Grade 12

Agricultural sciece

Teacher's Guide

(To be Implemented from 2017)

Department of technical Education
Faculty of Science and Technology
National Institute of Education
Sri Lanka
www.nie.lk

General Certificate of Education (Advance Level)

Grade 12

Agricultural Science

Teachers' Guide

Department of Technology Education
Faculty of Science and technology
National Institute of Education

Agricultural Science

Grade 12
Teachers Instruction Manual

First Edition - 2017

ISBN

Department of Technology Education
Facultyof Science and technology
National Institute of Education
Maharagama
Sri Lanka

Web site : www.nie.lk
Email : info@nie.lk

Printing:

Director General's Message

With the primary objective of realizing the National Educational Goals recommended by theNational Education Commission, the then prevalent content based curriculum was modernized,and the first phase of the new competency based curriculum was introduced to the eight yearcurriculum cycle of the primary and secondary education in Sri Lanka in the year 2007

The second phase of the curriculum cycle thus initiated was introduced to the education systemin the year 2015 as a result of a curriculum rationalization process based on research findings andvarious proposals made by stake holders.

Within this rationalization process the concepts of vertical and horizontal integration have beenemployed in order to build up competencies of students, from foundation level to higher levels,and to avoid repetition of subject content in various subjects respectively and furthermore, todevelop a curriculum that is implementable and student friendly.

The new Teachers' Guides have been introduced with the aim of providing the teachers withnecessary guidance for planning lessons, engaging students effectively in the learning teaching process, and to make Teachers' Guides will help teachers to be more effective within theclassroom. Further, the present Teachers' Guides have given the necessary freedom for theteachers to select quality inputs and activities in order to improve student competencies. Since the Teachers' Guides do not place greater emphasis on the subject content prescribed for therelevant grades, it is very much necessary to use these guides along with the text books compiledby the Educational Publications Department if, Guides are to be made more effective.

The primary objective of this rationalized new curriculum, the new Teachers' Guides, and thenew prescribed texts is to transform the student population into a human resource replete withthe skills and competencies required for the world of work, through embarking upon a pattern ofeducation which is more student centered and activity based.

I wish to make use of this opportunity to thank and express my appreciation to the members ofthe Council and the Academic Affairs Board of the NIE the resource persons who contributed tothe compiling of these Teachers' Guides and other parties for their dedication in this matter.

Dr. (Mrs.) Jayanthi Gunasekara
Director General
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Deputy Director General's Message

In considering theglobal agriculture, agricultural technology has achieved to an unbelievable development. Despite that, the technology used in the agriculture of Sri Lanka is ina backward trend. Specially, labour productivity and land productivity is in a low degree of mechanization in agriculture. Within the current global environment, the capital is the knowledge and the information. Therefore, the learning agricultural science would also be a very valuable opportunity to acquire agricultural knowledge, skills as well as unlimited modern agricultural conceptions

To successfully achieve these requirements in the school, the contribution of the teacher plays a leading role. It is with a great pleasure, we would like to mention that this Teachers' Guide has been prepared in the way it can be used as an aid to perform that leading role.

Although, in planning and introducing the lessons, the instructions mentioned in this Teachers' Guide can be implemented as it is, the teacher has the ability for planning and presenting lessons in different and innovative manner according to the teacher's creativity, students' potential and the requirements of the school and the area.

I wish to thank for all those who contributed in the preparation of this Teachers' Guide.

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Instructions for using the Teacher's Guide:

With this Teacher's Guide prepared for the grade 12 – Agriculture, it has been endeavored to provide proposed instruction to the teacher to prepare for the lesson before going to the classroom and build up the lesson in the classroom.

Accordingly, we expect that it may assist to build up the lesson in the classroom acquiring prior understanding about the learning aids, equipment and materials necessary for the lesson, thereby building up the lesson within the class room.

However,instruction given here are just only a guide for the teacher and it is not expected for them to use it in the same way.The teachers with creative ability may present the lesson innovatively so as to build up the competencies mentioned in the curriculum, within the students.While it is more suitable to build the lesson according to the teacher's creativity, experiences, students' potential levels, and facilities available in the school and would like to inform that the teacher has the absolute freedom to do so.

Introduction

This Teacher's Guide has been prepared in relation to the AgricultureScience syllabus which will be implemented for the grade 12 from year 2017. Specially, when studying agricultural science as an applied and technical subject, it has to face to the technological changes that take place day today. Along with the advancement of science, new specimens come to be used very soon in place of the present breeds of animals, seed varieties, weedicides and insecticides etc. Accordingly, the teacher should use the things that are being daily used inplace of examples and specimens provided in this Teacher's Instruction Manual.

The subject matters such as soil health, underground water, recharging, seed health, foods adulteration, ripening of fruits which had not been included before have been newly included to this syllabus in order to give the students the competences about timely important subject matters.

When implementing the instructions given by this Teacher's Guide, an assessment should be made by the teacher to ensure whether the learning outcomes given for every competency levelis achieved. In this approach, the teacher should prepare in advance to present followingsand the materialsprovided necessary for students' presentations should be supplied in the form of quality inputs.

It is you'reresponsibility toimprove the practical skills of students by arranging a necessary background to carry out the practical exercise mentioned herein. A teacher with qualificationsmentioned in the syllabus should be deployed for the purpose of teaching AgriculturalScience. In the instances, where a teacher with such qualifications is not available a teacher with a Diploma in Agriculturalcan be involved for this purpose.

Even though it is not mentioned in the Teachers' Guide that how a particular competency is actualized, the teacher has the complete right to use any suitable methodology forthe learning- teaching process. Similarly, it is my pleasure to inform you that your critical views regarding this publication may be useful for further development of the subject.

Table of Content

Competency Level 1 : Investigates the contribution of Agricultural sector to the development of Sri Lanka considering objectives of Agriculture practically.

Competency Level 1.1 : Iquires into how agriculture becomes a combination of technology and management.

Number of periods : 03

Learning outcomes :

- Explains the scientific background of agriculture with examples
- Describes relationships of development barriers of the country to the Agriculture sector
- Shows that most of the development barriers in the country are related to the technology and management.
- Explains the role of the technology for Agricultural resource management.

