made up of polypropylene (PP) plastic **(Figure 1.33)**.	 **Figure 1.33: Poly joiner**

Poly Elbow: A poly elbow is used to connect polytube or laterals when it is turned in 90 degrees. It is made up of PP plastic **(Figure 1.34)**.	 **Figure 1.34: Poly elbow**
Poly Tee: A poly tee is used when three poly tubes or laterals are connected. It is made up of PP plastic **(Figure 1.35)**.	 **Figure 1.35: Poly tee**

Joining of Pipes and Pipe Fittings

The general instruction that needs to be followed for the joining of pipes and pipe fittings are as follows **(Figure 1.36)**:

- Remove burr, if any, from the edges of the PVC pipe before applying solvent cement.
- Before applying solvent cement on PVC pipes, the outer surface of the pipe and the inner surface of the fittings should be cleaned with sandpaper.
- Apply a thin layer of solvent cement on the surfaces of the pipe and fittings. Rotate for even spreading of the solvent cement and join immediately. Hold it tightly for a few seconds.
- The insert end of the pipe must be pushed into the socket to the depth of the entering mark.

Figure 1.36: Joining pipe and pipe fittings

- Do not apply solvent cement on the threaded part (male/female) of PVC fittings or valves. Also do not apply solvent cement externally on PVC joints.

- As far as possible make use of PVC bends instead of elbows on sharp curves.
- Control valves should be installed at least one feet above the ground level and should be straight in position, both vertically and horizontally.
- For PVC or PP fittings, make use of Teflon tape to avoid leakage of water through threaded ends. Avoid over-tightening of fittings.
- Give proper support or fill in the trenches immediately after joining the PVC pipes or fittings on curves and installation of valves.
- Backfilling of trenches should be done only after testing is over and all backfilling material should be free of stones and hard material that can damage the pipes.

Laying of Lateral Pipes

(i) Lateral placement or carrying is done according to row distance with sufficient shrinking allowance. An extra length of pipe is provided at the end. The lateral is fixed to one end of the take-off.

(ii) To connect the laterals (poly-tube) to the sub-mains, holes are drilled on the PVC sub-main pipes using the appropriate drill guide and drill. Holes are drilled at a distance equal to the row spacing of the crop. The size of the hole depends on the size of the lateral and the grommet take-off (GTO). For 8 mm ID GTO, a drill of 11.9 mm diameter is used and for 13 mm ID GTO, 16.5 mm drill is used.

(iii) Grommets are fixed in the holes and take-offs are inserted and fixed on the grommets. Laterals are then connected to the take-offs.

(iv) A sufficient extra length of lateral (about 60 – 90 cm) is provided at the end of the last tree/plant to account for the snaking effect and shrinking allowance.

(v) On the laterals so laid, holes are punched with the help of drip punch as per the designed spacing and online, drippers are fixed in these holes.

(vi) The efficiency of the drip irrigation system depends largely on the proper placement of the drippers. The drippers should be placed upwards to prevent contact with soil. Dripper placement and spacing depend on the type of soil, the age of the crop, and the extent of the root zone.

(vii) Always run the drip irrigation system with proper pressure (0.8 – 1.5 kg/cm^2) to get maximum life or benefit of it.

Fixing of Drippers or Emitters

The following procedure may be followed for punching of laterals and fixing of drippers or emitters:

Figure 1.37: Making hole in lateral

1. Punching of lateral pipes should start from the sub-main **(Figure 1.37)**. Fill the laterals with water before fixing the drippers. Flow the water through lateral pipeline, and get it flushed, so that the lateral pipe can get bulge and make the punching easy. Locate the points of drippers on laterals as per design requirements **(Figure 1.38)**. The dripper position is fixed as per the spacing requirement. Mark a few drippers with arrows. The arrowhead should be towards the sub-main.
2. For fixing the drippers, push it inside the hole made in the lateral and pull it slightly **(Figure 1.39)**. Do not fix drippers on lateral until complete lateral is punched. Close the end of lateral using end cap.

Figure 1.38: Fixing of dripper

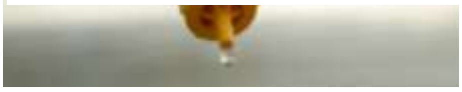


Figure 1.39: Dripper fitted on lateral

Laying of Drip Tape : Drip tapes are thin-walled integral drip lines with emission points spaced 10, 20, 30, 45 cm or any other distance apart, delivering lower quantities of water than the usual drippers at very low pressures, i.e., 0.4-1.0 litres/hour at 0.6-1.0 kg/cm² (0.6-1.0 bar). Drip tapes are made of LDPE or other soft PE materials in various diameters from 12 to 20 mm and in several wall thicknesses (0.10- 1.25 mm). A filtration system is incorporated inside the tubing, therefore, they are less susceptible to mechanical and biological blockages than conventional drippers. Laying of the drip tape is either done on the surface or buried beneath the soil. The drip tape is usually buried between 15 to 25 cm (6 and 10-inches) below soil depth; in a few root crops, the tape can be buried at a little deeper depth. However, the depth of tape in the soil depends on the crop, soil type, crop rooting pattern, soil wetting pattern, and tillage practices used in the field. For example, in loamy soil the water moves downward and laterally from the tape better than in sandy soil, therefore tape should be buried at shallow depths in sandy soils rather than the loam soils.

The step-by-step procedure followed for laying drip tape is as follows:

(i) The drip tape should be placed close to the plant. In general, the drip tapes are placed between 15 to 25 cm (6 and 12-inches) below the soil surface. A little more distance is used in the soils which have good lateral movement or when other means of irrigation are used to germinate the seed or to establish the seedlings.

(ii) The tape should be placed in such a way that the emitters are pointed upward. This causes the settlement of soil, silt, and clay particles away from the emitters.

(iii) The drip tape can be laid on the soil surface, especially if it is used in conjunction with black plastic mulch.

Advantages of this arrangement are that it is easy to install and repair them, but there is the possibility of greater evaporation loss in the early crop growth stage, and the tape is likely to get damaged by the wind and animals.

Check after Installation

- After installation, walk through the system and check that all the connections has been done properly and the installation is carried out as per the set guidelines.
- The system should be tested before the final backfilling of trenches. Ensure that there are no leaks at the joints in the pipeline and the start nipple.
- In the case of the sand filter as a primary filter, back flush the same. Maintain adequate sand level.
- Test all irrigation blocks and flush sub-main lines with adequate pressure. Check for leakages. If exists, rectify it immediately.
- Check for the pressure at the lateral end. Always maintain a minimum of 1 kg/cm^2 pressure at the lateral end for proper discharge through emitters and minimize clogging chances.
- Check for the discharge through emitters randomly. Compare it with emitter specifications.
- Check pressure at various points in the system.
- Also, check for pressure loss during filtration. Pressure relief valves should be adjusted to set pressure in the system.
- If adequate pressure is not achieved in the system, check for pump set performance.
- Flush out laterals one by one or in a group of 10-12 laterals at a time. This will help with flushing of laterals/drip lines under adequate pressure to remove all impurities in lines.

Activities

Activity 1: Identify and name the connectors and accessories of drip irrigation in the following table:

S. No.	Picture	Name of the accessories
1.		
2.		

3.		
4.		
5.		
6.		
7.		

8.		
9.		

Check Your Progress

A. Fill in the Blanks

1. Water distribution pipes network consisting of main, sub-main and ___________________.
2. Rigid Poly Vinyl Chloride (PVC) and High-Density Polyethylene (HDPE) pipes are normally used as main pipe to ___________________ corrosion and clogging.
3. Diameter of main and sub-main pipes depends on the ___________ requirement of crop and size of the fields.
4. Both main and sub-main lines are provided with flush valve at the outlets to occasionally flush the pipes to remove _______________ from the pipes.

B. Multiple Choice Questions

1. Lateral pipe diameter generally ranges between_____________.
   (a) 10-20 mm
   (b) 25-30 mm
   (c) 35-40 mm
   (d) 45-50 mm
2. ________ is used to change the direction of main and sub main pipes.
   (a) Reducer
   (b) Socket
   (c) Takeoff
   (d) Elbow
3. Rubber grommet is used to hold the__________.
   (a) Lateral line
   (b) Socket
   (c) Take off

(d) Reducer

C. Subjective Questions

1. Explain the process involved in the installation of lateral pipes.
2. Describe the different components of a water distribution network in a microirrigation system.
3. Describe the method of maintenance of pipes and fittings.
4. What is the purpose of a mainline in the pipe network?
5. Why is it important to maintain uniform slope during pipe installation?
6. What materials are commonly used for microirrigation pipes?
7. What is the function of a sub-mainline in the pipe network?
8. What type of fittings are used in pipe network installation?

Session 4: Emission Devices and Fertigation System

A drip irrigation system consists of emission devices serviced by a water distribution network. Drip irrigation emission devices include point source emitters, multiple outlet emitters, pressure compensating drippers, micro-sprays, bubblers, and misters. Emission devices vary according to their flow rate, hydraulic characteristics, and wetting pattern. The dripper or emitter is the most important device or system element, which makes drip irrigation dissipate pressure and discharge water at a low constant rate at different points along the lateral. Drippers function as energy dissipaters, reducing the inlet pressure head (0.5 to 1.5 atmospheres) to zero atmospheres at the outlet. These drippers are usually manufactured from polypropylene or LLDPE material. Drip irrigation emission devices are typically installed on the surface and sometimes in the sub-surface (below the soil surface) such that placement and convenience are flexible for management. An ideal emission device is durable, resists clogging, insensitive to pressure variation that occurs as a result of slope and/or lengths of the run, and is economically affordable.

Emission devices used should have the following characteristics:

(i) Compact, serviceable and inexpensive.
(ii) Relatively low discharge.
(iii) Discharge does not vary with pressure.
(iv) Covers a relatively large cross-section area.

Classification of Emission Devices

The emission devices can be classified as follows:

(i) Location of the emitters

a) Online Emitters: This type of emitter or dripper is used in widely spaced crops, such as fruit crops (e.g. mango, guava, and pomegranate,) **(Figure 1.40 and 1.41)**.

These emitters are fixed on the plain lateral pipe as per the crop spacing and water requirement of the crop.

Figure 1.41: Online Dripper Components

b) **Inline Emitters:** Inline emitters are inserted in the lateral pipes at pre-decided or desired spacing during manufacturing **(Figure 1.42)**. This type of emitter is used in closely spaced crops, such as vegetables, maize, fodder and close-growing row crops, e.g. onion, cabbage, cotton, banana, leafy vegetables, etc.

Polypropylene Cylindrical Inline

Figure 1.42: Inline Drippers

(ii) Wetting patterns made by emitters

Based on the wetting pattern, the emitters are classified into the following types:

a) **Point source**: These emitters discharge water from individual or multiple outlets. It is commonly used in the large canopy or widely spaced fruit and plantation crops (e.g. mango, litchi, coconut, and coffee).

b) **Line source:** These are used primarily on small canopy fruits (e.g., Strawberries, Melons, and Vegetables (Tomato, and Capsicum) or other closely spaced crops (e.g. Groundnut, Chickpea, etc.).

c) **Disc source**: These include micro-sprinklers, micro-sprayers, and bubblers which can be used for close-growing and under-irrigation of tree and fruit plants grown in irrigated areas (e.g. wheat, green pea, grass lawns).

(iii) Pressure regulation by emitters

The emitters (both in-line and on-line) can be classified as pressure compensating and non-pressure compensating drippers.

a) **Pressure compensating drippers:** A pressure compensating type dripper supplies water uniformly all along the rows and on uneven slopes **(Figure 1.43)**. These are manufactured with high-quality flexible rubber or silicone diaphragm or disc inside the emitter that changes its shape according to the operating pressure and delivers uniform discharge. These are suitable on sloppy lands and undulating topographic terrains.

Figure 1.43: Pressure compensating dripper

b) **Non-pressure compensating drippers:** In such types of drippers, discharge tends to vary with the varying operating pressures **(Figure 1.44)**. These could be simple thread type, labyrinth type, zigzag path, vortex flow path type, or have float type arrangement to dissipate energy. These are suitable for levelled fields and smaller farms. These are relatively cheaper than pressure compensating types.

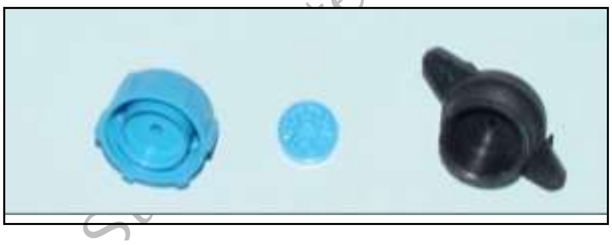


Figure 1.44: Non-pressure compensating drippers

Microtubes: Microtubes are small diameter (3-5 mm) tubes made up of Linear Low-Density Polyethylene or Low-Density Polyethylene material **(Figure 1.45)**. These are used as emission devices or as an extension tube to fit the dripper on it.

Figure 1.45: Microtube

Drip tapes: Drip tapes are thin-walled integral drip lines with emission points spaced 10, 20, 30, or 45 cm, delivering lower quantities of water than the usual drippers at very low pressures, i.e. 4-10 litre/hour at 0.6-1.0 kg/cm^2 **(Figure 1.46)**. They are integrated drip lines where the drippers are built in the pipe walls at the desired spacing during the manufacturing process. They are ready-made dripper laterals, with very high uniformity of application. Drip tapes are made of LLDPE or other soft PE materials in various diameters from 12 to 20 mm and in several wall thicknesses (0.10-1.25 mm).

