Agricultural Science

Year 1

SECTION

4

IRRIGATION SYSTEMS

New Dawn In Agriculture

Agricultural Machinery

INTRODUCTION

Welcome to the section on modern irrigation systems in agricultural production! In Ghana, agriculture relies heavily on rain, leading to seasonal crop production. However, this dependence is becoming unsustainable. To ensure year-round crop production, it is essential to introduce and utilize modern irrigation systems. This section introduces you to the various modern irrigation systems suitable for producing vegetable crops and ornamental plants. You will learn about these systems in detail and how to apply or adapt them for use in school gardens or farms. This section also aims to equip you with knowledge about different vegetable crops and ornamental plants, their specific water requirements, irrigation water sources, and availability, and the topography of growing areas—all crucial for choosing the right irrigation system. By mastering this content, you will enhance your critical decision-making skills in agricultural practices, particularly in selecting suitable irrigation methods. The section is important for your understanding of Agricultural Science and its connections to other subjects like engineering and economics.

At the end of the section, you will be able to:

- Describe the modern and efficient methods of crop irrigation.
- Use appropriate irrigation system to produce vegetable crops and ornamental plants.

Key Ideas:

- **Irrigation**: Irrigation is the artificial application of water to soil or land to assist in the growth of crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall.
- **Surface irrigation:** Surface irrigation is a technique for watering crops by allowing water to flow over and across the land using gravity.
- **Sub-surface irrigation:** This is a method of irrigation in which water is delivered below the ground surface, establishing an artificial water table at a depth typically ranging from 30 to 75 cm.
- **Pressurised irrigation:** Pressurized irrigation systems are agricultural irrigation methods that use pumps to create water pressure, enabling the delivery of water through a network of pipes, valves, and emitters.
- **Physical factors:** Physical factors pertain to the inherent characteristics of the soil and water sources in a given agricultural setting.

- **Environmental factors:** Environmental factors encompass the climatic and ecological conditions that affect irrigation needs and practices.
- **Financial factors:** Financial factors involve the economic considerations associated with implementing and maintaining an irrigation system.
- **Inches or Centimetres (in or cm)**: Water depth applied per week. This is a common measure for irrigation, indicating how much water is needed over a specific area.
- **Liters per Second (L/s)**: Flow rate for irrigation in metric units.
- **Cubic Meters per Hour (m^3/h)**: Volume flow rate for larger scale irrigation systems.

MODERN AND EFFICIENT IRRIGATION SYSTEMS IN VEGETABLE CROP AND ORNAMENTAL PLANT PRODUCTION

Irrigation

It is defined as the artificial application of water to the soil to supplement rainfall and groundwater, for crop production.

Methods of irrigation

1. Surface irrigation
2. Sub-surface irrigation
3. Pressurised irrigation

1. Surface irrigation method

This is the oldest and most common method, suitable for low to moderate infiltration rates and level lands. It is labour-intensive. Surface irrigation can be either border irrigation, check basin irrigation or furrow irrigation.

Types of Surface irrigation

a. ***Border irrigation:*** The land is divided into a number of long parallel strips called borders. These borders are separated by low ridges. The border strip has a uniform gentle slope in the direction of irrigation. Each strip is irrigated independently by turning the water on at the upper end. The water spreads and flows down the strip in a sheet confined by the border ridges.

Fig 4.1: Picture of border irrigation on a rice farm

b. ***Check basin irrigation:*** It is the most common surface irrigation method. The field is divided into smaller units so that each has a nearly level surface. Bunds or ridges are constructed around the area forming basins within which the irrigation water can be controlled. The water applied to a desired depth can be retained until it infiltrates into the soil. The size of the basin varies from 10m2 to 25m2 depending on soil type, topography, stream size and crop.

Fig 4.2: A picture showing check basin irrigation

c. ***Furrow irrigation:*** It is used for row crops. The furrows are formed between crop rows. The dimension of the furrows depends on the crop grown, equipment

used and soil type. Water is applied by small running streams in furrows between the crop rows. Water infiltrates into soil and spreads laterally to wet the area between the furrows. In heavy soils, furrows can be used to dispose of the excess water.

Fig 4.3: A picture showing furrow irrigation.

2. Subsurface irrigation

In subsurface irrigation, water is applied beneath the ground by creating and maintaining an artificial water table at some depth, usually 30-75cm below the ground surface. Moisture moves upwards towards the land surface through capillary action. Water is applied through underground field trenches laid 15-30m apart. Open ditches are preferred because they are relatively cheap and suitable for all types of soil. The irrigation water should be of good quality to prevent soil salinity.