Instruction for planning of Lesson :

- Produce the class, the samples of several crop varieties (Ex: fruits, vegetables, cereals) and animal products (Ex: eggs)
- Ask from students the means of obtaining such foods. Highlight the word "Agriculture" through the responses of the students
- Help the students to build a definition for Agriculture.
  - Agriculture is an art and a science of cultivating crops and raising animals for food or other needs for economic benefits.
- Ask the students about the various fields of the Agriculture.
  - Crop cultivation
  - Animal husbandry
  - Fisheries
  - Forestry
- Show that Agricultural science can be considered as a combination of pure and applied science which is the base of Agriculture.
  N.B. – Here, more attention should be drawn on the scientific basis of the Agriculture.
- Explain through discussions that pure science is based on the fundamental theories and that studying on plants and animals is the basis.
- Confirm through discussions that the Agriculture is based on fundamental scientific theories and studies on these plants and animals.
- Give students an opportunity to confirm and submit the facts that the practices of pure science shall be used in applied science and the Agricultural science is an applied science.
  Eg:
  - While the Botany deals with the study of plants, the crops are developed in crop science by using the useful characters of the plants. .
  - While the element of the nature is studied in chemistry, manufacturing fertilizer using these products to be important to the plant production in Agriculture.
  - Using principles of Biology for plants breeding and Bio technologies in Agriculture.
  - Including the inputs of physical science in post-harvest technology and Agricultural engineering.
- Accordingly, assist the students to confirm that the technology should be used to increase productivity of agriculture through the practices of the pure sciences.

- Give students an opportunity to make self-studies on how to use the agriculture to face for increasing population, demand of foods and national challenges.
  Ex -
  - The kinds of traditional paddy varieties in Sri Lanka and their amount of harvest
    Eg: - Suwadel, Kaluheneti, Pachcha Perumal, Kurulutuda, Ma vee
  - Present high yielding paddy varieties in Sri Lanka and their amount of harvest.
    Eg: - BG 300, BG 352, BG 358
  - High yielding cattle breeds
    Eg: - Friesian, Ireshayor Jersey
- Give students an opportunity to submit the facts on the means of facing national challenges by using these facts.
  Eg: -
  - Generating high yielding varieties.
  - Creating varietal resistance to control pest.
  - Improving crops and animals by developing genetic composition.
- Accordingly, Confirm through discussions that there is a scientific basis in Agriculture.
- However, show with examples that since the management is not duly performed due to the unawareness of the Farmer/ Customer about technology, social issues may be arisen.
  Eg: -
  - Seed monopoly
  - Manure monopoly
- Lead students to observe newspapers / news with many issues currently in Sri Lanka and lead them to study these issues with using them and identify the related fields.
- Produce examples through discussions to confirm that many of these issues may be occurred in relation to the management.
- Introduce the management and ask from students the ideas on its scientific basis.
  (It is sufficient to show through the discussion that the coordinating of resource and production is doing only in the management in an optimum level.)
- Emphasize that increasing the productivity of Agriculture should be done in the management of agricultural resources.
- Show that use of technology is a timely requirement to product in consistent with the necessities with the optimum use of Agricultural inputs.
- Guide students to gather information on how to combine the technology and the management for the productivity of the Agriculture.
- Give students an opportunity to give facts to confirm that many of the short comings in agriculture is not only a result of mere scientific and technological limits but also a result of inefficiency of the economy and market.
  Eg: -
  - Price fluctuation
  - Agriculture extension service
  - Storage facilities
  - Agriculture research and development process
- Show with examples that the technology as well as the management combination is also important to increase the efficiency of agriculture.
- Here, show that the signals on price and quality should be generated from data management market and these would lead for technology.
- Show through the discussions that the market is important to make this management process a success and that all these can be balanced by means of trading.

Key Words :

- Agriculture
- Agricultural science

Qualitative Inputs :

- Various kinds of crop (Ex- fruits, vegetables, grain) and animal products (Ex: - eggs)
- Newspaper reports indicating issues in current development process.

Instructions for evaluation and assessment:

Pay attention on following points.

- Introduction of Agriculture and Agricultural science
- Explaining contribution of the Agriculture to the development of the country
- Explaining the scientific basis of Agriculture
- Explaining the scientific basis of management
- Explaining that the shortcomings of Agricultural sector is a result of the inefficiency of the market.
- Explaining the contribution of agriculture and technology to the productivity of Agriculture.

Competency Level 1.2 : **Inquiries into the expansion and development process of Agriculture sector in Sri Lanka.**

Duration : 03 periods

Learning outcomes :

- Describes the facts for the ancient Agricultural prosperity in Sri Lanka.
- Describes how the plantation Agriculture industry was established for European commercial necessities.
- Explains desirable and adverse effects of plantation agriculture that were arisen due to Foreign/ European invasions.
- Explains how the green revolution has contributed for the Agricultural development
- Explains with examples that there is a requirement of commercial Agriculture industry that was based on the requirement of current world market.

Instructions for preparing the lesson:

- Display video scenes, related to the ancient Agricultural prosperity of Sri Lanka, local irrigation system, video scenes, of Agriculture industry that was arisen on local necessities, video scenes, of green revolution, video scenes, including current commercial agriculture industry, and development projects etc. to the class.
- With that, go to the lesson by asking from the students about ancient Agricultural industry.
- Ask from students about major evidences to confirm that there was Agriculture and related industries in Sri Lanka in the past.
  Eg: -
  - When the King Vijaya was coming, Kuweni was spinning cotton
  - Milk and milk products and animal husbandry
  - Construction of tanks by the kings to improve Agriculture
- Give students an opportunity to gather information about self-sufficiency of Sri Lanka in the past.
  - Importation of Agricultural production
    Eg: -
    - During the King Parackramabahu the Great, grain was exported to the foreign country.
- Give students the instructions to collect the reasons for ancient agricultural prosperity of Sri Lanka through the following points
  - Indigenous technologies
  - Cultural and religious background.
  - Irrigation systems – Proper water management
  - Government assistance
- Lead a discussion with students on how to assist the Indigenous technology to the ancient Agricultural prosperity of Sri Lanka.
  - To select suitable crops for each area. - local crops
  - Specification of land preparation equipment – equipment prepared for each area
    Eg: - Jaffna – mamotee
  - To prepare planting material by the person himself
  - To follow agricultural practices consolidated with the environment
    Eg: - organic manure
    Pest controlling methods – Diya Holmana, Takaya, Kurulu paluwa
  - To create soil conservation and environment equilibrium
  - Forecasting the rain – cultivating in proper time
  - Timely cultivation
    - clearing chena in during drought and setting fire
    - To start the cultivation with monsoon rain
    - To store the harvest – Vee Bissa