Drip tape is used on a wide variety of row crops (*e.g.* Strawberries, Peppers, Tomatoes, Watermelons, etc.) Drip tape is also used on sub-surface systems for cotton, sugarcane, and other similar crops. It is generally recommended to bury the drip tape under the soil with the emitters facing up. This aids in keeping the tape in place due to expansion or contraction, and helps prevent the tape from plugging due to settling particles in water. These tapes seem to be able to use less pressure so that they can irrigate more area (more lines/rows) at one time and are much cheaper than drip lateral pipes.

Figure 1.46: Drip tape

Porous pipes: The porous pipes release water into the ground along the entire length. The risk of clogging is minimal in porous pipes **(Figure 1.47)**. The pressure drop along its pipe length is significant as compared to the traditional lateral pipe.

Figure 1.47: Porous pipes

Fertigation: Fertigation is a system in which fertilizer or chemicals are applied along with the irrigation water, fertilization + irrigation = fertigation.

Fertigation is a technology for distributing fertilisers to the crops along with water through drip or sprinkler irrigation continually in a controlled manner, to allow for steady uptake of nutrients by plants. Fertigation is an efficient method of fertiliser application that gives higher nutrient use efficiency.

A drip irrigation system provides for the application of water-soluble or liquid fertilisers and other chemicals to be applied along with irrigation water to place them directly in the root zone resulting in a significant savings on the costly fertilisers. An additional component is required to inject liquid fertilisers or chemicals which is called a fertiliser injecting device. Application of fertiliser and other chemicals into a pressurized irrigation system is done by either a by-pass pressure tank or by Venturi injector or direct injection system (piston pump). Different types of commonly used fertiliser injecting devices are fertiliser tank, venturi injector, and piston pump. These units are installed just before the secondary filters.

Types of fertigation units

1. Bypass System

This method of fertigation employs a tank into which the fertiliser solution is filled. These tanks are generally made of mild steel and are available in different capacities. The tank is connected to the main irrigation line using a by-pass pipeline. Some amount of the irrigation water is diverted from the main irrigation line and flows through the tank **(Figure 1.48).**

Function: Water entering the tank dilutes the fertiliser solution. This bypass flow is brought about by a pressure gradient between the entrance and exit of the tank or created by a permanent constriction in the line or by a control valve.

Figure 1.48: Fertiliser tank assembly

Due to its robust design and to sustain high pressure, the cost of fertiliser tank is relatively higher than the venturi injectors. Due to the metallic constitution of the fertiliser tank, corrosion due to reactive chemicals and fertilisers is significant.

2. Venturi Injector

Venturi injector, also known as venturi pumps, are made of LDPE or PP plastic material. The venturi injector consists of a converging section, throat and diverging section. A venturi creates a constriction within a pipe that varies the flow characteristics of a fluid travelling through the tube. As the fluid velocity in the throat is increased there is a consequential drop in pressure. To start the venturi system, the desired pressure difference between the entrance and exit gauges is created by using pressure regulating valves which enable the flow of fertiliser into the drip system. The rate of flow is regulated using the valves. It is installed in parallel to the main pipeline.

Function: A venturi pump works on Bernoulli's principle, which states that an increase in a liquid's speed creates a pressure decrease and a decrease in a liquid speed creates a pressure increase **(Figure 1.49).** When the flowing water passes through the constricted throat section, its velocity increases and the pressure reduces, creating a suction effect. Due to suction, liquid fertiliser enters into the drip system through a tube from the fertiliser tank. The flowrate is regulated using the valves. The venturi system works because of differential pressure in the system (usually 20 %) from one side of the device to the other.

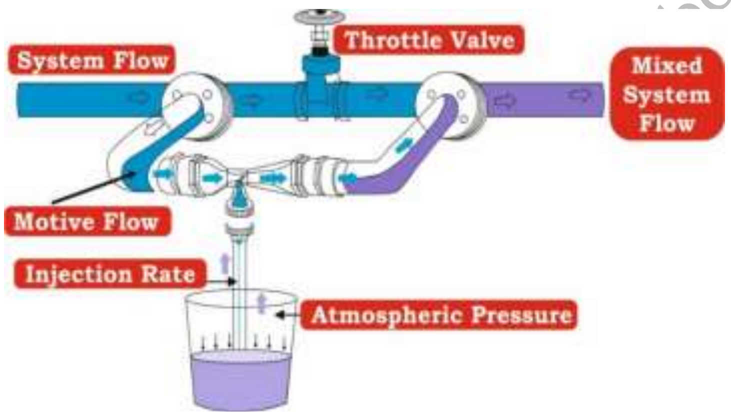


Figure 1.49: Schematic diagram of venturi injector

Venturi injectors are popular in India mainly due to their simple design and cheaper cost. The flow of fertilisers is visible and thus its duration and volume can easily be controlled in Venturi.

3. Fertiliser Injection Pump

Fertiliser injection pumps differ in their operation based on the energy source. Some are electrically powered, but this limits their use where electricity is available **(Figure 1.50)**.

Water-powered pumps are installed in-line and derive their operation energy from the pressure of the water in a drip system. The pumping rate and the concentration of the stock solution can be adjusted to attain the desired level of fertiliser application.

Function: The fertiliser pump draws the fertiliser solution from a fertiliser tank and injects it under pressure into the irrigation system. With this fertigation system, fertilisers may be supplied to the irrigation water at a more or less constant rate.

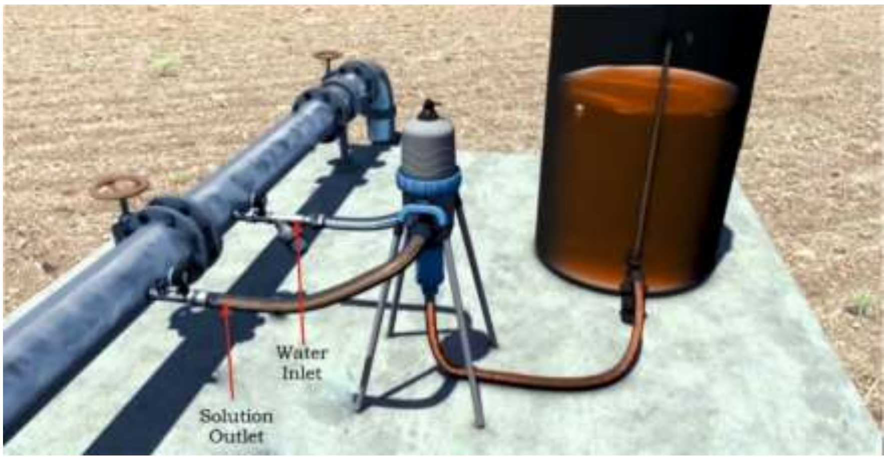


Figure 1.50: Fertiliser injection pump

Activities

Activity 1: Visit a farmland and study the various types of drippers or emitters in the drip irrigation system.

Activity 2: Identification of drippers used in drip irrigation system.

Identify and name the drippers in the following table:

S. No	Picture	Name of the dripper
1		
2		
3		

4		
5		

Check Your Progress

A. Fill in the Blanks

1. Drippers function as energy dissipaters, reducing the inlet pressure head to zero atmospheres at the ____________.
2. The ____________ devices can be classified on the basis of location, wetting patterns and pressure regulation
3. Point source emitter discharges water from ____________ or multiple outlets.
4. A pressure compensating type dripper supplies water ____________ all along row and on uneven slope.
5. ____________injector consists of converging section, throat and diverging section.

B. Multiple Choice Questions

1. Online emitters are installed on _______.
   (a) Main
   (b) Sub-main
   (c) Lateral
   (d) None of these

2. Which of the following material is generally used for dripper manufacturing?
   (a) PVC
   (b) PP
   (c) HDPE
   (d) Clay

3. Size of internal diameter of micro tube is __________ .
   (a) 5-7 mm
   (b) 10-12mm
   (c) 12-16 mm
   (d) 18-20 mm

4. Which among the following is not a fertiliser application system
   (a) Venturi Injector
   (b) Injection pump
   (c) Lateral
   (d) Fertigation tank

5. Venturi Injector does not have
   (a) Throat
   (b) Non-Return Valve
   (c) Diverging section
   (d) Converging section

6. Bypass valve in the drip fertigation system is used to regulate
   (a) Pressure
   (b) Temperature
   (c) Density
   (d) Viscosity

C. Subjective Questions

1. What is a micro-sprinkler, and where is it used?
2. How do bubblers differ from drippers?
3. What is a fertigation system in microirrigation?
4. Where is the fertigation injector installed in the system?
5. What are the benefits of fertigation?
6. What safety measure is required when using a fertigation system?

Module 2	Maintenance of Drip Irrigation System

Module Overview

This module provides a comprehensive overview of the maintenance of drip irrigation systems, essential for effective water management in agriculture. In Session 1 on operation of drip irrigation system, you will learn the fundamental principles of how drip irrigation delivers water directly to the plant root zone, covering the key components involved, such as mainlines, emitters, and filters. Session 2 on monitoring drip irrigation system focuses on the techniques and tools necessary to regularly assess the system's performance, ensuring proper flow rates, pressure levels, and emitter functionality to prevent issues like clogging and uneven distribution. In Session 3, on maintenance of head unit, you will explore essential maintenance tasks for the head unit, including the pump, filters, and valves, emphasizing routine inspections and cleaning procedures to maintain optimal operation. In Session 4 on maintenance of pipe distribution network and emission devices addresses the upkeep of the distribution network and devices like drippers and micro-sprayers, highlighting best practices for inspecting and repairing leaks and ensuring effective water application. This module will equip you with the practical knowledge and skills needed to maintain drip irrigation systems, promoting efficient water use and enhancing crop productivity.

Learning Outcomes

After completing this unit, you will be able to:

- Describe the factors that influence the operation and functioning of a drip irrigation system.
- Identify the pressure and discharge at which individual components of a microirrigation system operate.
- Explain the procedure of flushing for the maintenance of a drip irrigation system.
- Describe the procedure of acid treatment and maintenance during/after chemical treatment of a drip irrigation system.

Module Structure

Session 1: Operation of Drip Irrigation System

Session 2: Monitoring of Drip Irrigation System

Session 3: Maintenance of Head Unit

Session 4: Maintenance of Pipe Distribution Network and Emission Devices

Session 1: Operation of Drip Irrigation System

The efficient and effective operation of a microirrigation system depends mainly on the ability of the farmer to make the best use of it. The farmers should have a sketch of the irrigated area showing the locations of all the system's parts in the field. Starting and shutting down the pressurized irrigation installation needs to be done very carefully to prevent surges and water hammering and to avoid air pockets in the pipelines. **Figure 2.1** shows a drip irrigation system.

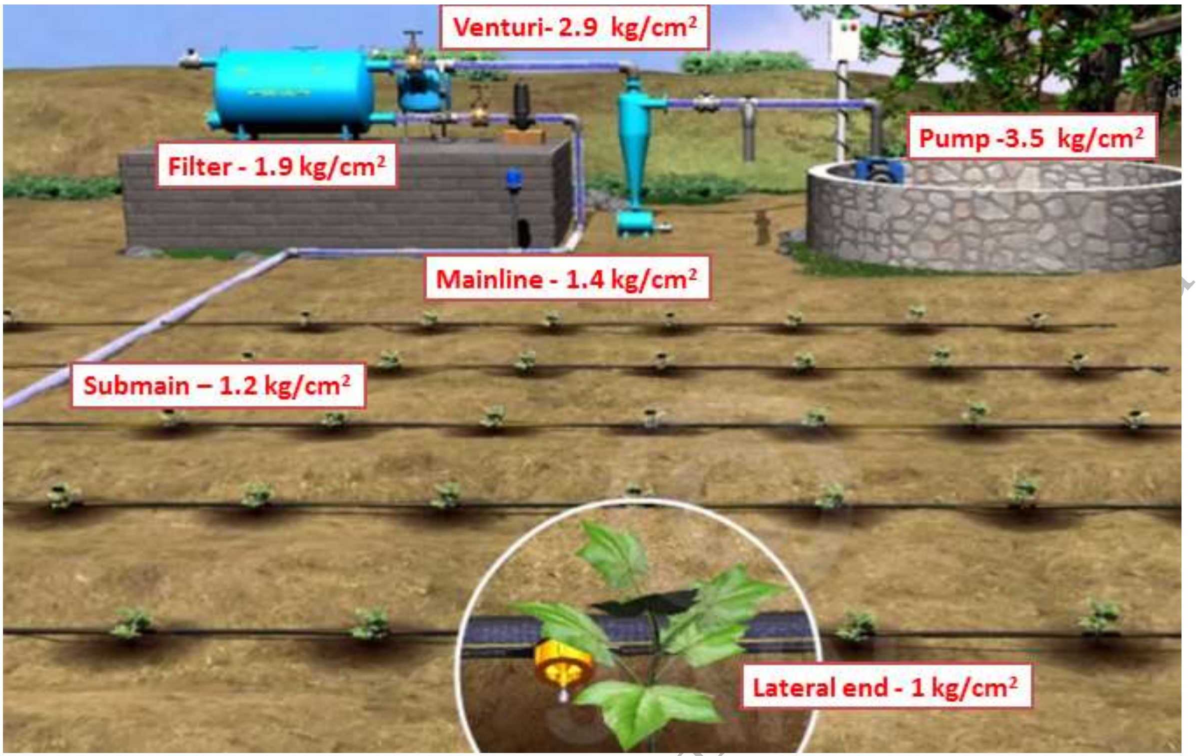


Figure 2.1: Drip irrigation system
(Note: The pressure ratings shown in the figure are only indicative)

The drip irrigation system consists of the following components:

1. Pump
2. Bye-pass valve
3. Filters
4. Fertigation unit
5. Main and sub-main valves
6. Laterals and emitters

Pump Unit: The pump unit takes water from the water source and supplies it to the mainline. Water should be delivered to the mainline at the right pressure. While operating a pump, the operator should confirm whether the pump is delivering proper discharge and developing the necessary pressure. For this, the operator has to measure the discharge on a volumetric basis and the pressure by observing the pressure value on the pressure gauge installed at the outlet of the delivery side. Pump discharge (flow rate) defines the quantity of water supplied by the pump during a one-time unit (units: m^3/hour, litre/second, or gallons/hour). If the discharge of the pump set is greater than the designed value, the bypass valve mechanism is used to divert the excess water to the water source. One can also adjust the pressure head at the end of the lateral by adjusting the bypass valve. The pressure (pressure head) defines the internal energy of a fluid due to the pressure exerted on its container's walls (also known as static pressure head or static head) (units: bar or psi. 1 bar = 14.5 psi). The output pressure of a pump is dependent on the pressure head and flow rate. A higher flow rate causes a lower pressure and vice versa, provided that all other variables remain unchanged. The pump operator should strictly follow the manufacturer's detailed instructions for starting and operating each pumping unit. The pump operator has to make sure that the pump can deliver an adequate flow rate and pressure for irrigation. Some control heads also contain a fertiliser tank or fertigation unit, and valves control the discharge and pressure of water in the system.