3. Pressurised irrigation systems

a. **Drip or trickle irrigation** is one of the most modern methods of irrigation. It is suitable for areas of scarce water and saline soils. Water is applied to the root zone of the crop.


Fig 4.4: Types of drip irrigation systems

Advantages of drip irrigation

i. More efficient water use – Soil evaporation, surface runoff and deep percolation are greatly reduced (~95 %, compared to less than 50 % in surface irrigation).

ii. It can apply small amounts of water leading to a smaller fraction of the soil volume being wetted thus reducing unnecessary water loss.

iii. Low interference with cultivation.

iv. Reduced nutrient and chemical leaching into subsoil.

v. Enhanced plant growth and crop yield.

vi. Improved plant health – Less disease and fungal pressure occurs due to drier and less-humid crop canopies (prevention of leaf wetting). The system can also be used for some types of soil fumigation.

vii. Improved fertiliser and pesticide management – Precise and more timely application of fertiliser and pesticides through the system can result in greater efficacy and, in some cases, reduction in their use.

Limitations of drip irrigation

i. High investment is needed.

ii. High level of knowledge needed for optimal and economical operation.

iii. Smaller wetting pattern – The wetting pattern may be too small on coarse-textured soils, resulting in too small an amount of water at the crop root zone.

iv. Reduced upward water movement.

v. Restricted plant root development.

vi. Row spacing and crop rotation limitations – Since the systems are fixed spatially, it may be more difficult to accommodate crops of different row spacing.

b. Sprinkler irrigation system is another modern technique which is widely used. The sprinkler (overhead or pressure) irrigation system conveys water to the field through pipes (aluminium or PVC) under pressure with a system of nozzles. This system is designed to distribute the required amount of water uniformly, which is not possible in surface irrigation. Water is applied at a rate less than the infiltration rate of the soil hence the runoff from irrigation is avoided.

Fig 4.5: Types of sprinkler irrigation systems

Advantages of sprinkler systems

i. Sprinkler irrigation systems are suitable for sloping fields and sandy soils.

ii. They use less water compared with other traditional methods and therefore conserve water, (35-40%) compared to surface irrigation methods.

iii. Fertilisers and other chemicals can be applied through the irrigation water.

iv. Such fertilisers are evenly distributed and avoid wastage.

v. They cover a large area of land in a relatively short time.

vi. They save time and labour as they can be automated to run on a schedule, reducing the need for manual watering.

vii. Sprinkler irrigation systems can be adjusted to different types of crops, soil and weather conditions, thus providing flexibility.

Limitations of sprinkler irrigation

i. They can be costly to install, especially for larger farms or orchards.

ii. Sprinkler irrigation systems can lead to water runoff, leading to nutrient loss.

iii. The systems can create a humid environment that is favourable for the growth of certain pathogens leading to disease and pest issues.

iv. There is high evaporation loss in spraying water.

v. Sprinkler irrigation systems can be adjusted to different types of crops, soil and weather conditions, thus providing flexibility.

Having gone through the modern and efficient irrigation systems in vegetable crop and ornamental plant production, try your hands on the activities below.

Activity 4.1

With the aid of the available background information/pictures/charts of various modern and efficient irrigation systems, explain the meaning of crop irrigation and its importance in agriculture and share your view with a friend.

To be able to explain the meaning of crop irrigation and its importance in agriculture, follow the **step**s below:

1. **Study the structured questions on crop irrigation and its importance below:**
   a. What is your understanding of the term crop irrigation?
   b. Explain how irrigation differs from natural rainfall in terms of providing water to crops.
   c. Why is irrigation essential for crop production, particularly in regions with irregular rainfall?
   d. How does irrigation contribute to maintaining crop health and yield during dry seasons?
   e. What role does irrigation play in ensuring food security?
   f. Provide examples where irrigation has significantly improved agriculture.
2. Reflect on background information/pictures/charts of various modern and efficient irrigation systems and share your views with your friend.
3. Use your understanding based on your reflections to answer the questions on the meaning of crop irrigation and its importance.
4. Share your views with your friend.
5. Document your final findings and present them for whole class discussions.

Activity 4.2

Make use of the given scenario below to explore modern irrigation systems for producing vegetable crops and ornamental plants.