- Show students the way to collect facts about the manner in which the government assistance helped to the ancient agricultural prosperity of Sri Lanka.
  - Direct contributions given by the kings to the Agriculture.
  - The proclamation of the Parackramabahu the Great
  - Construction of tanks by the kings and maintaining them under the government control.
  - To give the assistance of public Treasury for irrigation industry
  - To impose rules and laws relating to the tanks.
- Give students the instructions to collect points on the manner in which local irrigation industry and water management effected to the ancient Agricultural prosperity. Inform students to pay attention on following points.
  - Initial human settlement in Sri Lanka
  - Tanks industry in Sri Lanka
    - Special characters of the first tank, ancient tanks system. (Ellanga system)
    - Functions of different parts of the tank.
    - Special land marks in local irrigation technology
      Ex: - Jaya Ganga, Biso kotuwa, division method, drainage works
- Discuss how the cultural and religious background has effected to the ancient Agricultural prosperity Sri Lanka.
  - Improving cultivations due to the development of irrigation
  - Creating characteristics of a developed culture due to the self-sufficiency
  - Improving of ethics and unity among the people and affecting those for the success of Agricultural activities.
- Direct students to find the facts and the features of the Colonial agriculture which was established with the prime objective of the commercial requirements of the European subsequent to the breakdown of kingdoms. Here, lead the students to find facts on desirable and adverse effects caused to the agricultural economy due to plantation industry.
  Eg: -
  - Development of roads, transport and other infra-structural facilities
  - Changing in social structure – Emerging rich families
  - Being under control of foreign countries
  - Loss of lands to the persons who engaged in local agriculture
- Show students that changes occurred in Agricultural field due to the green revolution.
- Assist to submit a definition for green revolution.
  - Green revolution is a process that was accomplished to raise productivity of a land unit through the production of hybrid varieties, mechanization and use of extra inputs to meet the increasing demand of foods as per the increased population with the industrial revolution occurred in Western countries in early part of 1960s decade.
- Discuss on changes occurred in the field of Agriculture due to green revolution.
  Eg: -
  - Introducing high varieties
  - Excessive mechanization
  - Use of chemicals such as fertilizer, pesticides etc.
  - Applying of monoculture
  - Adopting modern water supply methods
- Give an opportunity to present ideas on the favorable and unfavorable outcomes of the green revolution
  Favorable outcomes -
  - Increasing food production.
  - Generating crops verities of high yield.
  - Increasing the harvest per unit land.

Unfavorable outcomes -
- acceleration of land degradation
- deterioration of qualities such as natural resistance
- pollution of water, soil, atmosphere due to unnecessary use of chemicals
- creating health problems
- creating social inequality within the agricultural society
- deterioration of Bio- diversity

- Assist to find the information about modern commercial Agriculture. Here, pay attention on following points
  - Export targeted agriculture
  - agriculture based on private enterprises
- Indicate that at present, there is a requirement of commercial Agriculture that was based on the necessities of the world market.
  - At present, existence of a market that was based on international market

  Eg: -
  - Export of ornamental plants through the hydro – cultured cultivation
  - Exporting the coir dust related products
  - Hydroponic cultivation methods
- Discuss the need of a commercial Agriculture that is based on the private enterprises.
  - Such as value addition is being important at market system that is not controlled by external forces.
  - Requirement for innovations

Key Words :
- Agricultural prosperity
- Colonial plantations Agriculture
- Green revolution

Qualitative Inputs :
- Newspapers, Magazines including the information about Green revolution
- Compact disks including the information about local agricultural technology, irrigation industry

Instructions for evaluation and assessment :

Pay attention on following points.
- To describe the facts that effected to the ancient Agricultural prosperity in Sri Lanka.
- To describe the manner of establishing plantation Agriculture industry for European commercial requirements.
- To explain the favorable and unfavorable impacts of plantation agriculture industry that was generated due to foreign/ European invasions.
- To explain how the green revolution has contributed for Agricultural development.
- To explain with examples the requirement of commercial Agriculture that was based on the necessity of the world market.

Competency Level 1.3 : Investigate the role of the agricultural policies in the case of restructuring the agricultural development process

Duration : 03

Learning outcomes :
- Introduces the re-structuring of Agricultural development and explains its importance.
- explains the importance of Policies and Enactments when the Agricultural development process is being restructured.
- explains the requirement of a national agricultural policy for Agricultural development.
- List the aims/ objectives of national agricultural policy.
- Name the fields that are important for the policy implementation.
- Identify most important policies, relevant institutes and Enactments incorporated in each fields.
- Explains the role of multi-purpose development projects when development process is being restructured.

Instruction for planning of Lesson:

- Enter to the lesson by asking students views on changes occurred in Agricultural field due to foreign invasions and consequently with the arrival of the Europeans.
- Analyze through a discussion that the arrival of Europeans to Sri Lanka is mainly based on the spices trading.
- Here show that their main aim was to prepare the market and the background for that and obtain raw materials.
- Discuss about the status of Agricultural industry in Sri Lanka after European administration.
- Accordingly, point out that restructuring was needed to uplift the Agricultural economy that was changed due to commercial plantation Agricultural industry.
- Give students the instruction to collect information on measures followed in the past to achieve this.

  Eg: -
  - To settle the people in other places
  - To create farming colonies.
- Discuss about the changes that occurred in the economy due to the economic policies which were introduced in 1978.

  Eg: -
  - Exposing the country's economy to foreign markets.
  - Creating a price decision and a price control
  - Creating agricultural plans based on cost
- Lead students to find information on changes that were occurred with the opening of goods import comprehensively to the world.
- Show that restructurings were needed towards the development aims at these occasions.
- Explain to the students that legal background is necessary at the re-structuring and there, policies are required.
- Give instructions to gather information about the important of laws, Enactments when the policies are implemented.
- Identify the targeted policies at development process in the relevant fields. Give instructions to gather information about the institutes which are important in deciding these policies and its roles and acts.