Bypass valves: These are specialized valves used in Microirrigation setups, to allow water to flow around a specific section of the system. They provide a way to divert flow from the main line to another route, ensuring that water can continue to move even if part of the system is shut off for maintenance or repair. Where else, isolation valves are used to shut off water supply for maintenance and repair and also during off-seasons. These are generally manually operated. Control valves on the other hand, are used to irrigate individual areas that are separate from each other. There can be automatic or manual backflow preventers that prevents the water from being siphoned back. The opening and closing of the valves at the head of the system, the main and submain pipelines, should always be done slowly.

Filters: These are designed to operate at a clear pressure drop, which may vary from 0.2 kg/cm^2 to 0.5 kg/cm^2, but when the pressure difference between the inlet and outlet of filter exceeds 0.5 kg/cm^2, it is an indication that the filter needs to be flushed or cleaned. With the system in operation, pressure measurements are taken at various points on the piping network, preferably at the beginning and at the end of the main and submain pipelines. The pressures of the first and last emitters in each lateral line should be measured. All pressures should be within the designed range. During operation, check for the minimum difference in pressure between the inlet and the outlet of the main filter.

Fertigation Unit: The different fertigation units explained in the previous sections are operated based on the differential pressure created by the throttling process. For example, when a venturi injector is used for fertigation, a minimum pressure difference of 0.5–0.7 kg/cm^2 is to be maintained to inject fertiliser solution into the pipe line. When fertiliser tank is used for fertigation, a minimum pressure difference of 0.2–0.3 kg/cm^2 is to be maintained for injecting the fertiliser solution into the pipe line. When fertiliser injection pump injector is used for fertigation, a minimum pressure difference of 0.3-0.5 kg/cm^2 is to be maintained for injecting the fertiliser solution into the pipe line.

Mainline and Submain: The water carrying pressure in main and submain pipe lines is to be maintained between 2.4-1.4 kg/cm^2, for this, the operator has to manage the valves provided on these lines so that the laterals get proper discharge at the rated pressure. However, the pressure to be maintained across, the main line as well as submain line depends upon the design, layout, and size of the farm.

Laterals and Emitters: In general, the drip laterals are to be operated at a pressure of around 1.0 kg/cm^2 at the end of the lateral for uniformity of application by emitters. In this case, the pressure loss should be within 20 percent and the discharge variation

should be within 10 percent in regular operation. The discharge of randomly selected twenty-five emitters was measured using catch cans for a known time period covering all the portions of the field, and the average of this discharge rate should be within 10 percent of the rated discharge. The above rated pressure values will differ depending on the location of the water source, topography, filtration rate, length of pipes, etc. Emitters are critical components in Microirrigation systems designed to deliver water directly to the plants' root zones. They regulate the flow of water, ensuring that it is applied efficiently and uniformly.

Activities

Activity 1: Visit a farmland to discuss the operation of drip irrigation system and try to understand the challenges farmers face during the operation of drip irrigation system.

Activity 2: List the different components of a drip irrigation system.

Check Your Progress

A. Fill in the Blanks

1. The operator has to measure the discharge on volumetric basis and pressure by observing the ______________ value on the pressure gauge installed on the outlet of pump delivery.
2. If the discharge of the pump set is greater than the designed value, the ______________ valve mechanism is used to divert the excess water to the water source.
3. When the pressure difference between the _____________ and outlet of the filter exceeds 0.5 kg/cm^2, it is an indication that the filter needs to be flushed or cleaned.
4. When fertiliser tank is used for fertigation, a minimum pressure difference of 0.2- ______ kg/cm^2 is to be maintained for injecting the fertiliser solution into the pipe line.
5. When fertiliser injection pump injector is used for fertigation, a minimum pressure difference of 0.3 - _____ kg/cm^2 is to be maintained for injecting the fertiliser solution into the pipe line.

B. Multiple Choice Questions

1. Filters are designed to operate at clear pressure drop which may vary between______________
   a) 0.2kg/cm^2 to 0.5 kg/cm^2

b) $0.3 kg/cm^2$ to $0.5 kg/cm^2$
c) $0.4 kg/cm^2$ to $0.5 kg/cm^2$
d) $0.1 kg/cm^2$ to $0.5 kg/cm^2$

2. When venturi injector is used for fertigation, a minimum pressure difference of ___________kg/cm2 is to be maintained for injecting the fertiliser solution into the pipe line.
a) $0.5 kg/cm^2$ to $0.7 kg/cm^2$
b) $0.7 kg/cm^2$ to $0.5 kg/cm^2$
c) $0.5 kg/cm^2$ to $0.8 kg/cm^2$
d) $0.6 kg/cm^2$ to $0.5 kg/cm^2$

C. Subjective Questions

1. Explain the importance of bypass valve mechanism in drip irrigation system.
2. How does drip irrigation work?
3. What is the main advantage of drip irrigation?
4. How do you prevent clogging in a drip irrigation system?
5. What is the importance of pressure regulation in drip irrigation?
6. What maintenance is required for drip irrigation?

Session 2: Monitoring of Drip Irrigation System

In this session, you will learn about the monitoring of a drip irrigation system. A checklist for timely inspection of the various components and their working should be prepared. The checklist may include flow, pressure, and condition of flush water, the overall condition of the pump station and distribution system that should be routinely inspected and/or calibrated, including control equipment, engines, motors, reservoirs, injectors, pipelines, valves, fittings, flow meters, and pressure gauges. Broken or non-functional equipment is to be replaced or repaired immediately with the same or similar equipment that could perform the same function according to the system design criteria.

After the irrigation system pressure gets stable for some time, the following few parameters should be monitored regularly to ensure the system's functioning.

Differences in System Pressure and Flow

Once the drip irrigation system stabilizes, the discharge and pressure should be monitored and compared with the previous readings recorded. This makes sure that the system is operating as designed. It may be noted that flow and pressure are related in microirrigation systems, therefore, a difference in the observed and benchmark readings would indicate the following:

- Incorrect setting of control equipment or its failure.
- Clogging of the filters or emission devices due to inorganic or organic impurities and mineral precipitants.

- Leaks from pipe breaks, loose fittings, rodent or insect damage.

Water Quality

Water contains dissolved substances, which include ions of dissolved salts such as chloride, sodium, and nutrient elements (e.g., nitrogen, phosphorous, potassium, etc.). Calcium and magnesium influence the hardness of the water, iron and manganese are liable to be found either dissolved or as residues, along with other dissolved organic compounds. Water from the source must be tested regularly for its quality, mainly during seasonal changes, annual changes, and/or whenever the water source changes. Water quality parameters may be as per the 'Normal Level' mentioned (Clause 4.3 of IS 14791).

The water testing should be done to determine its electrical conductivity, pH, calcium, magnesium, sodium, potassium, bicarbonates, carbonates, chloride, sulphate, phosphate, nitrogen-ammonium, nitrogen-nitrate, boron, iron, manganese, total soluble solids, total dissolved solids, etc.

Flush Water Quality

Flush water quality refers to the specific characteristics of the water used during the flushing process in irrigation systems. This process is essential for maintaining system efficiency, as it removes debris, sediment, and potential contaminants that can clog emitters and reduce water flow. The quality of flush water is crucial; if it is contaminated or contains high levels of sediments, it can exacerbate existing issues within the irrigation system rather than resolve them. Ideal flush water should be clear and free from pollutants, ensuring that the flushing process effectively cleans the system without introducing new contaminants. Monitoring and maintaining high flush water quality is vital for the longevity and optimal performance of irrigation systems, ultimately supporting healthy plant growth and maximizing agricultural productivity.

Mechanical Damage

Drip main, submain, and lateral pipes, etc. may be damaged for several reasons, including installation of equipment, tillage equipment, insects, birds, rodents, excessive pressure, or the lens effect of sunlight when magnified through the water beneath clear plastic mulch. Routine inspections may be made for the evidence of mechanical damage, indicated by puddles of water, squirting, loss of pressure, or crop loss. If such damage occurs, pests must be controlled or managed or equipment adjustments should be made to avoid future problems. The following measures may be followed for proper monitoring of the drip irrigation systems.

1) After starting the pump, the pressure should be stabilized after a short time. If pressure is inadequate adjust it by throttle or by-pass valve. It should be as per

the design. If not being controlled, check for leaks and adjust the pressure at the submain.

2) Inspect the drip and ensure that water is reaching the nooks and corners of the plot or field. If at some point water is not dripping correctly, find the cause and correct it.
3) A twist, fold, cut, puncher, etc. in a lateral may cause discharge variation that should be corrected immediately.
4) Detect the clogging, scaling, precipitation, and mechanical damage due to intercultural equipment, animals, or rodents. If found, take corrective measures immediately.
5) Flush each submain at the end of every section till clean water starts flowing.
6) Flush the laterals by opening the end plugs of about a quarter (i.e., 25%) of the total number of laterals installed in a group so that the pressure drop does not go beyond permissible limits. Close them in the same sequence, allowing flushing for a few minutes until clean water starts flowing.
7) Check the inlet and outlet filter pressures. Remove debris from hydro-cyclone, back flush sand filter, and flush screen or disc filters at the end of the day's operation.

Activities

Activity 1: Visit a farmland, where a drip irrigation system is installed, understand the differences between System Pressure and Flow, and also write your understanding about water quality and mechanical damage.

Check Your Progress

A. Fill the Blanks

1. The overall condition of the ___________ station and distribution system should be routinely inspected and/or calibrated.
2. Differences in ___________ and flow should be compared with previous readings recorded.
3. Leaks from ___________ breaks, loose fittings, rodent or insect damage are common causes of malfunction in drip irrigation systems.
4. Water contains dissolved substances, including ions of dissolved ___________ such as chloride, sodium, and nutrient elements.
5. Water testing should determine its ___________ conductivity, pH, calcium, magnesium, sodium, potassium, bicarbonates, and other elements.

B. Subjective Questions

1. Why water quality needs to be tested in drip irrigation system?

2. Why is monitoring important in a drip irrigation system?
3. What are common indicators of problems in a drip irrigation system?
4. How can you check for clogs in a drip irrigation system?
5. How do soil moisture sensors assist in monitoring drip irrigation?
6. What should be inspected during routine monitoring of a drip system?
7. What are signs of leaks in a drip irrigation system?

Session 3: Maintenance of Head Unit

Maintaining a drip irrigation system is crucial for ensuring its efficiency, longevity, and optimal performance. The first step in effective maintenance is regular inspection. This involves visually checking the entire system for signs of leaks, damage, or wear, particularly looking for broken pipes, clogged emitters, and damaged fittings. Testing each emitter to ensure it functions properly and delivers the correct flow rate is also essential.

Another key aspect of maintenance is cleaning the filters. It's advisable to clean filters every few weeks, or more frequently if the water quality is poor. To clean, remove the filter and rinse it with clean water. For a thorough cleaning, soaking it in a mild detergent solution can be effective, followed by a thorough rinse to remove any residue. Flushing the system is equally important; this should be done at the beginning and end of each irrigation season, as well as periodically throughout. Opening the flush valves at the lowest points allows debris to exit, helping maintain system integrity.

Maintenance of a drip irrigation system

Inspecting pressure regulation is vital for optimal performance. Use a pressure gauge to check that the system pressure is within the recommended range. If necessary, make adjustments or replace pressure regulators to ensure the system operates efficiently. Additionally, inspecting emitters for clogs is essential. Periodically removing and checking emitters can help identify blockages; clean or replace any that are not functioning correctly. Measuring the flow rate of each emitter can also ensure it meets specifications.

Beyond these tasks, regular checks of system components are necessary. Inspect all pipes and fittings for leaks or damage, replacing any cracked or broken sections immediately. Ensure that valves are operational and free of leaks to maintain proper flow control. Adjusting the irrigation schedule based on seasonal changes, crop needs, and soil moisture levels is also beneficial, and utilizing moisture sensors can help optimize timing.