Scenario

Your school is undertaking an initiative to enhance its agricultural programme by expanding the school garden to encompass both vegetable crops and ornamental plants. To allow successful year-round cultivation, it is important to implement an efficient irrigation system. The school administration has identified three modern irrigation systems as practical options: surface irrigation, sub-surface irrigation and pressurised irrigation. They would like to know your expert input to help decide which system would be the most appropriate for your school garden.

Now, follow the **step**s below as a guide to help you explore modern irrigation systems, their advantages, and disadvantages.

1. Review the available background information/pictures/charts on the three types of modern irrigation systems: surface irrigation, sub-surface irrigation and pressurised irrigation.
2. Surf the Internet for further information on your preferred irrigation system.
3. Explore the following aspects:
   a. How does the system work?
   b. What are its key components?
   c. What are the advantages and disadvantages of using this system?
   d. How suitable is it for the types of crops and plants in your school garden?
4. Write a comprehensive report that includes descriptions of different irrigation systems, their advantages and disadvantages, and recommendations on which system would be most appropriate for your school.

Activity 4. 3

Note that you can embark on either Option A or B

1. **OPTION A**

   Search for information on modern and efficient crop irrigation methods using the links provided (https://study.com/academy/lesson/definition-types-of-irrigation.html) (https://www.intechopen.com/chapters/82224), and write a detailed report.

   Follow the **step**s as a guide to search for information on modern and efficient crop irrigation methods and write the report.

   a. Click on the links provided above and watch and read the content. Jot down relevant notes to help you in the report writing.
   b. Write your detailed report. Note that your report should have an introduction, main points and conclusion.

2. **OPTION B**

   Visit farms in the school community or nearby where irrigation systems are used to enable you to see the systems in action.

   The **step**s to follow in your visit to a local crop irrigation farmer.

   Prepare a questionnaire that could be used on your visit. The list of questions should include:

   a. What type of irrigation system do you use, and why?
   b. What is the source of your irrigation water?
   c. How often do you irrigate your crops and what is the average amount of water used per session?

d. How do you monitor soil moisture levels and manage water usage efficiently?
e. What are the main challenges you face with your irrigation system and how do you address them?
f. Have you encountered any issues with water quality and how do you deal with them?
g. What are the costs associated with maintaining your irrigation system and do you find it cost-effective in the long run?
h. Is there anything else you would like to share about your irrigation practices or farming experience?
i. Do you have any suggestions for other farmers looking to improve their irrigation practices?

EXTENDED READING

- Advantages and Disadvantages of Sprinkler Irrigation, https://en.wikipedia.org/wiki/Irrigation_sprinkler
- Advantages and disadvantages of subsurface drip irrigation by Dr Freddie R. Lamm, Professor and Research Irrigation Engineer, Northwest Research-Extension Centre. Kansas State University. Colby, Kansas, flamm@oznet.ksu.edu (Chapter 8 of Advantages and disadvantages of SDIs)
- Criteria for choosing a Suitable Irrigation Method | Irrigation | Agronomy Article shared by: Renuka G. Criteria for Choosing a Suitable Irrigation Method Irrigation Agronomy.

CRITERIA FOR SELECTION OF AN APPROPRIATE IRRIGATION METHOD

Greetings, learner! In the previous lesson, you explored the various modern and efficient irrigation systems suitable for vegetable crops and ornamental plants. We examined surface, sub-surface, and pressurised irrigation, along with their respective advantages and disadvantages. In this lesson, we will focus on the criteria for selecting the appropriate irrigation system for producing these crops. This lesson also prepares you for advanced studies or careers in agronomy, horticulture, and environmental management. This knowledge not only boosts agricultural productivity and sustainability but also empowers you to tackle real-world challenges in modern farming, contributing to the advancement of agronomic practices and food security.

Choosing the appropriate irrigation system for producing vegetable crops and ornamental plants involves a systematic approach by carefully considering the physical, financial, and environmental factors before choosing the most appropriate irrigation

system. This helps to optimize resource utilisation, plant growth, and yield for both vegetable crops and ornamental plants. The key factors to consider are:

a. ***Water needs:*** Determine the water requirements of your specific vegetable crops and ornamental plants. Some plants need more frequent watering, while others prefer less frequent but deep watering. Understanding their individual needs is crucial in selecting the right irrigation system.

b. ***Water source and availability:*** Assess the water source and its availability. If water is scarce, consider more water-efficient systems like drip irrigation to minimise waste.