- Guide to identify the fields that are important during implementation of policies and gather information about policies and relevant Enactments and their aims included therein

  Eg: -
  - Enactments
    - Ex: - Irrigation Ordinance No: 23 of 1889, Agricultural Lands and Settlement Act No: 42 of 1973, Water Management Act, Plant conservation Act, National Environmental Act of 1980
  - Targeted fields
    - resources
      - Lands
      - Irrigations
    - Inputs
      - Crops
      - Chemicals
      - Animal husbandry
      - Labour
    - Foods
      - Post-harvest technologies
    - Markets
      - Marketing

  Instructions: it is suggested that this categorization is suitable for teachers to motivate the students.
- Relevant policies
  - Policies on lands and land use
  - Policies on irrigation and water management
  - Policies on sustainable agricultural industry
  - Policies on seeds and planting
  - Quarantine policy
  - Policies on manure
  - Policies on agricultural conservation
  - Policies on post-harvest technology
  - Policies on marketing
- Department and Institutes that are based on policies.
  - Department of Agriculture
  - Department of Irrigation
  - Department Agrarian Services
  - Mahaweli Authority
  - Department of Export Agriculture
  - Ministry of Fisheries
  - Institute of Post-harvest technology
  - Research Institute for Miscellaneous crops
  - Livestock Development Board
  - Institute of Aqua - culture Development
- Give students an opportunity to produce ideas on the requirement of National Agricultural Policy in the Agricultural Development Process.
- Discuss about the requirement of Agricultural policies to create planned social economic development, create agricultural development at national level and foods security in the country.
- Assist to prepare a list of aims/objectives of national Agricultural policy. Give students the instructions to use internet facilities for this purpose.

- Provide an opportunity to gather information on working load of multi-purpose development projects when Agricultural development process is re-structured.
- Here give an opportunity to submit
  - Aims,
  - Contribution of these proposals to the social economic development,
  - Social and environment issues of multi-purpose development projects such as Mahaweli, Udawalawa, Gal- Oya.

Key Words :

- Agricultural development
- Agricultural policies and acts

Instructions for evaluation and assessing:

Pay attention on following points.

- To define Agricultural development
- To identify the requirement of re-structuring the Agricultural development and the background.
- To identify the aims of Agricultural policies and Acts
- To explain the requirement of national Agricultural policy
- To identify institutes, acts based on Agricultural policy and its tasks
- To explain the working load of multi-purpose development projects at Agricultural development process.

Competency Level 1.4 : Investigates the contribution of Agriculture sector to Gross Domestic Production and activities that taken to improve the agriculture sector

Duration : 02

Learning outcomes:
- Compares the way that crops, animal husbandry, fisheries and forest resource contribute for the Gross Domestic Product with numeric and using graphs.
- Indicates the importance of up lifting above fields.
- Lists out information about the employment opportunities in agricultural sector.

Instruction for planning of Lesson:

- Go to the lesson by asking about the sectors that contribute to the Gross Domestic Product at present.
- There lead students to gather information on the contribution of industries, service and Agriculture with the use of sources such as central bank reports, census and statistics information, internet.
- Give students the instructions to tabulate the contribution that was made by industries, service and agriculture to the Gross Domestic Product in last few years.

Year	2013	2014	2015	2016
Agriculture				
Industry				
Services				

- With that give students an occasion to submit the contribution made by each sector to the Gross Domestic Product comparatively.
- Ask from students about the main sectors of the Agricultural industry.
- Lead to compare the contribution made by following sectors to the Gross Domestic Product during the last five years period.
  - Crop cultivation
  - Animal husbandry
  - Fisheries and aquatic resource
  - Forest / forest resources
- With that give students an occasion to submit the contribution made by each sector to the Gross Domestic Product comparatively.
- Ask from students about the main sectors of the Agricultural industry.
- Lead to compare the contribution made by following sectors to the Gross Domestic Product during the last five years period.
  - Crop cultivation
  - Animal husbandry
  - Fisheries and aquatic resource
  - Forest / Forest resource
- Discuss about the measures that have been taken by the government to develop the Agriculture of Sri Lanka.

  Eg: -
  - Granting loans and subsidies
  - Research and extension activities
  - Fixing of guaranteed price
  - Price control

Key Words :

- Gross domestic product
- Agricultural based occupations

Qualitative Inputs :

- Central bank reports (about last five years)
- Internet information

Instructions for evaluation and assessment:

Pay attention on following points.

- To name agricultural fields that contribute to the Gross Domestic Product
- To indicate contribution of each sector with graphs
- To indicate information about different enterprises in agricultural sector.
- To indicate measures that have been taken by the government to uplift current Agriculture

Competency Level 1.5 : Investigate about industries and services related to agriculture sector.

Duration : 02

Learning outcomes :
- Categorizes and indicatesAgricultural based main industries.
- Prepares a leaflet includingAgricultural based main productions, by-products and inputs.
- Submits information aboutAgriculture based services.

Instructions for preparing the lesson:

- Produce true examples, diagrams or photographs of variousAgricultural and Agriculture based products.

  Eg: - Tea, paddy, pepper, fruits, eggs, manure, yoghurt, chicken etc.
  Advertisement items (hand bills, labels, posters)
- Ask from studentsabout these products.
- Show that Agriculture based products and services can be mainly divided in to two sectors.
- Give students an opportunity to indicate examples forAgricultural products and Agriculture based services.
- Indicate that production field can be further categorized as main products, by products and input products.
- Ask from students examples for each kind of products
- Using that, lead students to complete the following chart

Main products	by products	Inputs

- Ask from students examples forAgriculture based services.
- By using 'ideas, indicate that following services are considered as the examples for various Agricultural services
  - Agricultural consultancy services
  - Agricultural researches
  - Financial services and insurance services
  - Agricultural goods marketing and distribution
  - Agricultural training
  - Supply of skilled labour
  - Supply of infra-structure facilities – Ex: - storage and transport
  - Constructions of agricultural structure
- Ask from students examples for each service.
- Give students instruction to prepare a hand bill including Agriculture based products.

Key Words :
- Agro-based industries
- Agro-based products
- Agriculture related services

Qualitative Inputs :

- Agriculture based products such as tea, paddy, pepper, fruits, eggs, manure, yoghurt, chicken etc.
- Hand bills, labels, posters

Instructions for evaluation and assessment:

Pay attention on following points.

- To categorize Agro-based industries with examples
- To categorize and indicate Agricultural based main products, by products and input products differently with examples.
- To prepare ahand bill including Agriculture based products and services

Competency Level 1.6 : Inquires into institutional structure that provides services in the present Agriculture.