Maintenance of the filters

The filtration system is the heart of microirrigation systems. Properly maintained filters can maximize the efficiency of irrigation system by preventing clogging of pipes and emitters or sprinklers. Install the filter on a properly constructed platform. Connect all the assemblies properly. Ensure that all the filter candles inside the sand or media filters are at their place before filling up the sand. If the hydrocyclone is to be connected before the sand filter, install an air release valve at the highest point of the fitting.

Maintenance of hydrocyclone filter

Hydrocyclone filter requires the least maintenance by cleaning the dirt inside the under-flow chamber daily **(Figure 2.2).** Flush the chamber by opening the flush valve or cap or opening the main valve for thorough cleaning. It may be noted that the hydrocyclone filter becomes ineffective once the dirt collection chamber is full. Always run the hydrocyclone filter at nominal operating pressure. Excess pressure on dun-gutted dirt chamber may lead to erosion of walls.

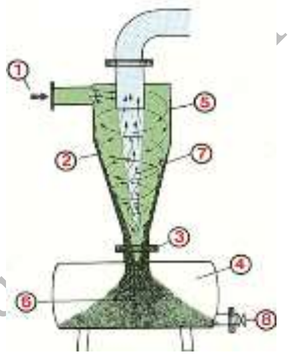


Figure 2.2: Hydrocyclone filter

1. Water inlet, 2. Sloping side, 3. Flange, 4. Dirt collection chamber, 5. Vortex, 6. Dirt/sediments, 7. Filtered water, 8. Flush valve.

Maintenance of media filters

Media filters (gravel or sand) consist of a metal or plastic enclosure incorporating small gravel stones or sand, which traps the dirt. This filter includes a flushing system for washing the gravel or sand. Sand filters are effective for removing heavy organic and inorganic pollutants. Over some time, the contaminants present in water accumulate and clog the pore space of the sand bed reducing the filter efficiency. Daily backwashing of the sand filter is desired.

Backwashing is a process in which the direction of water flow is reversed and the sand bed is lifted and expanded, allowing it to release the collected dirt mainly from the top. The dirt is carried away through the backwashing valve opening. Backwash flow should be adjusted properly, because excessive backwash flow may lead to the removal of sand from the filter, while insufficient backwash flow would not clean the sand properly **(Figure 2.3).**

The steps of the backwash operation are as follows:

Step 1. Open the backwash valve.
Step 2. Close the outlet valve.
Step 3. Open the bypass valve.
Step 4. Close the inlet valve.

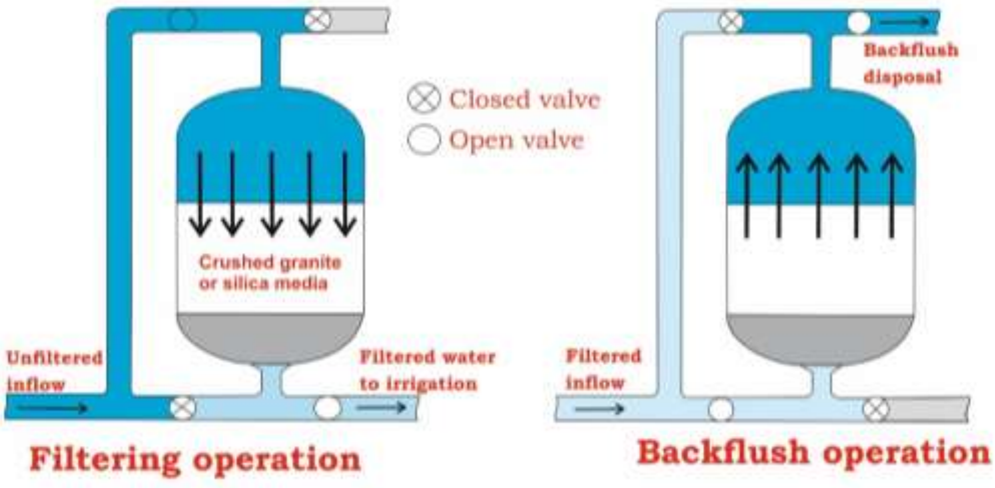


Figure 2.3: Filtering and back flush operations

Steps to resume filtration operation are as follows:

Step 1. Open the inlet valve.
Step 2: Open the outlet valve.
Step 3: Close backwash valve.
Step 4: Close bypass valve.

Few installations come with a semi-automatic and automatic backwash option, where opening and closing of the valve are done at the same time. The sand filter should also be cleaned regularly, as follows:

(i) Open the cap of the sand filter.
(ii) Start the back flush operation.
(iii) Put the hand inside the sand filter and stir the sand thoroughly.
(iv) Allow all the water, along with the dirt, to flow through the main hole of the sand filter.
(v) Close the cap for normal operation.

Maintenance of screen filter

Flushing at a scheduled daily interval is necessary to maintain the screen filter. It is recommended to flush the screen filter when the pressure drops more than 0.5 Kg/cm^2 (5 m at the water head). The pressure difference can be observed by checking inlet and outlet pressure by using a single 3-way control valve at regular intervals.

Flushing of a screen filter is done by simply opening the drain valve (flush outlet), allowing the force of water to flush the dirt out through drain valve. The procedure for cleaning the screen filter is as follows: (i) Open the screen filter lid, and (ii) Remove the screen and clean it in running water by rubbing with a cloth or soft nylon brush. **(Figure 2.4)**

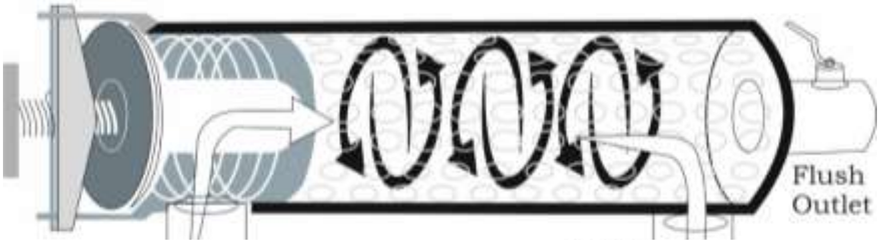


Figure 2.4: Flushing of screen filter

Maintenance of disc filter

Disc filters are designed for use as a primary or secondary filter, especially when water contains high amounts of organic or inorganic matter. These are generally made of nylon-reinforced plastics and are available in 50 to 200-mesh sizes. The grooves made in a sinusoidal or concentric fashion on both sides of the disc enhance the surface area, which is unachievable by any other filter. The disc filter requires less maintenance, as the grooves provide a longer duration between two cleanings and more durability or reliability for an extended life of the filter. Flushing of a disc filter is done by simply opening the drain valve if provided, or else by back flushing. The procedure for cleaning a disc filter is very simple. Open the disc filter lid, remove the disc, and clean it in running water by rubbing it with a cloth or soft nylon brush. Discs are easy to dismantle. The discs can be cleaned at a desired concentration of a cleanser, acid, or chlorine solution using a nylon brush.

Maintenance of pump unit

The pumps have to be maintained for parameters like intake pressure, outlet pressure, flow rate, pump speed (revolutions per minute), pump efficiency, and power requirement. One should also monitor the pump for vibration and noise levels. The performance of these parameters of the pumps should be inspected manually weekly. Routine inspection should include checking of oil level, noise, vibration, bearing temperatures, leaks from the pump housing, leaks from pipe connections, discharge pressure, operating temperature, and shaft alignment should be done quarterly. The following checks and inspections should be done weekly:

- Unusual noise, vibration, leakages, and temperature of bearings and windings.
- Electric connections and voltage are proper.
- Fuel or power consumption.
- Leakages in pipes.
- Capacity and output (water discharge and dynamic head)
- Oil pressure
- Leakages in seal and stuffing box.

Activities

Activity 1: Study the various parts of the filter used in drip irrigation system or a filter used in water filter system

Materials Needed:

1. Drip irrigation system filter (or a model of one)
2. A small tub or bucket of water
3. Brushes or sponges for cleaning
4. Safety gloves

Procedure

Step 1: Disassemble the filter, if possible or otherwise study without disassembling it.
Step 2: Inspect the filter for blockages, debris, or damage.
Step 3: Brush and water and clean the filter parts.
Step 4: Reassemble the filter and check if water flow improves.

Record Your Observations

After cleaning, write the answers to the following questions in your notebook:

1. What type of debris clogged the filter?
2. How often should the filter be checked?
3. What problems could arise from a poorly maintained filter?

Check Your Progress

A. Fill in the Blanks

1. If hydrocyclone is to be connected before the ___________, install air released valve at highest point of the fitting.

2. The hydrocyclone filter becomes ineffective once the ___________ collection chamber is full.
3. Backwashing is a process in which ___________ flow direction is reversed and sand bed is lifted and expanded allowing it to release the collected dirt mainly from top.

B. Multiple Choice Questions

1. What is the process called in which the direction of water flow is reversed, causing the water to flow upwards through the sand bed?
   (a) Backwashing
   (b) Flushing
   (c) Cleaning
   (d) Pumping

2. Disc filters are designed for use as a primary or secondary filter when water contains a high amount of ______________.
   (a) Organic matter
   (b) Inorganic matter
   (c) Both (a), (b)
   (d) None of the above

3. Disc filters are generally made of nylon-reinforced plastics and available in 50 to _________ mesh sizes.
   (a) 200
   (b) 100
   (c) 300
   (d) 400

4. It is recommended to flush screen filter when the pressure drops more than ______ kg/cm^2.
   (a) 0.5
   (b) 0.4
   (c) 0.2
   (d) 0.6

C. Subjective Questions

1. Why is proper maintenance of the filters necessary in drip irrigation system?
2. State the reasons for regular backwashing of the sand filter in drip the irrigation system.
3. How often should filters in the Head Unit be cleaned?
4. How do you prevent clogging in the fertigation injector?
5. What should be done if the Head Unit malfunctions?

Session 4: Maintenance of Pipe Distribution Network and Emission Devices

A drip irrigation system requires more careful attention and proper maintenance compared to other irrigation systems. Properly designed, installed, operated, and maintained drip irrigation systems may last pretty long. However, drip irrigation systems are vulnerable to over-pressurization and clogging, both of which can drastically reduce the system's life and performance.

The best way to determine whether the maintenance program has been working is by constantly monitoring and recording the irrigation system flow rates and pressures at various locations and comparing it with previously recorded data after installation. Drip maintenance could be preventive as well as corrective type. In preventive maintenance, a procedure or group of procedures are adopted to prevent obstructions from plugging, clogging, or blocking the drippers, provided these procedures have been conducted accurately. While in the corrective maintenance, the removal of obstructions that have caused the dysfunction in the system was the major action.

System Flushing

System flushing is a procedure of opening flush valves on the mainline, submains, or laterals while under pressure. Flushing increases the water velocity inside the pipeline or dripper line which scours and removes contaminants off the walls or from individual emitter. The pressure of the regulating valve is increased to achieve enhanced velocities, nevertheless, care is required not to exceed the burst pressure of the emitter (lateral) line and take-off adapters. Recommended flushing velocities are as follows:

- **Mainline:** 1.0 meter per second
- **Submain:** 1.0 meter per second
- **Laterals:** 0.5 meter per second

System flushing should be done at regular intervals. The frequency of the flushing depends mainly on water quality, loading, and the weather. **Table 2.1** indicates a starting point for the maintenance of flushing. However, the increase or decrease in flushing intervals mainly depends on the individual site conditions.

Table 2.1: Flushing interval based on water quality

Quality	Water source	Flushing interval
Good	• Municipal water supply. • Bore well water with no presence of iron or magnesium.	6 Months
Average	• Rivers, Dams, or Lagoons especially those that are slow-flowing. • Possibility of sedimentation.	4 Months

	• Effluent water after Class A treatment.	
Poor	• Bore water which is drawn from a poor-quality aquifer. • Rivers, Creeks, or Canals found in hot climates with increased biological growth and no chemical treatment. • Dams or Lagoons in a hot climate. Poor placement of the pumping point in the direction of the wind with little or no sedimentation or a soluble content that enables the development of a high organic load. • Effluent water after effective sedimentation with little or no biological treatment.	Monthly
Very Poor	• Bore well water which has a high load of iron or magnesium. • Rivers, Creeks or Canals affected by flood flows and having a shortage of sedimentation facilities. • Dams or Lagoons, where the water source has been mixed with effluent or flood waters and the pumping point is poorly placed. • Effluent water without sedimentation due to water flow and added oxygen.	Fortnightly

Daily Maintenance

1. After starting the pump, the pressure should be stabilized after a short time. If pressure is inadequate, adjust it by throttle or by-pass valve. It should be as per the design. If not being controlled, check for leaks and adjust the pressure at the submain.
2. Inspect the dripping and ensure that water is reaching the nooks and corners of the plot/field if at some portion water is not dripping correctly find the cause and correct it.
3. A twist, fold, or lateral may cause discharge variation. It should be corrected immediately.
4. Search and detect the clogging, scaling, precipitation, and mechanical damage due to intercultural equipment, animals, or rodents, if found take corrective measures immediately.

5. Flush the laterals by opening the end cap of the first 3-5 laterals so that the pressure drop does not go beyond permissible limits, then close them in the same sequence allowing flushing for a few minutes until clean water starts flowing.
6. Flush each submain at the end of every section till clean water starts flowing.
7. Check the inlet and outlet filter pressures. Remove debris from hydro-cyclone filter, back flush sand filter, and flush screen/ disc filters at the end of the day's operation.

Weekly or Fortnightly Periodic Maintenance

1. Repeat daily maintenance operations as stated above and take corrective measures.
2. Remove the element of the screen or disc filter and clean it thoroughly.
3. Open the cap of the sand (media) filter, allow the water to come out through the manhole, and stir the sand thoroughly by moving the hand in between the filter candles without disturbing the position for thoroughly separating accumulated foreign material with media.
4. Open the inlet and outlet of the venturi without disturbing its settings.