c. ***Soil and drainage:*** Evaluate the soil type and its drainage capabilities. Sandy soils drain faster and may require more frequent irrigation, while clay soils retain water longer. The irrigation system should match the soil's characteristics to avoid waterlogging or drought stress.

d. ***Topography:*** Sprinkler or drip irrigation is preferred over surface irrigation on steeper or unevenly sloping lands as they require little or no land levelling.

e. ***Climate conditions:*** Consider the local climate, including temperature, relative humidity and rainfall patterns. In arid regions, a more efficient irrigation system might be needed, while in areas with frequent rainfall, a simpler system would be sufficient.

f. ***The crop:*** Surface irrigation can be used for all types of crops. Sprinkler and drip irrigation are mostly used for high-value cash crops, such as vegetables and fruit trees because of their high capital investment. Drip irrigation is ideal for irrigating individual plants or trees or row. Crops such as vegetables but it is not suitable for close-growing crops like wheat, rice, sorghum, groundnuts and pulses.

g. ***Financial strength:*** Determine your budget and available resources for installing and maintaining the irrigation system. Some systems may have higher upfront costs but can lead to long-term savings in water usage and labour.

Good! Having studied the criteria for selecting an appropriate irrigation system for vegetable crops and ornamental plants, please proceed with the following activities.

Activity 4.4

Work in small groups to discuss and compile a list of various crop species commonly grown in your locality and the different irrigation systems used in the production, and then share your findings with the large class.

To discuss and prepare a list of crop species and irrigation systems prevalent in your locality in groups, please follow the **step**s below:

Step 1: Identify and prepare a list of crop species.

a. Form a small group (Where possible in a mixed-gender grouping)

b. Identify and list different crop species commonly grown in the locality.

c. You are encouraged to consider a variety of crops, including cereals, vegetables, fruits, and legumes.

d. Each group is encouraged also, to use available resources to gather information. Resources may include textbooks, local farmers, agricultural extension officers, the internet, and visits to local farms.

e. Document your findings for group discussion.

Step 2: Identify and prepare a list of irrigation systems.

a. Revisit the content covered in the previous lesson on irrigation systems used in crop production.

b. Identify and list various irrigation systems discussed.

c. Create a list of the irrigation systems for group discussions.

d. You are encouraged to include key features, merits, and demerits to the list of irrigation systems.

Step 3: Discuss and compile a list of crop species and irrigation systems and then share it with a large class.

a. Discuss the various crop species and irrigation systems identified by your group.

b. Compile a master list of all the crop species and irrigation systems identified.

c. Create a table or a chart to help Categorize various crop species under different types of irrigation systems. You are encouraged to surf the internet or textbooks to create tables or charts.

d. Prepare and share with the larger class.

Example of a table or a chart to help Categorize various crop species under different types of irrigation systems.

Crop Species	Ideal Irrigation System	Justification for Selection
Tomatoes	Drip Irrigation	Precise water delivery reduces disease risk
Roses (Ornamental)	Sprinkler Irrigation	Even water distribution, suitable for flower beds
Lettuce		
Corn		
Carrots	Subsurface Irrigation	

Activity 4.5

Working in the same groups, identify the water needs of various crop species, design simple irrigation plans for selected vegetable crops or ornamental plants, and present your findings to the larger class.

Follow the **step**s below to help you identify the water needs of various crop species and design simple irrigation plans for selected vegetable crops or ornamental plants to present our findings to the class.

The steps:

Step 1: Search for water needs of local crop species discussed in the previous activities as a base for the design.

a. Work in the same small group to **review** crop species and the irrigation systems discussed.

b. Select some crop species from the list of local crops identified in previous activities and share it with individual group members. You are encouraged to choose a variety of crops covered, including cereals, vegetables, fruits, and legumes.

c. Surf the internet or available reliable textbooks for information on the water requirements of crop species selected. You could Include the following information:

   i. Optimal water needs (in mm per day or liters per week)

   ii. Best irrigation methods for the crop

   iii. Seasonal variations in water needs

   iv. Impact of under-watering and over-watering on the crop

d. Discuss your findings on the water needs and growth requirements of the chosen plant.

e. Take detailed notes and record the sources of their information for reference.

f. Write a summary of the water needs for the chosen plant, along with any notable details or recommendations for irrigation practice.