Duration : 02

Learning outcomes :
- Names various institutes that contribute to the Agricultural development.
- Summarizes about the services performed by various institutes for Agricultural development.
- Produces suggestions to apply services of Agricultura linstitutions productively.

Instructions for preparing the lesson:

- Ask from students the services needed to those who have engaged in Agricultural industry.
  Eg: - obtaining local and foreign market information, instructions on export market, obtaining of other institutions and services.
- Go to the lesson asking students about the from which the information can be obtained in these occasions and discussing on the regarding the need of various institutions.
- Point out that these institutions are important to supply the various services for Agricultural entrepreneurs, investors.
- Assist students to categorize institutions that are important in Agriculture.
  Eg: -
  - Government institutions
  - Non-Government Organizations
  - Private
  - International
  - Multi community organizations
  - Farmer's organizations
- Ask from students the examples for services supplying Government institutions.
  - Institutions related to extension and training service
  - Agricultural research institutions.
  - Marketing institutions.
  - Post-harvest processing institutions.
- Give students instructions to gather information about the role of these institutions.
- Accompany students to the Agricultural services office in the area and pay attention to its role and services and guide them to understand the requirement of those institutions.
- Ask from students examples for private institutions supplying Agricultural services. Indicate that all the farmers, commercial institutes involving at the market and other people are included here
  Eg: - Institutions/companies related to fertilizer and certain inputs
  Loans and financial facilities
  Wholesalers
  Retailers
  Super markets
- Give students instructions togather information about the international organizations supplying agricultural services.
- For this, guide them to use the newspapers, internet facilities.

- Here, give students instructions togather information about the institutes that are more important to the Agriculture and operating under United Nations Organization.
  Eg:
  - Food and Agricultural Organization -FAO
  - International Rice Research Institute - IRRI
  - International Water Management Institute - IWMI
  - World Health Organization -WHO
- Here, in case there are more important events to Sri Lanka, highlight them specially.
  Eg: The Main office of the International Water Management Institute is currently located in Sri Lanka. (Battaramulla) Ancient Inland water technology of Sri Lanka is considered as the reason for this.
- Lead students to gather information about Non-government multi community organizations. Give students assignments to gather information about the functions/ services of these organizations.
  Ex: Farmers' organization, Sri Lankan Farmers Labours Association
- Give students instructions togather information about the structure and functions of Farmers' organization. Indicate that these organization have been generated in relation to the crops cultivation like paddy, tea
- Lead to gather information about the services done by those organizations.
- Discuss the timely information about the projects which were carried out by these organizations.
  Eg: - Organic cultivation, poison free foods
- Discuss about the co-operative companies created by the combination of private and multi community organizations.
  - Creating these organizations as a result of the solidarity of those who do business in a small scale.
  - Empowering the farmers through the development of supply chain.
  - To reduce the influence of intermediaries
  - Receiving profit directly by the manufacturer.
  - Ability to bargain on input price
    Ex: Indian Amul Company

Key Words :

- Agricultural institutions

Quality inputs :

- Internet facilities
- Leaflets, labels, posters

Instructions for evaluation and assessments :

Here draw the attention on following points

- Identifying the need of various institutions in Agriculture
- Categorizingof various institutes which are important in agriculture, with example
- Identifying the functions of different institutes and their services
- Identifying about the institutes which are commonly used when obtaining services within Sri Lanka

Competency Level 1.7 : Inquires into potentials which have to be developed Agricultural activities in the country.

Duration : 02

Learning outcomes :
- Defines the Agricultural potential.
- Describes the potentials that existin various fields to develop Agriculture in Sri Lanka.

Instructions for preparing the lesson:
- Lead the discussion as the way to build a definition on the Agricultural potential
- The Agricultural potentialis the ability to develop Agriculture further.
- Give opportunity to name various fields contributing to the Agricultural sector.
  - Crop cultivation
  - Animal husbandry
  - Fisheries
  - Forestry
- Discuss the potentials existing in Sri Lanka to improve crops cultivation.
- Guide students to list them.
- Discuss the potentials existing to improve the activities relating to Animal husbandry
- Give opportunity to list those points.
- Discuss the potentials existing in our country for fisheries resources.
- Discuss the ways that can be used to develop these potentials.
- Guide students to list these points.
- Discuss the potentials existing for Forestry
- Guide students to list these points.

Key Words :
- Agricultural potential

QualityInputs:
- Central Bank reports
- Articles and leafletscontaining the potentials for Agriculture,animal husbandry, fisheries and forestry

Instructions for evaluation and assessment:

Pay attention on following points.
- To describe the potential existing to develop crop production
- To describe the potential existing to develop animal husbandry
- To describe the potential existing to develop fisheries
- To describe the potential existing to develop forestry

Competency 2 : Investigates the importance of climatic factors on crop production.

Competency Level 2.1 : Inquires into main climatic factors affected on crop cultivation

Duration : 03 periods

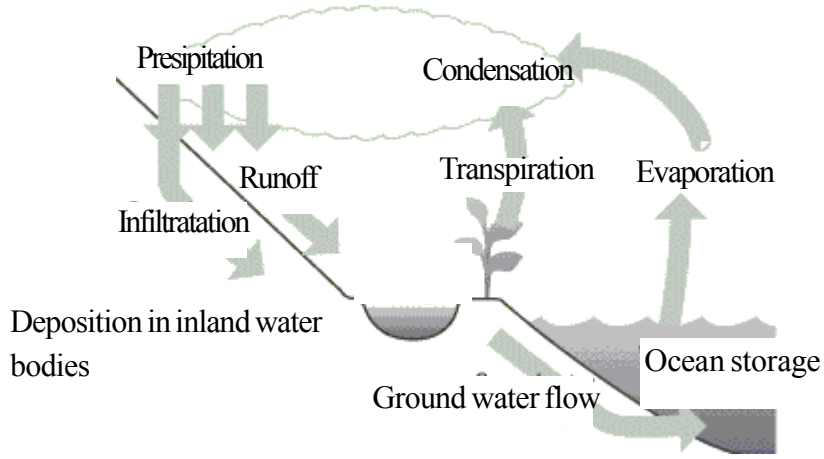
Learning outcomes :
- Names main Agricultural climatic factors and introduce them.
- Describes rainfall mechanism.
- Describes water cycle.
- Indicates components of water cycle.
- Describes the rainfall pattern and relationship between the crops seasons.