5. Maintain an appropriate pressure difference between the inlet and outlet of a fertiliser tank by adjusting the throttle valve.

To prevent emitter clogging chemical treatments (acid and/or chlorine treatment) are provided. Detailed procedures provided in the Indian Standard (IS 14791) must be followed for this purpose. Though many chemicals are used for treatments of the drip irrigation system, the following major groups of chemicals should never be used in a drip irrigation system: Poly-phosphates, red potassium chloride, red potassium sulphate, borax, organic products with high contents of suspended solids (without preliminary treatment), products and fertilisers with low solubility, e.g. gypsum, waxy chemicals, oil solvents, petroleum products and detergents; active Chlorine (at the injection point) with more than 40 ppm; and acid with a pH <2.0.

Permitted Chemicals

It is important to know a chemical's quality, purity, recommended dosage, solubility, Electrical Conductivity (EC), pH and application method as well as its order of preparation for application before using it. The following chemicals (liquid or highly soluble) are permitted for injection in drip irrigation systems **(Table 2.2)**.

Table 2.2: Chemicals permitted for injection in drip irrigation system

Chemical / groups	Names/ Types
N – Nitrogen	• Urea • Ammonium Nitrate • Nitrate Acid
P – Phosphorus	• Phosphoric Acid • MAP (Mono Ammonium Phosphate) (with high solubility) • Ammonium Phosphate

K – Potassium	• Potassium Nitrate • Potassium Chloride
Microelements	• Chelates, Ethylene-Diamine-Tetra-Acetate (EDTA), (Diethylene Triamine Pentacetic Acid) DTPA, Ethylene diamine di-2-hydroxyphenyl acetate ferric EDDHA, N-(2-Hydroxyethyl) ethylenediaminetriacetic acid HEDTA, Boric Acid etc.

Acid Treatment

Acids are used to lower the pH of irrigation water and descale chemical precipitation by dissolving chemical contaminants, such as carbonates, calcium, phosphate, hydroxide deposits, etc., which further enhance the effectiveness of chlorine injection. If acid is injected on a continuous basis to prevent calcium and magnesium precipitates from forming, the injection rate should be adjusted until the pH of the irrigation water is just below 7.0. pH can be tested using a pH meter or a pH paper **(Figure 2.5)**. pH paper can help us know if a solution is basic, acidic, or neutral. When the pH paper is dipped into a solution whose pH has to be determined, a colour will develop. This colour is compared with the standard pH colour chart. The pH paper will turn red in acid and blue in bases.

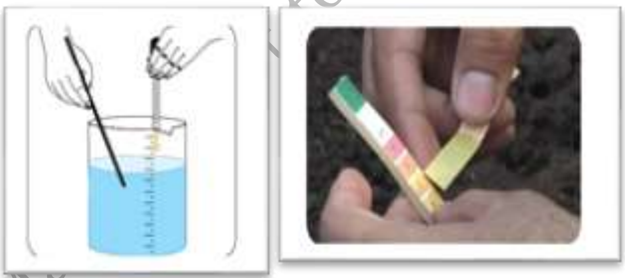


Figure 2.5: PH testing of water

Acids are dangerous and toxic to humans and animals. Eyes, skin contact, and swallowing or inhaling acid fumes should be avoided. For this, protective clothing and gear like gloves, masks, goggles, and closed heeled shoes are recommended. When diluting an acid, it is to be added in small quantities to water, and water should not be poured over or added to the acid. Treatments of acids should never be administered or in a mix with fertigation or chlorination. The use of acids should be restricted to non-reactive materials (like PVC, polyethylene etc.), while corrosive or reactive metals (like aluminium, iron etc.) or asbestos-cement, concrete pipes, or fittings made thereof should be avoided.

Acids come in various forms and at different concentration levels **(Table 2.3)**. The level of acid concentration added to the irrigation water depends on the type of acid being used, its percentage, and its valence. The amount of acid to be injected depends on the buffering capacity or basic nature of irrigation water as well as the concentration of the acid to be injected. One milli-equivalent of acid completely neutralizes one milli-equivalent of base. The acid injection port should be beyond any metal connections or filters to avoid corrosion. Generally, 0.5 ppm acid may lower the pH of water to nearly 1.0.

Table 2.3: Typical acid concentrations

Acids (Percentage)	Commercial grades available (percentage)	Recommended Concentration in Treated Water (percentage)
Hydrochloric acid, 20– 40	35	0.6
Phosphoric acid, 60-85	85	0.6
Nitric acid, 33-90	33	0.6
Sulphuric acid, 30 –98	65	0.6

Acid Injection

Acid injection is the process of injecting specific concentrations of acid into the irrigation system during regular system operation to lower the pH level in the water, which dissolves calcium, magnesium carbonates, iron, and manganese sulphides. Acid injection can also be used to burn plant roots that have entered the dripper. Generally, the use of acid treatment can be divided into two types:

Chemical Clogging Treatment: The treatment is typically considered for dissolving minerals and iron. The pH level should be between 2.5 –5.

Root Intrusion Treatment: It is considered for burning roots that have entered the dripper passages. The pH level should be between 2-2.5. Several heavy treatments may be required, depending on the intensity of root infiltration.

Acid treatment is done to lower the pH of the water sufficiently and to treat the desired problem. While minimizing the amount of acid to be used, the pH can be lowered to a level of 2.0 for the treatment of dissolving calcium carbonates.

The duration of acid injection depends on the flow rate of the system as well as the quantity of acid being injected. In practice, the actual injection time may vary from the calculated one. The measurement should be taken at the last dripper in the system while the pH is in the range of 2.5 for at least 5 minutes.

Chlorine Treatment: Chlorine is a common biocide used to control micro-organism such as bacteria and algae. As a strong oxidiser, it prevents the growth of organic, bacterial, and inorganic slimes. It oxidises iron, sulphur, and manganese and as a result, it improves filtration efficiency. A continuous residual rate of 1 to 2 ppm of free available chlorine at the distant end of the irrigation system or an intermittent rate of 10 to 20 ppm for 30 to 60 minutes per treatment cycle is effective.

Precautions

Chlorine liquid, solid, or gas is dangerous and toxic to humans and animals. Eye, skin contact, or inhaling fumes should be avoided. Use of guards like gloves, masks, goggles, full-length trousers and sleeves, and closed-heeled shoes are recommended.

Before using chlorine all safety instructions provided by the manufacturer must be gone through.

Nitrogenous fertilisers, should not be applied during chlorination to avoid the formation of sublime compounds like Ammonium Chloride. Never mix acid in chlorine solution; instead, use another device of injection for acid before Chlorine. While making or diluting the solution add Chlorine product into water but do not pour water in chlorine substance or solution.

Application

Chlorine is commonly available for use in the following three forms:

a. **Solid chlorine (Calcium Hypochlorite) -** Solid chlorine have 65% available chlorine. When both the calcium level and alkalinity of the water are above medium and the pH is above 8.0.
b. **Liquid chlorine (Sodium Hypochlorite) -** Liquid chlorine have 10-12% available chlorine. Liquid chlorine is unstable and decomposes spontaneously in the storage tank with time, temperature, and radiation. It is the most commonly used and easily available material.
c. **Chlorine gas –** Chlorine gas have 100% available chlorine. Gas chlorine is a stable, pure, and effective chlorine source for injection. It requires specialized controllers and equipment. However, it is very dangerous, poisonous, and corrosive.

Generally, there are two methods of chlorination.

- **Continuous injection:** Chlorine should be continuously injected throughout the whole irrigation cycle. This is the most efficient method, but chlorine consumption is the highest.
- **Intermittent injection:** Chlorine is injected at a regular interval. Depending on the water quality, the interval will be decided, i.e., higher with sources that contain a large proportion of organic material. Usually, chlorine is injected until it reaches the furthest point in the valve. The valve is turned off and left to allow contact time between the chlorine and the organic matter. A higher organic load will require a longer contact time. The system is then flushed, in the order of mainlines, submains, and then laterals.

Maintenance after chemical treatment

Chlorine can be injected at two different points in a system (as shown in **Table 2.4).** Each position has its advantages and disadvantages.

Table 2.4. Chlorine-injection point

Injection Point Location	Remarks
As close as possible to the main pump of the water source (river, dam, well).	It prevents the growth of bacterial slime in the main pipe and protects the drip system much better than when the injection point is far away from the water source.
Far from the main pump and as close as possible to the irrigated plot.	It does not protect the main pipe and is not recommended in cases of effluent, or water with sulphur, iron and manganese.

- After the injection of acid, allow acidified water to react with precipitated salts for 4-6 hours. It is desirable to prolong the period for 24 hours. Then open the ends of the laterals and the submain flush valve. Start the pump and allow all the water to flow out. Measure the discharges of selected emitters. Flush the main, submain, and lateral pipes. If there is no significant improvement, repeat the treatment.

- At the end of the acid treatment, wash the equipment and vessels with clean water. If clogging is observed due to algae or other causes, carry out chlorination treatment.

- Run the system for half an hour more than the normal irrigation period so that an extra quantity of acid is taken away from the root zone.

Activities

Activity 1: Understanding the Procedure of System Flushing in Drip Irrigation

Visit a farm where the drip irrigation system is installed, and understand the procedure of system flushing.

Step 1: Before the visit, study the drip irrigation system and its components (pipes, emitters, filters, valves).
Step 2: Understand how blockages in the drip irrigation system can reduce water flow and harm crops, and why system flushing is essential for maintenance.
Step 3: Understand the process of cleaning the pipes and emitters to remove any sediment, debris, or algae that may accumulate and clog the system over time.
Step 4: Visit the farm and upon arriving at the farm, the manager or irrigation expert will explain the following:

1. How the drip irrigation system is set up on the farm.
2. Why regular flushing is necessary to maintain optimal water flow.
3. The steps they take to ensure the system is properly flushed.

Record Your Observations

After returning from the field trip, discuss what you observed. The key points that you can cover are as follows:

- What types of debris were flushed out?
- How often should flushing be done on a farm?
- What might happen if the system is not flushed regularly?

Check Your Progress

A. Fill in the Blanks

1. ____________________ is a procedure of opening flush valve on the mainline, submain or lateral while under pressure.
2. Acids are used to _________ the pH of irrigation water and descale chemical precipitation by dissolving chemical contaminants.

B. Multiple Choice Questions

1. If acid is injected on a continuous basis to prevent calcium and magnesium precipitates from forming, the injection rate should be adjusted until the pH of the irrigation water is just below
   a) 7.0
   b) 7.5
   c) 8.0
   d) 9.0

2. Acid injection can also be used to burn plant ____________ that have entered the dripper.
   a) Leaves
   b) Roots
   c) Flower
   d) Branch

C. Subjective Questions

1. What is the difference between preventive and corrective types of drip maintenance?
2. Which chemicals should never be used in a drip irrigation system?
3. How often should pipes in the distribution network be inspected?
4. How do you prevent clogging in the pipe network?
5. What is the best way to detect leaks in the pipe network?
6. What should be done if a pipe burst?
7. How do you prevent emitters from clogging?
8. What are common signs of emitter malfunction?
9. How should emitters be cleaned?
10. What should you do if multiple emitters are malfunctioning?

Module 3	Occupational Health, Hygiene and First Aid Practices

Module Overview

This module will help you to acquire essential knowledge and skills to ensure safety and health in agricultural environments. In Session 1 on types of hazards, you will learn about the risks and hazards, including physical, chemical, biological, and ergonomic hazards. Understanding these hazards is crucial for implementing effective preventive measures to protect workers' health. In Session 2, you will practice fundamental first aid techniques for responding to injuries and emergencies that may arise on the job. This session emphasizes assessing situations, providing immediate care, and recognizing when to seek professional medical assistance. The Session 3, focuses on agricultural waste management and disposal, covering the proper handling of organic materials, chemicals, and plastics. It highlights best practices for minimizing environmental impact while promoting hygiene and safety in agricultural operations. Together, these sessions will provide you with the skills needed to enhance workplace safety, respond effectively to health emergencies, and manage agricultural waste responsibly.

Learning Outcomes

After completing this unit, you will be able to:

- Differentiate between risk and hazard.
- Understand the common hazards that can occur in an agricultural farm.
- Describe the first aid techniques for burns and wounds.
- Identify the various types of agricultural wastes.
- Identify the use of various personal protective equipment.

Module Structure

Session 1: Types of Hazards

Session 2: First Aid

Session 3: Agricultural Waste Management and Disposal

Session 1: Types of Hazards

Types of Hazards

Hazard is defined as "a dangerous condition or event that threatens or has the potential to cause injury to life or damage to property or the environment." It is any source of potential damage, harm, or adverse health effects on something or someone under certain conditions at work. Hazards can be grouped into three broad categories: natural, manmade and safety-related hazards.

Natural hazards: These are hazards that are caused by natural phenomena, which could be meteorological (e.g., heavy rains), geological (e.g., landslides, chemical gas leaks) or even biological (e.g., plague) **(Figure 3.1).** Examples of natural disasters are cyclones, earthquakes, tsunamis, and volcanic eruptions which are exclusively of natural origin. Landslides, floods, droughts, fires are socio-natural or hybrid disasters since their causes are both natural and manmade. The natural disasters threatening India include earthquakes (usually in the Himalayan region), floods, including tsunamis (usually in river deltas and coastal areas), and landslides (particularly in hilly areas during the rainy season).