Step 2: Design simple irrigation plans for named vegetable crops or ornamental plants.

a. Using the same grouping, **review** the optimal water requirements and best irrigation methods for the specific crops discussed.

b. Surf the internet or available reliable textbooks for information on how different irrigation methods suitable for your specific crops or ornamental plants are designed.

c. You are encouraged to consider these factors in your search:

   i. Crop's water requirements and irrigation frequency

   ii. Soil type and topography of the planting area

iii. Climate conditions and seasonal variations

iv. Cost and availability of irrigation equipment

d. Take detailed notes and create a rough sketch of your irrigation plan based on your findings and observations.

e. Discuss the strengths and weaknesses of your plan. You could include these key points about designing a plan in your discussion:

i. Overview of the crop's water needs

ii. A detailed explanation of the irrigation plan design

iii . Visual aids such as diagrams or digital renderings of the irrigation system

f. Create a detailed irrigation plan for your s specific crop or ornamental plant to serve as a resource for the large class. You are encouraged to use graph paper or design software.

Activity 4.6

With the same grouping, create a chart or database that details the watering frequency for various crop species commonly grown in your locality, incorporating knowledge of designing irrigation plans for specific vegetable crops or ornamental plants and sharing with the large class

Follow the guidelines provided carefully below in creating a chart or database.

Step 1: Guidelines for Data Collection

a. Reflect on designing irrigation plans to understand the specific irrigation requirements for each crop. or ornamental plants discussed.

b. Work with your group members and surf the internet or, use other Search Engines to search for information from various reliable sources. You could consider these reliable sources for information:

i. Agricultural websites,

ii. Online agricultural databases, such as the Food and Agriculture Organization (FAO) website,

iii. Local agricultural extension services

iv. Established agricultural organizations.

c. Ensure that the information is up-to-date and relevant to your locality.

d. Take into account the following key parameters: water needs, conditions, and categorizations in gathering your information

i. Gather information on these water needs: watering frequency, water needs volume (in Liters per plant or per square meter), and suitable irrigation systems for each crop

ii. Consider local conditions: climatic conditions, soil types, and typical agricultural practices.

iii. Organise the crops into categories such as cereals, vegetables, fruits, legumes, and ornamental plants.

e. Document your findings based on the key parameters (water needs, conditions, and categorizations) for your analysis.

Step2: **Guidelines for Analysing Data for the Design of the Chart/Database based on the key parameters.**

a. Engage in the provided leading questions for your group discussion on analysing data for the design of the Chart/Database to effectively support Irrigation planning for various crop species in your Locality. These questions include:

i. How do we determine the optimal watering frequency for different crop species to ensure healthy growth and maximum yield?

ii. What historical data on watering frequency is available for our locality, and how can it be used to inform our chart/database?

iii. How can we accurately measure and document the water requirements for each crop species under varying environmental conditions?

iv. What are the best practices for estimating water needs for crops at different growth stages and how can these be integrated into our database?

v. What factors should we consider when selecting the most suitable irrigation system for each crop type?

vi. How can we evaluate the effectiveness of different irrigation systems based on our local conditions and incorporate this into our data analysis?

vii. How does the variability in soil types across our locality impact the water retention and distribution for different crops?

viii. What specific soil characteristics should we analyse to ensure our irrigation plans are effective for all crop types?

ix. In what ways do seasonal climate variations affect the water needs and irrigation scheduling for different crops?

x. How can we use climate data to predict irrigation requirements and ensure our database remains accurate throughout the year?

xi. How do the water needs and irrigation strategies differ among cereals, vegetables, fruits, legumes, and ornamental plants?

xii. What common characteristics within each crop category can help us streamline our data analysis and irrigation planning?

xiii. How do water requirements change from seedling to maturity for various crops, and how should this be represented in our chart/database?

xiv. What growth stage-specific data is critical for accurate irrigation planning, and how can we ensure it is comprehensively included?

b. Write comprehensive notes on key points for analysis to be used in the creation of a chart or database.

Step 3: Guidelines to Design the Chart/Database

a. Create a table with columns for crop name, type, watering frequency, water needs, and suitable irrigation systems.

b. Extract key information on water requirements, such as daily, weekly, and seasonal water needs for different crop species.

c. Input the data into the chart or database, maintaining consistency in units of measurement and terminology.

d. Include notes or comments for any specific observations or unique requirements for certain crops.

e. Document the **step**s and sources used for data collection and analysis.

f. Prepare and present findings to the larger class.