Instructions for preparing the lesson:

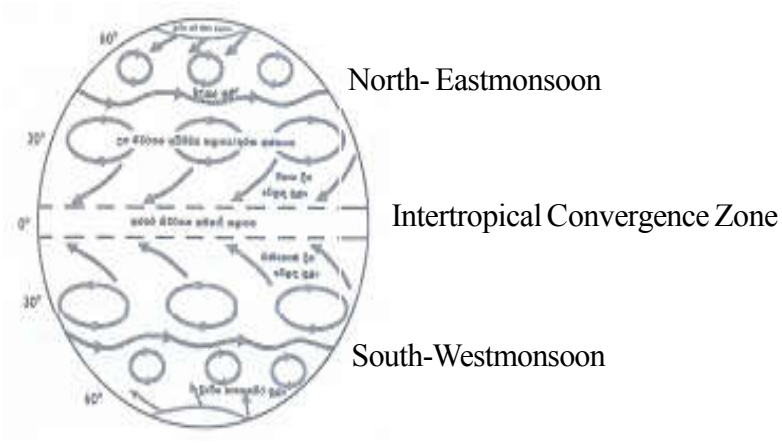
- Go to the lesson by submitting a weather report to the class or througha suitable access.
- Ask students' ideas on what the weather is.
- Using that, guide students to build a definition for weather.
  - Weather is introduced as the changes occurring in atmosphere over a short period of time like 24 hours.
- Ask students' ideas about the meaning of climate
- Guide students to build a definition for climate.
  - The climate of a certain area is introduced as the condition identified by studying long term weather pattern.
- Give opportunity to name Agricultural climatic factors.
  - Rainfall
  - Temperature
  - Light
  - Relative Humidity
  - Wind
  - Evaporation
- Help the students to build an introduction on each climate factors.

  Eg: -
  - Rainfall – rainfall is the droplets water reaching the earth from the atmosphere in liquid form
  - Relative Humidity – The ratio of the actual amount of water vapor present in a volume of air at a given temperature to the maximum amount that the air could hold at that temperature, expressed as a percentage.
  - Wind - Movement of air from one area to another area in the atmosphere.
  - Evaporation - Vaporization of water from an open water surface.
- Indicate that water cycle is helpful to get rainfall and it is a process occurring as a circle.
- Accordingly, point out that water cycle is introduced as the phenomenon in which returning of water in a certain place in the earth to its original place undergoing different status in different places,in different time periods.
- Discuss the process of water cycles with students.
- Give students an opportunity to name the components of water cycle.
  - Evaporation
  - Transpiration
  - Atmospheric circulation
  - Condensation
  - Distillation
  - Precipitation
  - Run-off
  - Infiltration
  - Underground water discharge

- Instruct students to draw the water cycle and name its components.



- Ask students about the Rainfall patterns in Sri Lanka.
- With the help of students' ideas, indicate that there are three rainfall mechanisms for Sri Lanka.
  - Monsoons
  - Inter-monsoons
  - Weather System
- Discuss on each rainfall mechanism.
- Indicate that according to the periods of rainfall occurring in Sri Lanka, it can be divided in to four seasons.
  - First inter-monsoon season – From March to April
  - South-Westmonsoon season - From May to September
  - Second inter-monsoon season - From October to November
  - North- Eastmonsoon season - From December to February
- Discuss on the manner that the rainfall occurs in each season.
  Eg: - Displacement in inter tropical convergent zone to occur monsoon rains.



- Discuss the relationship between the crop seasons in Sri Lanka and rainfall patterns.
  - Yala season
  - Maha season
- Point out that there are three main status in the weather systems
  - Perturbation in low atmosphere or areas of low pressureareas
  - depressions
  - Cyclones/storms

- Indicate that there is a diversity in temperature in various places in Sri Lanka.
- Discuss the reasons for diversity.

  Eg: -
  - Elevation
  - Geographical location
  - Vegetation density
  - Human activities
- Point out that readings are taken as maximum temperature and minimum temperature.
- Indicate that there are threeforms of light.
  - Intensity of light
  - Quality of light
  - Duration of Light
- Define those three patterns.
  - Intensity of light – energy amount contained in the light
  - Quality of light- composition of wave length of visual light
  - Duration of Light - Duration of a certain plant exposing to day light
- Indicate that there are two patterns of wind.
  - Wind speed
  - Wind direction

Key Words :

- Agro-climatic factors
- Hydrological cycle
- Rainfall patterns

Quality Inputs :

A Diagram of the water cycle

Instructions for evaluation and assessment:

Pay attention on following points.

- To name Agricultural climate factors and introduce each factor.
- To explain the water cycle
- To describe the relationship between the rainfall and water cycle
- To indicate the relationship between the rainfall crops patterns and crops seasons in Sri Lanka.
- To introduce main three properties of visual light.
- To name the factors those effects to change environment temperature.

Competency Level 2.2 : Inquires into the impact of climatic factors on crop cultivation

Duration : 04

Learning outcomes :
- Describes the effect of the climatic factors on crop cultivation.
- Selects suitable crops according to theclimatic factors.
- Plans crop cultivation activities to get climate factors as optimum.

Instructions for preparing the lesson :

- Remind about climate factors that effect to crops cultivation.
- Discuss with student show the rainfall effects to the crops production.
  - Land preparation
  - Seed germination
  - Plants growth
  - Flowering of some plants
  - Drying of crop yield
  - Prevent from post-harvest losses
- Discuss on adverse effect caused by the heavy rainfall for crop cultivation
  Eg: - falling of tress, falling of immature fruits and flowers, spread of deceases and pests
- Indicate that not only soil temperature but also aerial temperature effect on crops cultivation
- Discuss the manner in which soil temperature and aerial temperature effecton crops cultivation.
  Eg: -
  - Soil temperature – to seed germination
  - Aerial temperatures – to photosynthesis
- Discuss on adverse effect that arisen when the temperature is high.
  Eg: - when temperature of night is high, growth of tubers becomes disrupted
- Discuss the manner in which relative humidity is important to the Agricultural activities.
  Eg: - To pollination, rooting plant parts
- Discuss the manner that affects crop cultivation due to not receiving an optimum relative humidity.
  Eg: - When relative humidity is high, pollination does not occurduly.
- Discuss the manner in which the three patterns of the light affect to thecrops cultivation.
  Eg: -
  - Intensity of light – to photosynthesis
  - Quality of light – blue light - to photosynthesis
  - Duration of light – for flowering
- Discusswith students the manner in which trees can be divided in to main parts according to the effect of duration of light.
  - Long day plants
  - Short day plants
  - Day neutral plants
- Define the Photoperiodism.
  - Some plants react to the variationof short day and long day duration of light at flowering. This is introduced as Photoperiodism.
- Give students an opportunity to show examples for plants in each category.
  Eg: -
  - Short day – old paddy varieties, strawberry, sesame
  - Long day – beat, spinach, mysore dhal
  - Day neutral – tea, luffa, green pea

- Discuss the way that the wind may be important for crop cultivation.