Figure. 3.1: Natural hazards

Manmade hazards: These are hazards that are caused by human negligence or wrong intentions. Manmade hazards include explosions, leakage of toxic waste, pollution, dam failure, wars, civil strife, train crashes, road accidents, industrial accidents, and terrorist attacks.

Safety related hazards: A safety-related hazard is anything that can harm your safety. There are a lot of safety hazards, that you may encounter at the workplace or an agricultural farm, for example, (a) the use of sharp knives or sickle; (b) energized electrical wires; (c) hazards in deep water; (d) being struck by moving equipment; and (f) falling off an unguarded roof.

Workplace hazards: Workplace hazards are hazards that exist in the workplace. These are most likely to affect workers and/or the surrounding environment and have the potential to lead to severe consequences. Workplace hazards will vary from workplace to workplace and which is why separate risk assessment and strategic measures for reducing the possibility of workplace hazards are necessary.

Psycho-Social Hazards: Agricultural workers spend almost 40 hours per week on average at their workplaces. Psycho-social hazards refer to the risks to the mental and emotional health and safety of workers, such as job insecurity, poor work-life balance, and long working hours.

Common Hazards in Agricultural Farms: A number of occupational hazards exist for the farmer and farm workers. They include hazards related to farm machinery, biological and chemical hazards, and stresses. The hazards may cause injuries, health disorders or diseases. Some of the reasons for injuries or accidents at agricultural farms are as follows:

- being struck by a moving vehicle;
- tools and machinery related hazards;
- falls from a height;
- injuries due to contact with large animals;
- drowning;
- electrocution; and
- musculoskeletal injury

Hazards due to tools and machinery

Tools and machinery-related hazards may be caused by the following: (i) use of machines or sharp objects; (ii) heavy vehicles offloading large amounts of material; (iii) speed of vehicles; (iv) unguarded machinery or faulty equipment.

Hazards related to electricity

It includes dangers due to faulty switches, cords, machinery, or overhead power lines. Poor electrical installations and equipment can cause fires. Electricity can jump gaps when equipment or machinery gets close enough to high-tension lines, and the driver can be severely injured.

Hazards related to heights

Hazards related to heights include falls from ladders or rooftops, farm machinery, tractors, and windmills. They are a major cause of injury.

Hazards related to pesticides and chemicals

Pesticides are substances meant for attracting, seducing, and then destroying, or mitigating any pest. Although an accidental death from the consumption of pesticides is rare, skin disorders and health problems occur if precautions are not taken. Additionally, improper handling or use of pesticides can result in harmful effects on the environment. Pesticide safety begins with the selection of the pesticide product, transportation, storage, mixing, loading, application, and disposal of the residual pesticide and its container.

Hazards related to water

Floods, droughts, and other water-related hazards have major impacts on the socio-economic well-being of farmers. Lakes, ponds, wells, rivers, channels, tanks, etc. are all hazardous, especially for young children.

Hazards related to extreme weather

Hazards due to extreme weather conditions at an agricultural farm may occur due to dust and hail storms, cyclonic wind, sunburn, heat stroke, dehydration, and extreme exposure to cold. The warning signs of heat stress include tiredness, headaches, nausea, and loss of concentration, muscle cramps, and dizziness **(Figure 3.2).**

Principles of Safety and Health

The various principles of health and safety in the workplace include the following:

- Secure the health and safety of the employees and other people at work.
- Eliminate workplace risks at the source.
- Involve employees and other stakeholders in the organisation or farm in the formulation and implementation of health and safety standards.
- Identify and correct health and safety hazards in a manner protective of the environment.
- Follow good safety and health practices and comply with applicable health and safety regulations and guidelines.
- Training people on the use of personal protective equipment and safety procedures will improve productivity.

Preventing Risks and Hazards

Preventing electric shocks

Shocks occur when a human body comes into contact with a source of electricity. Electricity finds its path to the earth through the human body. So, it is important to be careful while working in a place that extensively uses electrical appliances. Some practices that must be taken care of are as follows:

Figure 3.2: Warning sign for danger

1. Check and ensure electrical fittings, fixtures, plant and equipment, wiring, insulation,

switches, power cords, plugs, earth wires, guarding, and welding equipment are in good condition and regularly maintained.
2. Keep all electrical appliances unplugged when not in use and at the time of a power cut.
3. Ensure that an extension cord is not overloaded, and replace it when it gets damaged. Pull out the plug only after turning off the switch.
4. Electric appliances always need to be kept away from water. Do not keep or use any appliances near wash basins, and never spill water on them.
5. Do not touch an electronic device with wet hands.
6. Make sure that the insulated grounding system or earthing is functional.
7. Do not try to repair an appliance on your own. Let an electrician handle the repair work.
8. Keep the electric appliances out of the reach of children.

Activities

Activity 1: Write down precautions to be taken while working in a place that extensively uses electrical appliances.

Activity 2: Describe the type of hazard and write down the precautions to prevent the hazard in the table given bellow:

S. No.	Hazards	Precautions

Check Your Progress

A. Fill in the Blanks

1. Occupational Health and Safety deals with all aspects of ________________and safety in the workplace.
2. The _____________ of the earthquake is measured on a Richter scale.

B. Multiple Choice Questions

1. Which disaster is caused by heavy rainfall?
   (a) Flood
   (b) Earthquake
   (c) Tsunami

(d) Cyclone

2. Which of the following is not part of geological disaster?
   (a) Volcanoes
   (b) Earthquakes
   (c) Tsunami
   (d) Sea Surge

C. Subjective Questions

1. What is hazard?
2. List types of hazards related to agriculture.
3. What occupational hazards exist for farmers and farm workers?
4. What are physical hazards in the workplace? Give two common examples?
5. What are ergonomic hazards?
6. Why are environmental hazards?
7. What are the most common physical hazards faced by agricultural workers?
8. What are biological hazards in agriculture?

Session 2: First Aid

First aid is the first assistance or treatment given to a casualty or a sick person for any injury or sudden illness before the arrival of an ambulance, the arrival of a qualified paramedical or medical person, or before arriving at a facility that can provide professional medical care. First aid can be given for recovery from small wounds, minor or major bleeding, fractures, sprains, burns, or inflammation.

First Aider

A first aider is a person who takes charge of an emergency scene and gives first aid. Often, the first aider at an emergency scene is a passer-by who is willing to help. First aid is never the substitute for medical attention from a doctor. A security guard, if trained in First Aid can provide relief in case of illness or accident by using the available equipment and material.

Lifesaving Procedures

The elementary lifesaving procedures for first aid are head tilt, first aid at choking, and recovery position. Important rules for first aid are as follows:

Check	Find out: (a) what has happened, (b) what is wrong with the person, (c) comfort the victim and arrange shelter.	
Call	Arrange for professional aid.	
Care	Help the victim without moving him or her.	

The services of priority that should be followed by the first-aider in an emergency are as follows:

Step 1 - **Check for bleeding**: Stop bleeding by applying direct pressure on the wound site.

Step 2 - **Check for head, neck, and spinal injury**: If any of these are suspected, do not move the victim unless it is necessary to prevent further injury. Moving a victim will often make injuries worse, especially in the case of spinal cord injuries.

Step 3 - **Determine responsiveness:** If a person is unconscious, try to rouse him/ her by gently shaking and speaking. Do not give any fluid as the victim cannot swallow and could suffocate. Look for the victim's chest rise and fall and listen for sounds of breathing (place your ear near the nose and mouth and feel for breath on your cheek).

(a) If the victim is not breathing then mouth-to-mouth resuscitation is to be given. If you are not trained to do that, then call for medical help at the earliest.

(b) If the victim is breathing, but unconscious, roll him/ her on one side, keeping the head and neck aligned with the body. This will help drain the mouth and prevent the tongue or vomit from blocking the airway.

If the person remains unresponsive, carefully roll him/ her onto the back and open the victim's airway.

Step 1: Keep head and neck aligned.
Step 2: Carefully roll the victim onto the back while holding his/ her head.
Step 3: Open the airway by lifting the chin.
Observe ABC as follows:

A – Airway: Ensure that the tongue or any foreign body does not obstruct the airway.

B – Breathing: Make sure the victim is breathing. If you are trained to give mouth-to-mouth respiration, then facilitate breathing.

C – Circulation: Check for the pulse to ensure that the heart is beating properly.

Figure 3.3: Airway, Breathing and Circulation

Check heartbeat or pulse of the victim.

If there is no pulse and if you are trained to do Cardio Pulmonary Resuscitation (CPR), then begin CPR immediately. (Note: CPR is administered when both the heart and lungs have ceased to function) **(Figure 3.3).**

Step 4: Call emergency services: call for help or ask someone else to call for help as soon as possible.

If you are the only person on the scene, try to establish breathing before calling for help, and do not leave the victim alone for long.

Stay calm, and do not give up. Continue to aid the victim until medical help arrives.

First Aid Techniques

The following are some of the first aid techniques:

Bleeding

Figure 3.4: Dressing for bleeding hand

1) Seek medical assistance.
2) Keep victim in lying posture.
3) In case there is no sign of fracture, lift the persons wounded area above the heart so as to control bleeding.
4) The wounded area needs to be cleaned, washed and then blot dry.
5) Apply antibiotic ointment to the wound and cover with a sterile gauze dressing. **(Figure 3.4)**

(ii) Eye Injuries

1) If an object is lodged in the eye, do not remove the object on your own.

2) To minimize the movement of the injured eye, cover both eyes with dressings.
3) In case some chemical is splashed into the eye, flush with cool water for 15 minutes by positioning the victim's head with the contaminated eye down. This position helps prevent the flow of harmful chemicals from one eye to another.
4) Doctors are trained to take out objects lodged in an eye injury. Hence, do not attempt to remove such objects from the eye.

(iii) Burns

Basic first aid treatment is only for 1st degree burns and some 2nd degree burns. Let us look at the degrees of burn **(Figure 3.5).**

First Degree Burn: The skin will be red and will also appear swollen or painful. Such burns usually do not call for immediate medical attention.

Second Degree Burn: The skin will appear red, blistered, and swollen. Such burns may require medical attention.

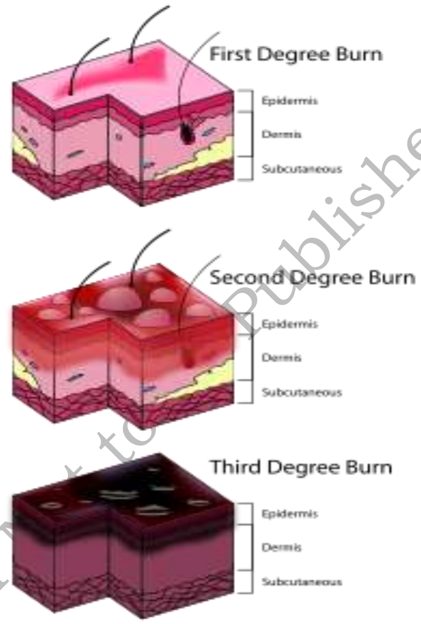


Figure 3.5: Degree of burns

Third Degree Burn: Such burns need immediate attention from a doctor. In such cases, the skin appears to be charred, and the patient suffers from severe pain. Until the pain stops, place the affected area in cool water. Cover it with a wet cloth if the affected area is large. If there are blisters, do not try to break them. If there is a need for immediate medical attention, do not apply any ointment to the burned area. If cloth is stuck to a burned area, never try to remove it. Instead, cover it with a germ-free dressing and seek immediate medical attention.

(iv) Unconsciousness

1) Call for medical help.
2) Find out the state of awareness of the person by asking if they feel all right.
3) Check the person's Airway, Breathing, and Circulation (ABCs).
4) If the victim's ABCs are not present, perform Cardio Pulmonary Resuscitation (CPR). Only a trained and qualified person should administer CPR.
5) If breathing and circulation are found to be normal and there is no symptom of spinal injury, place the individual on the side with his/her chin towards the ground to allow for drainage of secretion.

First Aid Kit

The contents of the first aid kit are mainly meant to provide first aid in cases of bleeding, bone fractures, and burns. A basic first aid kit should include: (a) bandages of all sizes; (b) 4” by 4” gauze pads for cleaning wounds; (c) 4” by 4” dressing bandages for wounds, cuts, and abrasions; (d) 2” dressing rolls or crepe bandages for wrapping and bandaging injuries; (e) medical tape; (f) cotton balls; (g) safety pins; and (h) alcohol pads or isopropyl alcohol for cleaning wounds.

Precautions to Prevent Common Diseases

Some of the common diseases, like malaria and dengue, are caused by mosquitoes, while others, like typhoid and jaundice, are caused by contaminated water. Others include diarrhoea, food poisoning, and heatstroke.

1. Avoid them by taking the following precautions:
2. Ensure that there are no breeding places for mosquitoes around the house and place of work.
3. Wash your hands thoroughly after being in public places.
4. Food spoils very quickly and becomes contaminated with disease-causing bacteria. Do not eat stale food.
5. Avoid eating in unhygienic places, and drink boiled water.
6. Heatstroke can cause the death of a person or damage internal organs like the brain. It is caused by prolonged exposure to high temperatures coupled with dehydration. This causes the body to lose control of its body temperature. Avoid going out during peak summer as much as possible to prevent heat strokes. Drink a sufficient quantity of water (at least 8 glasses a day) to keep your body hydrated. If you plan to go outside, you have to drink more water. In peak summer or during a heat wave, wearing lightweight, light-coloured, and loose-fitting clothes is recommended. It is also better to wear a wide-brimmed hat. Using a sunscreen lotion or cream with an SPF of 30 or more would be very helpful.
7. Use insect repellents to protect yourself from mosquito bites.
8. Wear clothes (like full-sleeve shirts instead of half-sleeve shirts) that cover the maximum parts of your body. This further reduces the chances of mosquito bites.
9. Always wash your hands with soap before you eat and after using the restroom **(Figure 3.6)**.