Example Chart/Database Design

Crop/ Ornamental Plant	Type	Watering Frequency	Water Needs (Liters/Week)	Suitable Irrigation Systems
Maize	Cereal	Twice a week	15	Drip, Sprinkler
Rice	Cereal	Daily (growing season)	25	Surface, Border, Check Basin
Tomatoes	Vegetable			
Lettuce	Vegetable			
Mangoes	Fruit			
Pineapple	Fruit			
Beans	Legume			
Roses	Ornamental			
Tulips	Ornamental			

Activity 4.7

Work in small groups, select a simple irrigation procedure and use it to cultivate a vegetable or ornamental plant, document the process and results, and then share with the large class

Follow these steps as your project outline to produce one vegetable or ornamental plant using a chosen irrigation system, documenting the process and results.

The Steps for the Project Outline:

Step 1: The planning: **Crop and irrigation system Selection**

a. With the formed group, reflect on key parameters (Water Needs, Conditions, and categorization) used in the design of the chart/database to support your project effectively.

b. Choose either a vegetable or ornamental plant and a suitable irrigation system for your production. For example: Group A: Drip Irrigation for Tomato Plants

c. Search for more information on your crop and irrigation system selected. Include these guidelines for your search:

   i. Watering frequency and volume.

   ii. Equipment and materials needed.

   iii. Steps for setting up and maintaining the irrigation system.

d. Write your findings as your reference for the project

Step 2: Implementation

a. Set up the irrigation system according to the plan based on the selected vegetable or ornamental plant and the irrigation system.

b. Maintain the irrigation system and monitor plant growth over a specified period)

c. Record observations on plant health, growth rate, and any challenges encountered.

d. Take notes on the effectiveness of the irrigation system

e. Document your findings as a record for presentation in class.

Step 3: Final Preparation and Presentation

a. Prepare a presentation that includes:

   i. An overview of the irrigation procedure used

   ii. Steps taken to set up and maintain the system

   iii. Observations and data collected on plant growth

   iv. Lessons learned and recommendations for improvement

b. Present findings to the larger class, using visual aids such as charts, photos, or videos.

Example of Project Outline: Drip Irrigation for Tomato Plants

Step	Description
Crop Selected	Tomatoes
Water Needs	1-1.5 inches of water per week
Soil Conditions	Loamy soil with good drainage
Environmental Factors	Moderate temperature, low humidity, occasional rainfall
Irrigation System	Drip Irrigation
System Layout	The main water source is connected to drip lines, with emitters placed at the base of each plant (Refer to Diagram)
Watering Schedule	Seedling: 3 times/week for 15 minutes; Vegetative: 3 times/week for 20 minutes; Flowering: 4 times/week for 25 minutes; Fruiting: 4 times/week for 30 minutes
Monitoring	Weekly soil moisture checks, visual inspection of plant health

REVIEW QUESTIONS 4.1

1. Explain two modern irrigation systems and state the advantages of each.
2. Explain the importance of irrigation systems in producing crops.
3. Compare the drip irrigation and sprinkler irrigation methods for crop production.

REVIEW QUESTIONS 4.2

Study the scenario and answer the questions that follow.

In an agricultural science class at the senior high school level, students learn abo*ut the practical application of irrigation and its importance through a case study of a local vegetable farmer, Mr. Asare, who employs various irrigation methods on his farm. These methods include surface irrigation for lettuce, sprinkler irrigation for tomatoes, and drip irrigation for carrots. The teacher highlights the necessity of irrigation to ensure adequate moisture for crops, enhance yields, improve crop quality, reduce plant stress, and facilitate nutrient uptake.*

Questions:

1. List and explain three reasons why it is necessary to irrigate crop plants.
2. Sketch a simple irrigation system that supplies water directly to the root zone of crops.
3. Discuss why different plant species have unique water needs and how these requirements can vary based on factors like growth stage and climate conditions.

ANSWERS TO REVIEW QUESTIONS 4.1

1. Explanation of two modern irrigation systems and stating the merits of each

Surface irrigation method

This is the oldest and most common method, suitable for low to moderate infiltration rates and level lands.

Sub-surface irrigation

In subsurface irrigation, water is applied beneath the ground by creating and maintaining an artificial water table at some depth, usually 30-75cm below the ground surface.

Pressurised irrigation

Pressurised irrigation systems are agricultural irrigation methods that utilise pumps to create water pressure, enabling the delivery of water through a network of pipes, valves, and emitters.

Merits of surface irrigation

- Low initial cost.
- Simple to design and install.
- Easy to maintain and repair.
- Suitable for flat or gently sloping fields.
- allows for natural soil aeration and water infiltration.