  Eg: -
  - Increasing of photosynthesis speed due to breeze
  - Contribution of low wind for pollination of some crops.
  - Creating of monsoon rain

- Discuss the damages caused to the crop cultivation by heavy wind.

  Eg: -
  - Increasing the rate of transpiration and evaporation from soil surface.
  - Decreasing photosynthesis surface through due to tearing off leaves by heavy wind.

- Discuss the effect of transpiration for crop cultivation.

  Eg: -
  - Withering of plants

- Discuss the measures which can be taken to decrease adverse effects of climate factors.
  - Heavy rainfall – greenhouse crop cultivation
  - Drought – water supply
  - Heavy light intensity and high temperature - crop cultivation under shelter houses.
  - Low relative humidity - crop cultivation under playhouse

- Discuss the importance of selecting crops for the optimum use of climatic factors.

  Eg: -
  - High quality harvest
  - Increasing of harvest

Key Words:

- Photoperiodism

Quality Inputs :

- Videos, photographs indicating flood, drought

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To describe the way of importance of each climate factor for the cultivation
- To describe the adverse effects that are arisen for crop cultivation when each climatic factor is not received as optimum
- To describe the measures that can be taken to decrease the effect of climatic factor for crop cultivation.

Competency Level 2.3 : Involves in collecting meteorological data using instruments in an Agro-meteorological unit.

Duration : 06

Learning outcomes :

- Defines the Agro- meteorological unit.
- Explains the necessity of an Agro- meteorological unit.
- Describes the factors which should be considered in the selection of a suitable site for installing an Agro- meteorological unit.
- Describes how to install an Agro-climatic unit.
- Receiving, recording and analyzing the climatic data.

Instructions for preparing the lesson:

- Go the lesson by displaying to the class a picture of an Agro-climatic unit, Agro-climatic equipment or any other approach.
- Define the Agro- meteorological unit.
  - Agro- meteorological unit is the place that has been established the equipment to get climatic information that is related to the agriculture.
- Discuss the necessity of an Agro- meteorological unit.
- Discuss the differences between an Agro- meteorological unit and a meteorological unit.

  Eg: -
  - Sunshine recorder, evaporation tank, soil thermometer are not required for the meteorological center.
  - Barometer are not essential for the agro meteorological center.
  - While wind direction indicator is installed at 2m at an agro- meteorological unit; it is installed with various levels at a meteorological center.
  - Modern equipment's are used in a meteorological center to identify the instant changes of climate.
- Discuss the factors which should be considered in the selection of a suitable site for an Agro-meteorological unit.

  Eg: -
  - selected lands should represent the area.

    Eg: -Should not close to a pond or reservoirs
  - Should be an exposed open area and select an area of 10 x 10m in the center of 50 x 50m extended area.
  - Should be a plain area with a satisfactory drainage.
  - Should be free from external barriers (if there are tress and buildings nearby, it should be located the distance of the height of them). (Select an open place as far as possible)
- Discuss about the equipment that is used to measure each climate parameter.
  - Rainfall – non- recording and automatic rain gauge.
  - Maximum temperature – maximum thermometer
  - Minimum temperature – minimum thermometer
  - Soil temperature – soil thermometer
  - Relative humidity – wet and dry bulbs thermometer
  - Sunshine duration – sunshine recorder
  - Light intensity - Sun radiometer
  - Wind direction – wind vein
  - Wind velocity– anemometer
  - Evaporation - Evaporation tank

- Discuss the factors that should be considered in the installation of each equipment.
  - Rain guage (non- recording)
    - Place the top edge of rain gauge at 30cm from the earth.
    - Inner container of rain gauge should be without water leakage, dust and debris
  - Rain gauge (recording)
    - Proper function of the rain gauge and recording parts
    - Localization of graphic sheet properly.
  - Anemometer
    - Fixing of Anemometer at 2m height.
    - Fixing the cups of anemometer so as to rotate to the same direction nevertheless the direction of wind. .
  - Wind vane
    - Marking the main four directions correctly on the post.
  - Maximum and minimum thermometer
    - Installing in the Stewansen screen.
  - Soil thermometers
    - Installing of soil thermometer at various soil depths (5, 10, 20, 30, 100cm)
  - Wet and dry bulbs thermometers
    - Installing in the Stevansson's screen
    - Preparing wet bulbs thermometer duly
  - Sunshine recorder
    - Localizing at 1.5m height from the earth level in accordance with East - West direction.
    - Replacing graph sheets with new ones in every morning.
  - Actinograph
    - Installing at 1.5m height from earth surface.
    - Feeding graphic sheets to the equipment in every morning.
  - Evaporation tank
    - Diameter of evaporation tank is 120cm and depth is 25cm
    - Should have been made of galvanize sheets and painted in white
    - Evaporation dtank should be filled with water up to 18cms
    - Mounting on a wooden frame with 15cm height
    - Should be covered with a net
- Make aware students to search information about Stevansson screen
  Eg: - Its structure, equipments that should be installed there.
    - Discuss with students about the way of obtaining data in an Agro-meteorological center.
  - Rainfall
    - Show the students how to measure the collected to the rain gauges as a height.
    - Give students the instruction to calculate annual rainfall, monthly average rainfall and rainfall intensity in the area.
  - Maximum temperate and minimum temperature
    - Indicate that Six's maximum – minimum thermometer is used to measure temperature.
    - Show the students that after obtaining readings from this instrument, indicator should be calibrated.
    - Indicate that mean temperature is calculated by using maximum temperate and minimum temperature of the day.

$$\text{Mean temperature of the day} = \frac{(\text{maximum temperate value} + \text{minimum temperature value})}{2}$$