Figure 3.6: Wash hands before you eat

Keep your nails trimmed, as overgrown nails can lead to the ingestion of harmful bacteria while eating.

Basic Exercises

Basic exercises that can keep you healthy are shown in the figure given below. These are classified into warm-up exercises (running, push-ups, sit-ups, and chin-ups) and warm-down exercises (quadriceps stretch, glutes stretch, hamstring stretch, and chest exercise). At the end of a strenuous workout, there is a possibility that the muscles may become stiff or tight, leading to injury. Hence, it is always better to do the stretch and hold it static (without any movement) for 15 seconds. Other exercises that can be done regularly are shoulder stretches, etc.

Occupational Hazards

Occupational hazard is a risk because of a particular occupation. A microirrigation technician should be aware of the occupational hazards. Some of these hazards include the following:

1. Wet or slippery surfaces
2. Electrical short circuits: a significant occupational hazard for people working with electrical equipment
3. Working at heights
4. Manual handling
5. Toxic fumes
6. Fire
7. Plant and equipment: The hazard related to this is high where dangerous equipment like cutters and welding equipment are used.
8. Hazardous or sharp objects in the waste: Manual handling of metal or glass waste is an occupational hazard.
9. Confined spaces like manhole, and warehouse: Such confined spaces could lead to suffocation in case of fire and could even make evacuation difficult in case of an emergency.

Risks at Workplace

We have already studied the different hazards that one can come across at a workplace in the previous section. The risks associated with these hazards are as follows **(Figure 3.7):**

- Tripping over wires on the floor
- Bumping into things and equipment placed in the way
  and falling or getting injured
- Electric shock or fire due to loose or frayed cables
- Slipping on water or some other liquid spilled
  on the floor

Figure 3.7: Risks at workplace

- Catch an infection from unsterilized tools
- Burns from heating rods and hot water

Preventing slips, trips and falls

Slips

(a) Watch your steps while moving on a slippery floor.
(b) Do not throw rubbish, banana peel, etc. on the ground.
(c) Clean up all spillages immediately.
(d) Pick up any rubbish left lying around.

Trips

(a) Identify any tripping hazard.
(b) Remove that hazard or make it safe.
(c) Be careful of any leads, especially extension leads.

Falls

(a) Use both hands when ascending/descending the ladders.
(b) Keep one hand free to support yourself when ascending/descending steps and stairs.

Postures for carrying weight

Elevated arms can lead to musculoskeletal disorders, affecting the neck and shoulders, while bending and standing for long hours can affect the backbone and other body parts. Sudden and heavy lifting can lead to muscle pulls and ligament ruptures. So, one needs to be careful with her/his posture while working at all times **(Figure 3.8)**.

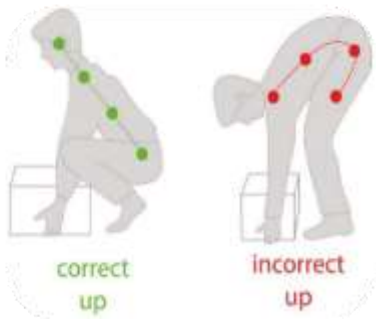
Methods to avoid posture-related problems

- Do not strain a particular part of the body for a long period of time.
- Move and stretch the body between services or after every half hour.
- Change your body posture by carrying out a variety of services or activities.
- While sitting at the time of rendering a service, it is important to have the chair at the right height.
- Exercise to keep the body fit and flexible.

Measures to adopt while lifting and carrying loads

- Get help while carrying heavy and large loads.

- While lifting, bend at the knees to sit, use both hands to hold it between the knee and the chest, and stand straight without bending at the waist.
- While turning, move the legs and feet; avoid twisting at the waist.
- Always use the leg and buttock muscles while lifting the load, as they are strong. Lower back muscles are weak, so avoid straining them.
- Use equipment, like hand trucks or forklifts, to carry the load, as they minimize the risk of injury.



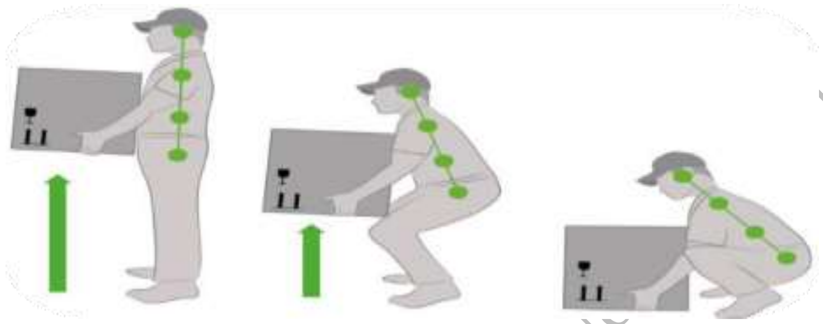


Figure 3.8: Correct body posture for lifting weight

Activities

Activity 1: Identifying Agricultural Hazards and Learning First Aid Practices

Materials Needed:

1. Posters or flashcards depicting various agricultural hazards (e.g., sharp tools, machinery, chemical exposure, heatstroke, animal-related injuries)
2. First aid kits (for demonstration)
3. Bandages, gloves, antiseptic wipes, and other basic first aid supplies
4. Safety gear (gloves, helmets, goggles) for demonstration
5. A small mock field setup or images to simulate the farm environment
6. Notebooks to record observations

Procedure:

Begin with a short discussion on the types of hazards present in agriculture, including:

1. Physical Hazards: Sharp tools, heavy machinery, falls.
2. Chemical Hazards: Pesticides, fertilizers.
3. Biological Hazards: Bites from animals or insects, exposure to bacteria or viruses.
4. Environmental Hazards: Extreme weather conditions, heat exhaustion, sunburn.

Use posters or flashcards to illustrate each hazard, explaining why it is dangerous and how to prevent it through safety measures (e.g., wearing gloves, goggles, helmets).

Invite a health professional or trained First Aider to demonstrate basic first aid techniques for common agricultural injuries. Key areas to cover are as follows:

1. Cuts and wounds: Cleaning the wound, applying antiseptic, bandaging.
2. Heatstroke: Recognizing symptoms, cooling the person, hydrating.
3. Chemical exposure: Rinsing the affected area, avoiding further exposure, and seeking medical help.
4. Insect bites or stings: Cleaning the bite area, applying soothing creams, and monitoring for allergic reactions.

Check Your Progress

A. Multiple Choice Questions

1. How one should open the airway of an unconscious casualty for First Aid?
   (a) Head tilt and chin lift.
   (b) Jaw thrust.
   (c) Head tilt and jaw thrust.
   (d) Lift the chin.
2. What names are given to the three different depths of burns?
   (a) First, second, and third degree.
   (b) Small, medium, and large.
   (c) Minor, medium, and severe.
   (d) Superficial, partial and full.
3. Which of the following is the leading cause of falling fatalities in the workplace?
   (a) Slippery tiles
   (b) Ladders
   (c) Stairs and steps
   (d) Tripping over objects

B. Subjective Questions

1. What actions should be taken to minimize slips, trips, and falls in the workplace?
2. Write a short note on occupational hazards in agriculture.
3. What is the primary goal of first aid?
4. What is the first step in assessing a first aid situation?
5. What is the correct rate of chest compressions during CPR?
6. How should you treat a burn injury?
7. How do you stop severe bleeding?

Session 3: Agricultural Waste Management and Disposal

Agricultural waste may be in the form of liquid, slurry, semi-solid, or solid. Solid waste management systems have a reduced total volume of waste because of the reduction in the amount of water.

Solid waste handling equipment may have lower cost and power requirements; however, the labour required for operation and management is generally greater than that for other methods. Biodegradable solid waste is subjected to either composting, vermicomposting to produce a solid bio fertiliser or it is directed to anaerobic digestion or biogas production.

Types of Agricultural Wastes

Field waste

It includes waste generated from agricultural or farm activities e.g., wheat or paddy straw, husk, bran, fruit peels, seeds, leaves, etc.

Animal-based waste

Animal waste is the faeces of animals, which are usually mixed with undigested food material or agricultural waste materials such as straw, husk, etc. It includes the dung of animals such as cows, buffalos, goats, horses, sheep, etc.

Agro-industrial waste

It includes waste generated from industries such as sugar factories, textile factories, etc. Boiler ash produced during the burning of wood waste and biomass fuels is also waste generated by most industries.

Concerns about Agricultural Waste Management

If not managed properly, agricultural waste can pollute the environment. The degradation of water quality can impact adjacent waterways and groundwater both onsite and offsite. This degradation reduces the ability of these resources to support aquatic life and water for human and animal consumption.

Nitrates can be found in fertilisers and agricultural waste runoff can seep into groundwater through leaching.

Well water contaminated with nitrates is hazardous to humans, as it results in oxygen depletion in the blood.

Management Processes

Production

Production is the result of the amount and nature of agricultural waste generated by an agricultural enterprise. The waste requires management if the quantity produced is sufficient enough to become a resource concern. A record should be kept of the data, assumptions, and calculations used to determine the kind, consistency, volume, location, and timing of the waste produced.

Collection

Collection refers to the initial capture and gathering of the waste from the point of origin or deposition to a collection point.

Transportation

Transportation refers to the movement and transportation of waste throughout the system. It includes the transfer of the waste from the collection point to the storage facility, to the treatment facility, and to the utilization site.

Storage

Storage is the temporary containment of waste. The waste management system should identify the storage period, required storage volume, type, estimated size, location, and installation cost of the storage facility, management cost of the storage process, and the impact of the storage on the consistency of the waste.

Disposal

The common agricultural waste disposal methods include burning, dumping, land filling, random piling, and so on. All these methods may cause pollution and the waste of resources. The above mentioned agricultural organic wastes contain multiple nutrient elements that can be made into organic fertilizer.

Treatment

Treatment is any function designed to reduce the pollution potential or modify the physical characteristics of the waste, such as moisture and TS content, to facilitate more efficient and effective handling. Manure treatment is comprised of physical, biological, and chemical unit processes. It also includes activities that are sometimes considered pre-treatment, such as the separation of solids.

Utilisation

Utilization includes reusing and/or recycling waste products. Agricultural wastes may be used as a source of energy, bedding, mulch, organic matter, or plant nutrients. Properly treated, they can be marketable.

Dairy waste is used as bedding for livestock, marketed as compost, and used as an energy source, but the most common form of utilization is through land application. Liquid waste can be distributed through an irrigation system.

Organic manure in the form of compost improves soil health and reduces the use of chemical fertilizers, which also reduces the cost of cultivation.

Benefits of Waste Management

Enhanced nutrient use efficiency through recycling of waste is part of green technology. Improved crop yields lead to higher income, and safe practices lead to fresh and non-toxic food grains and vegetables.

Use of Personal Protective Equipment

Wearing Personal Protective Equipment (PPE) can significantly reduce the potential for exposure to harmful chemicals and pesticides. It can also significantly reduce the chances of pesticide poisoning, but it does not necessarily eliminate it. Equipment and clothing can help farmers remain safe when working around the many hazards on farms. Let us see some of the examples.

Eye and face protection - Eyes are very sensitive to the chemicals contained in some pesticide formulations. To provide protection during exposure to hazards like liquid chemicals, flying particles, metal or sparks, caustic liquids, and light radiation, safety glasses or goggles are worn by the workers **(Figure 3.9).**

Figure 3.9: Mask for eye and face protection

Hearing protection - PPE should be worn when the noise level is 85 decibels or greater, averaged over an eight-hour period. Most hearing protection devices have a noise reduction rating (NRR) that indicates the amount of protection provided. To provide protection during exposure to high pitched and loud noise levels **(Figure 3.10).**

Figure 3.10: Ear muffs for hearing protection

Hand protection: To provide protection of the hand during exposure to potential hazards such as sharp objects, abrasive surfaces, temperature extremes, and chemical contact.

Wearing gloves reduced exposure by at least 98% for farmers who had spills while mixing or applying pesticides. As a result, most product labels require the use of waterproof or chemical-resistant gloves during handling and mixing **(Figure 3.11)**.

Figure 3.11: Gloves for hand protection

Head protection: To provide protection from potential hazards such as falling objects, striking against low-hanging objects, electrical hazards, or toxic chemicals, or chemical application.

When both face and eye protection is needed, a face shield can be worn over goggles. Clean them after each use. Be careful of the headband; it is often made of a material that readily absorbs and holds chemicals. Have several spares and change them often or use a chemical-resistant strap. If possible, wear the strap under your head covering. The hair and skin on your neck and head must be protected too by using chemical-resistant rain hats.

Foot protection: To provide protection for situations with the potential for injuries such as falling or rolling objects, chemical or liquid exposures, piercing objects, and where feet are exposed to electrical hazards. Shoes and socks are often sufficient to protect your feet during many handling activities.

The product labels for those pesticides require wearing waterproof or chemical-resistant footwear, which could be shoe covers or boots **(Figure 3.12).** If a pesticide is likely to get on the lower legs or feet, chemical-resistant boots that extend past the ankles and at least halfway up to the knee should be worn.

Wear waterproof boots when entering or walking through recently treated areas, such as lawns, before the spray has dried.