Merits of sub-surface irrigation

- Reduced water loss through evaporation.
- Increased crop yields due to targeted water delivery.
- Improved water distribution uniformity.
- Reduced soil erosion and runoff.
- Decreased labour requirements for irrigation management.

Merits of pressurised irrigation

- High water application efficiency.
- Ability to irrigate large areas with a single system.
- Flexibility in water application rates and timing.
- Reduced labour requirements for irrigation management.
- Suitable for a wide range of crops and soil types.

2. Explanation of the importance of irrigation systems in producing crops.
   - Increased crop yield.

- Improved crop quality.
- Water conservation.
- Enhanced food security.
- Expanded crop selection and production.

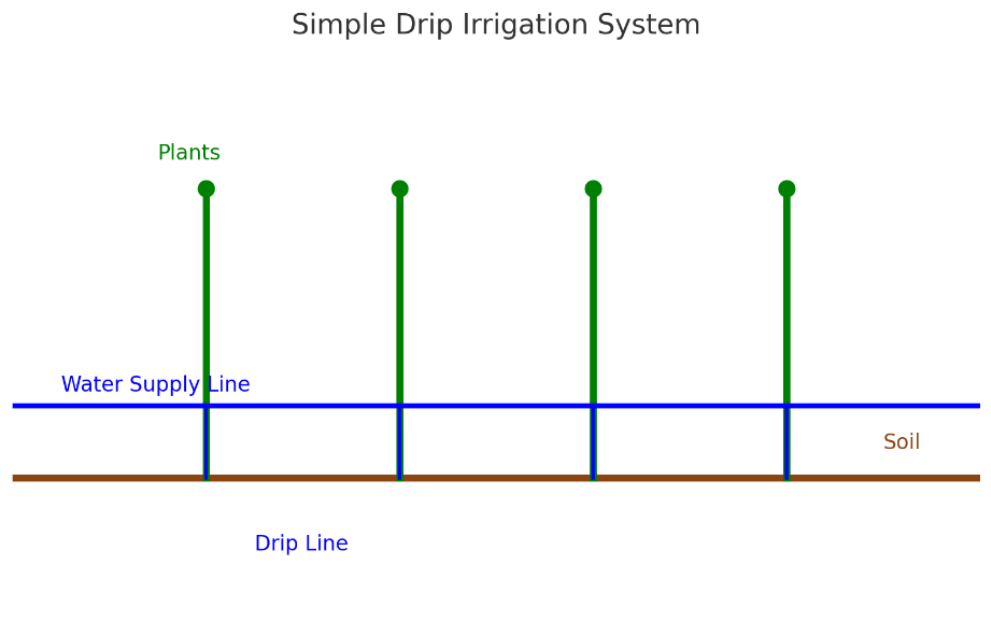
5. Comparing drip irrigation and sprinkler irrigation methods for crop production.

Characteristics	Drip irrigation	Sprinkler irrigation
Water application	Direct to roots	Uniformity over soil surface
Water efficiency	High (90-95%)	Medium (70-80%)
Water loss	Minimal	Significant evaporation
Soil erosion	None	Possible soil erosion
Crop yield	Increased	Good, but lower than drip
Labour requirement	Low	High
Initial cost	High	Medium
Maintenance	Easy	Regular cleaning needed
Water pressure	Low	High
Fertiliser application	Easy	Difficult

ANSWERS TO REVIEW QUESTIONS 4.2

1. Irrigating crop plants is necessary for several key reasons:
   - Ensures Adequate Moisture: Irrigation provides the necessary water for crop plants to thrive, especially in areas with insufficient or irregular rainfall. Consistent moisture is essential for seed germination, root development, and plant growth.
   - Enhances Crop Yield: Proper irrigation can lead to increased crop yields. Farmers can ensure optimal growth conditions by supplying crops with an adequate and regular amount of water, leading to higher productivity and better harvests.
   - Improves Crop Quality: Adequate irrigation helps in producing high-quality crops. Plants that receive sufficient water are less likely to suffer from water stress, resulting in better size, appearance, and nutritional value of the produce.
   - Reduces Plant Stress: Irrigation helps to mitigate the adverse effects of drought and high temperatures. By maintaining adequate soil moisture, plants are less likely to wilt or suffer damage, thereby maintaining their health and growth potential.
   - Facilitates Nutrient Uptake: Water is crucial for dissolving nutrients in the soil and transporting them to plant roots. Proper irrigation ensures that plants can effectively absorb the nutrients they need for growth and development.
   - Supports Soil Health: Regular irrigation helps to maintain soil structure and prevents soil compaction. This, in turn, enhances root penetration and microbial activity, promoting a healthier soil environment for crop growth.
2. In sketching a simple irrigation system that supplies water directly to the root zone of crops follow these guidelines:
   - Identify a specific irrigation system (e.g., Simple Drip Irrigation System)
   - Provide a simple description of the selected system.