Figure 3.12: Boots for foot protection

Clothing protection: To protect from potential hazards such as entanglement, skin cancer, bodily injury, and pesticide contamination. Dress appropriately and use personal protective equipment (PPE) to help minimize pesticide exposure and reduce the risk of pesticide poisoning. These measures are also required and necessary for appropriate and legal pesticide use **(Figure 3.13).**

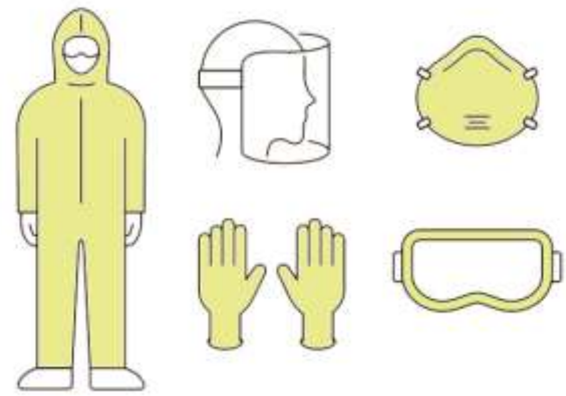


Figure 3.13: Clothing and other protective gear for body protection

Manual Handling

The most common cause of lost time in agriculture due to injury is manual handling. Bad backs are not only painful but also keep you from working easily. Manual handling injuries result from activities that involve pushing, pulling, bending, twisting, and lifting. They can include handling livestock, jumping down from machinery, and repetitive movements like loading hay bales onto a trailer.

Most manual-handling injuries are cumulative. It is the gradual wear and tear from manual handling that takes its toll on your body. Therefore, the way you handle things on a day-to-day basis will make a difference. That means trying to maintain a good posture whatever you are doing and not continually lifting and handling heavy, awkward items.

Control the risk

Nowadays, more equipment is ergonomically designed to prioritize user comfort and ease of use. Take full advantage of these features to make your tasks easier. For instance, spend a few minutes familiarizing yourself with the adjustability and comfort options of your tractor seat—you might be pleasantly surprised. When getting off a large tractor or header, use the steps provided instead of jumping down. Back issues can often be alleviated with treatments such as physiotherapy or chiropractic care. Other options for relief may include rest, gentle exercise, and medication.

Activities

Activity 1: Identification of Agricultural Waste and Generation of Ideas for Waste Management

Materials Needed:

- Examples or images of agricultural waste (e.g., crop residues, plastic bags, fertilizer packaging, animal waste, etc.)
- Compost bin or materials to simulate composting (organic waste, soil)
- Recyclable items (bottles, cans, packaging)
- Waste segregation bins (organic, recyclable, hazardous, non-recyclable)
- Gloves and safety gear for handling waste
- Observation sheets for students to document their findings

Procedure

1. **Introduction to Agricultural Waste:** Begin by discussing the various types of waste generated in agriculture:
    - **Organic Waste**: Crop residues, animal manure, food waste.
    - **Plastic Waste**: Packaging materials, irrigation pipes.
    - **Hazardous Waste**: Pesticide containers, chemical fertilizers.

    Show images or examples of these wastes, and ask others students in group to identify them as organic, recyclable, or hazardous.

    - **Organic**
    - **Recyclable**
    - **Hazardous**
    - **Non-Recyclable**

2. **Hands-On Composting Demonstration**: Learn the process of composting by performing the activity and generating new ideas of composting.

    - **Step 1**: Gather organic waste (fruit peels, vegetable scraps, leaves, etc.).
    - **Step 2**: Layer the organic waste with soil in a compost bin.
    - **Step 3**: Turn the compost regularly to help it decompose.

You and other members of the group will participate by adding waste to the compost bin, turning the mixture, and discussing what materials are compostable.

Reflect on the Activity

1. What are the main types of waste generated in agriculture?
2. How composting benefits agriculture by reducing waste and creating natural fertilizer?

Check Your Progress

A. Fill in the Blanks

1. Enhanced nutrient use efficiency through recycling of waste as a part of _______________
2. Eyes are very sensitive to the ____________ in some pesticide formulations.
3. PPE should be worn when the noise level is _____________ averaged over eight hours.
4. When both face and eye protection are needed, a ___________ can be worn over goggles.
5. If not managed properly, agricultural waste can pollute the___________.

B. Multiple Choice Question

1. Waste generated from sugar factories are _____________
   a) Agro-industrial waste
   b) Animal-based waste
   c) Domestic waste
   d) Commercial waste

2. PPE should be worn when the noise level is_________
   a) 65 decibels
   b) 85 decibels
   c) 55 decibels
   d) 95 decibels

3. Which of the following should be used to help minimize pesticide poisoning?
   a) Personal protective equipment
   b) Diving equipment
   c) Camping equipment
   d) Agricultural equipment

C. Subjective Questions

1. Explain the types of Agricultural Wastes (any three).
2. Write the importance of Personal Protective Equipment and explain any three-protective gear.
3. What is agricultural waste?
4. Why is agricultural waste management important?
5. What are some common methods of managing organic agricultural waste?
6. What is Farm Yard Manure?
7. What is the role of composting in agricultural waste management?
8. What steps can be taken to reduce pesticide waste on farms?

Answer Key

MODULE 1: LAYOUT AND INSTALLATION OF MICROIRRIGATION SYSTEM

Session 1: Components of Microirrigation System

A. Fill in the Blanks

1. Discharge
2. Laminar
3. 10

B. Multiple Choice Questions

1. a
2. b
3. d

Session 2: Installation of Head Unit

A. Fill in the Blanks

1. Control
3. One
4. Non-return
5. Air release

B. Multiple Choice Questions

1. (c)
2. (a)
3. (d)

C. Match the Columns

1. (b)
2. (c)
3. (d)
4. (a)

Session 3: Installation of Pipe Network

A. Fill in the Blanks

1. Lateral
3. Prevent
4. Water
5. Sediments

B. Multiple Choice Questions

1. a
2. d
3. c

Session 4: Emission device and fertigation system

A. Fill in the Blanks

1. Outlet
2. Emission
3. Single
4. Uniformly
5. Venturi

B. Multiple Choice Questions

1. c
2. b
3. a
4. c
5. b
6. a

MODULE 2: MAINTENANCE OF DRIP IRRIGATION SYSTEM

Session 1: Operation of Drip Irrigation System

A. Fill in the Blanks

1. Pressure
2. Bypass
3. Inlet
4. 0.7
5. 0.5

B. Multiple Choice Questions

1. (a)
2. (c)

Session 2: Monitoring of Drip Irrigation System

A. Fill in the Blanks

1. Pump
2. Pressure
3. Pipe
4. Salts
5. Electrical

Session 3: Maintenance of Head Unit

A. Fill in the Blanks

1. Pump
2. Sand collection

3. Water

B. Multiple Choice Questions

1. (a)
2. Both (a) & (b)
3. (b)
4. (a)

Session 4: Maintenance of Pipe Distribution Network and Emission Devices

A. Fill in the Blanks

1. Flushing
2. Lower

B. Multiple Choice Questions

1. (a)
2. (a)

MODULE 3: OCCUPATIONAL HEALTH, HYGIENE AND FIRST AID PRACTICES

Session 1: Type of Hazard

A. Fill in the Blanks

1. Health
2. Magnitude

B. Multiple Choice Questions

1. (a)
2. (d)

Session 2: First Aid

A. Multiple Choice Questions

1. (a)
2. (a)
3. (c)

Session 3: Agricultural Waste Management and Disposal

A. Fill in the Blanks

1. Sustainable agriculture
2. Irritants
3. 85 decibels
4. Face shield
5. Environment

B. Multiple Choice Questions

1. (a)
2. (b)
3. (a)

Glossary

Chlorination: The introduction of chlorine—at a calculated rate—into an irrigation system. Chlorination can use liquid sodium hypochlorite (household bleach) or chlorine gas.

Cleaning agent: A substance used to remove dirt, filth and contaminants.

Connectors: The connectors are used to connect two or more pipes with one another while system installation work is going on.

Control valve: A device used to control the flow of water. Control valves turn on and off water to the individual zones.

Disc filter: A stack of round, grooved discs used to filter water in a drip-irrigation system. Sediments and organic matter accumulate on the discs as water passes through the groves.

Drip irrigation: A method of irrigation using the slow application of water under low pressure through tube openings or attached devices just above, at or below the soil surface.

Emitter: A dispensing device or opening in a microirrigation tube that regulates water application. An emitter creates a controlled flow expressed in LPH.

Emitter spacing: Distance between two consecutive emitters. Typical emitter spacing for vegetable crops are 10, 20 and 30 cm.

Evapotranspiration (ET): The combined losses of water by evaporation from the soil and transpiration from the plant.

Fertigation: The application of soluble fertiliser (plant nutrients) through microirrigation irrigation system.

Field capacity: The water content of the soil after all free water has been allowed to drain by gravity.

Filter: A canister device containing a screen or a series of discs of a specified mesh or filled with a coarse solid medium and designed to catch solid particles large enough to clog emitters.

Fittings: The array of coupling and closure devices used to construct a microirrigation system and including connectors, tees, elbows, goof plugs and end caps.

Fertiliser: It is a chemical or natural substance added to soil or land to increase its fertility.

Flooding Method: It is oldest methods of irrigating fields are surface irrigation (also known as flood or furrow irrigation), where farmers flow water down small trenches running through their crops.

Flow: The amount of water that moves through pipes in a given period of time. For microirrigation (drip irrigation), flow is expressed in m^3-per-hour or litres-per-hour.

Flow meter: A device used to measure changes in flow in pipe or open channel.

Goof plug: An insert able cap used to plug holes in mainline and micro-tubes where drip devices have been removed or are no longer needed or when an accidental hole needs to be plugged.

Hole punch: A device that makes round holes in the pipes so to connect dripper with laterals (available in different diameters).

Hydrochloric acid (HCl): An acid often used to lower the pH of water to increase the efficiency of chlorination. Use of HCI is prohibited in certified organic production.

Irrigation schedule: Irrigation scheduling helps in deciding as to when and how much water to apply to a field in order to maximize irrigation efficiencies by applying the exact amount of water needed to replenish the soil moisture to the desired level.

Mainline: The tubing used in the microirrigation (Drip irrigation/Sprinkler Irrigation) system. It may be made of hard PVC or soft polyethylene material and comes in diameters of 63 mm and above with a pressure of 4 to 8 kg/cm^2.

Media filter: A pressurized tank filled with fine gravel and sand. The sand is placed on top of the gravel. Sharp-edged sand or crush rock are more efficient in catching soft algal tissue than round particles. Media filters should be used for filtering water that contains high levels of organic matter.

Micro-sprinkler: A micro-sprinkler is a device used to irrigate agricultural crops, lawns, landscapes, golf courses, and other areas.

Part-per-million (ppm): The ratio of one in one million: 1 ppm = 1/1,000,000. The "ppm" measurement may also represent concentrations: 1 ppm = 1 mg/L.; 1% = 10,000 ppm.

Pressure loss: It is the difference in total pressure between two points in a pipe carrying water. Pressure loss or drop can take place when water enters one end of a piping system, and leaves the other. The loss of water pressure under flow conditions caused by debris in a filter, friction in pipes and parts, and elevation changes.

Pressure-relief valve: A valve that opens and discharges to the atmosphere to relieve the high-pressure condition when pressure in a pipeline exceeds a pre-set point.

Pressure-compensating emitter: An emitter designed to maintain a constant output (flow) over a wide range of operating pressures and elevations.

Pressure-sensitive emitter: An emitter that releases more water at the higher pressures and less at lower pressures, which are common with long, mainlines or terrain changes.

Root zone: The depth and width of soil profile occupied by the roots of the plants being irrigated.

Sand separator: A device also called hydrocyclone filter that utilizes centrifugal force to separate sand and other heavy particles out of water. It is not a true filter, but could be considered a pre-filter.

Schedule: A list of planned activities or things to be done showing the times or dates when they are intended to happen or be done

Screen filter: A type of filter using a rigid screen to separate sand and other particulates out of irrigation water.

Self-flushing end cap: A spring-loaded device that lets water go out at the end of the drip tape when the water pressure is less than the threshold of the cap.

Soap: Alkaline salts of fatty acids used to remove hydrophilic particles.

Strong acid: An acid that is totally dissociated in water. Common strong acids are hydrochloric acid (HCl) and sulphuric acid (H_2SO_4).

Tape-to-lateral connector: A device sometimes called a barbed adapter and that is placed at the end of the drip tape (screw end) to connect it with the lateral (snap end).

Tape-to-tape connector: A device used to repair or replace a leaking section of drip tape. The tape-to-tape connector allows two pieces of drip tape to be connected together.

Turbulent-flow emitter: Emitters with a series of channels that force water to flow faster, thereby preventing particles from settling out and plugging the emitter.

Venturi injector: A tapered constriction which operates on the principle that a pressure drop accompanies the change in velocity of the water as it passes through the constriction. The pressure drop through a venturi must be sufficient to create a negative pressure (vacuum), relative to atmospheric pressure. Under these conditions, fluid from the tank will flow into the injector.

Water alkalinity: Ability of water to neutralize acids. Water alkalinity is based on the content of hydroxide (OH^-), carbonate (CO_3^{--}) and bicarbonate (HCO_3^-) ions.

Water use efficiency: It is the ratio of the amount of irrigation water applied that is beneficially used by the plant to the total amount of irrigation water applied.

Water velocity: The speed at which water travels inside a pipe, usually expressed in m/second.

Zone: A section of an irrigation system that can be operated at one time by means of a single control valve.

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