     For example: A drip irrigation system is a highly efficient method of supplying water directly to the root zone of crops. This method involves using a main water supply line, which runs along the rows of plants. From this main line, smaller drip lines extend to each plant, delivering water directly to the base of the plant.
   - Create a simple sketch of the specific irrigation system (e.g., Simple Drip Irrigation System)



- Give an interpretation of the component of the sketch
- **Main Water Supply Line:** The blue horizontal line represents the main water supply line that runs parallel to the plant rows. This line carries water from the source and distributes it to the drip lines.

  Drip Lines: The vertical blue lines extending from the main water supply line to the base of each plant illustrate the drip lines. These lines have small emitters that release water slowly and directly to the root zone, ensuring minimal water loss through evaporation or runoff.

  Plants: The green elements represent the plants, with the stem and top shown, indicating where the water is being delivered.

  Soil: The brown line at the bottom signifies the ground level, highlighting the positioning of the drip lines just above the soil to facilitate direct water delivery to the roots.

3. The reasons why water needs to differ among plant species and how these needs can vary:

Different plant species have unique water needs due to a variety of intrinsic and extrinsic factors that influence their growth and development. These requirements can vary significantly based on the species' physiological characteristics, growth stages, and the environmental conditions they are exposed to. Here are the key reasons why water needs differ among plant species and how these needs can vary:

- *Physical Characteristics:* Different plants have varying root structures and transpiration rates, which affect their water uptake efficiency and overall water needs. Deep-rooted plants, such as trees, can access water from deeper soil layers, while shallow-rooted plants, like grasses, depend on surface moisture. Additionally, plants with larger leaf areas or those

adapted to humid environments have higher transpiration rates, leading to increased water requirements.

- *Growth Stages:* Plants have different water needs at various growth stages. Seedlings require frequent watering to establish roots and support initial growth. During the vegetative stage, water demand increases to support rapid growth and metabolic activities. In the reproductive stage, water needs to peak as plants produce flowers, fruits, and seeds, making adequate water supply critical for yield and quality. As plants reach maturity, their water requirements often decrease as they prepare for harvest.
- *Climate Conditions:* Climate conditions significantly affect plant water needs. Higher temperatures increase soil evaporation and plant transpiration, leading to greater water demand, while cooler climates reduce these needs. Humidity levels also play a role; in humid environments, plants lose less water through transpiration compared to arid regions where high evaporation rates necessitate more frequent irrigation. Regular and sufficient rainfall can lower irrigation needs, whereas drought-prone areas require supplemental watering. Additionally, windy conditions can increase water loss from plants and soil, further raising water requirements.
- *Soil Type*: Soil type influences plant water needs through its water-holding capacity and structure. Soils with high clay content retain water longer, reducing irrigation frequency, while sandy soils drain quickly, requiring more frequent watering. Well-structured soils with good aeration support efficient water uptake by roots, whereas compacted soils hinder root growth and water absorption, necessitating tailored irrigation practices.

EXTENDED READING

- Criteria for choosing a Suitable Irrigation Method | Irrigation | Agronomy Article shared by: Renuka G. Criteria for Choosing a Suitable Irrigation Method Irrigation Agronomy. html
- Food and Agriculture Organisation; https://www.fao.org
- Furrow irrigation, Department of Earth Sciences/Integrated Water Resource Management - from traditional knowledge to modern techniques

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- Stem Agricultural Science Curriculum 1. X.1.3.LO.1; I.X.1.3.CS.1
- South Eastern University of Sri Lanka, https://www.seu.ac.lk. Principles of Irrigation, BSE 11042 Principles of Irrigation. Furrow Irrigation
- Surge Irrigation, United States Department of Agriculture (.gov), https://efotg.sc.egov.usda.gov

GLOSSARY

- **Drainage:** Drainage refers to the removal of excess water from the soil to prevent waterlogging and ensure optimal growing conditions for plants.
- **Topography:** This involves the physical layout and elevation of the land where crops are cultivated.
- **Water needs:** Water needs refer to the specific amount of water required by plants to sustain optimal growth, development, and productivity.

Acknowledgements

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