- Soil temperature
  - Show that soil thermometer is placed at various depth levels (5cm, 10cm, 30cm, 100cm)
- Relative humidity
  - Show that readings of the dry bulb thermometer and wet bulb thermometer should be taken here.
  - Show that relative humidity is calculated by finding the difference of thermometer readings and using stranded graphs.
  - Give students instruction to determine the relative humidity by using wet and dry thermometer.
- Sun shine hours
  - Indicate that special notes sheets are used for this equipment and duration of bright sun shine can be determined during the periods that spent to burn them.
- Intensity of light
  - Indicate that notes are recorded on a graph sheet with the help of mechanical lever according to the change of the length caused by falling solar radiation on its two metal strips.
  - Point out that the amount of solar radiation is measured by using the graph.
- Wind direction
- Wind velocity
  - Indicate that wind speed is measured in terms of the rotation frequency in a unit time.
  - Indicate that arrow of the indicator has been faced to the direction of wind blowing.
- Evaporation
  - Discuss that calculate the evaporation as a height.

- Ask from students about the units of measuring each metrological parameter.
- Indicate that standard time of taking readings is 08.30 hour and 15.30 hour.
- Indicate that some readings are taken only once a day.
  Eg: - Rain fall, temperature, sunshine hours, solar radiation, wind velocity and direction, daily evaporation
- Show that some readings are taken twice a day.
  Eg: - Wet and dry bulb thermometers readings, soil thermometers readings.
- Discuss with students about recording data.
  - Data that is taken once a day should be entered against the of the previous day
  - Readings that are taken at twice a day should be recorded morning and evening of the same day.
- Discuss with students about the way of data analyzing.
  - After recording rainfall values daily, it should be arranged as monthly and annual values.
  - After recording temperature and humidity daily, it should be arranged as monthly and annual values.
  - Drawing graphs about rainfall, temperature, humidity.

Key Words :

- Agro-meteorological unit
- Meteorological equipment
- Meteorological data

Quality Inputs :

- Meteorological equipment
- Figures/ a picture of metrological unit
- Data records sheets – graphs

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To define an Agro-meteorological unit
- To state the factors which should be considered in the selection of a suitable site for an Agro-meteorological unit.
- To indicate the way of installing equipment in the Agro-meteorological unit
- Collecting, recording and analyzing of Agro-meteorological data

Competency Level 2.4 : Classifies climatic zones further more in order to facilitate agricultural activities.

Duration : 03

Learning outcomes :

- Indicates the basis of determining climatic zones of Sri Lanka.
- Maps the main climatic zones.
- Categorizes agro climatic zones and agro ecological zones.
- Explains the importance of a map of agro ecological zones.

Instructions for preparing the lesson:

- Enter to the lesson by presenting to the class a climatic zones map and inquring about that.
- Ask students about the basis of determining climatic zones of Sri Lanka.
- show that Sri Lanka is divided in to three major climatic zones
  - Wet zone
  - Intermediate zone
  - Dry zone
- Lead students to mark major climatic zones on a map of Sri Lanka.
- Guide students to present rainfall value in each climatic zone.
- Define the Agro-climatic zones.
- Indicate that Agro-climatic zones have been divided in to seven.
- Categorize and indicate seven agro climatic zones.

Major climatic zones	Agro climatic zones
Wet zone	Up Country wet zone
	Mid Country wet zone
	Low Country wet zone
Intermediate zone	Up Country intermediate zone
	Mid Country intermediate zone
	Low Country intermediate zone
Dry zone	Low Country dry zone

- Classify climatic zones into Agro-ecological zones.
- Define what an Agro-ecological zone is.
  - Agro ecological zone is an area consisting of analogous ecological characters that arise when climate, soil, physical features and diversity of land use are interconnected.
- Indicate that the following factors should be considered to classify agro-climatic zones up to agro-ecological zones.
  - Average Monthly rainfall (75% expected value) and monthly distribution.
  - Elevation
  - Major land use
  - Major soil types

- Discuss with students the basis of classification agro-ecological zones.

Wet zone	→ Up Country wet zone	→	Sub zones - 04
	→ Mid Country wet zone	→	Sub zones - 06
	→ Low Country wet zone	→	Sub zones - 05
Dry zone	→ Low Country dry zone	→	Sub zones - 11
Intermediate zone	→ Up Country intermediate zone	→	Sub zones - 07
	→ Mid Country intermediate zone	→	Sub zones - 08
	→ Low Country intermediate zone	→	Sub zones - 05
			46

- Discuss with students the way that each Agro-ecological zone has been symbolized with two English letters and digits.
  - The wet zone, the dry zone and the intermediate zone are named W, D and I respectively.
  - The low country, mid country and up country are named as L, M and U respectively.
  - Thirdly, the given digit shows the moisture content of the relevant zone
  - The given simple letter (from a to f) shows positional and topical changes in each rainfall season and the effect of other physical factors on moisture.

    Eg: - Low Country wet zone - WL

    Sub zones - 5.

    WL_{1a} WL_{1b} WL_{2a} WL_{2b} WL_{3}

- Discuss with students the importance of dividing Agro-ecological zones.
  - Identifying areas of having stereo typed climatic conditions
  - Ability to recommends suitable crops for each zone.
  - Easy to plan and implement agricultural projects.
  - Easy to do land development and conservation activities.
  - Easy to plan cultivation activities.
  - Ability to get due outcomes from the investments in agricultural field and miniize the risk.
  - Ability to minimize effects that take place through the climatic changes.

Key Words :

- Climatic zones
- Agro-climatic zones
- Agro-ecological zones

Quality Inputs :

- Maps of climatic zones and agro ecological zones

Instructions for Evaluation and Assessment:

Pay attention on following points.

- Categorizing major climatic zones of Sri Lanka
- Categorizing Agro-climatic zones
- Categorizing Agro-ecological zones
- Explaining the importance of dividing Agro-ecological zones

Competency 3 : **Prepares plan to obtain high yield through the management of the soil quality.**

Competency Level 3.1 : **Inquires into the effect of soil formation and soil profile development on crop cultivation.**

Duration : **05**

Learning outcomes :
- Deseribes the Agricultural importance of soil.
- Describes the factors that effect to rock weathering process.
- Describes the factors that are importance for soil genesis.
- Creates a model of a soil profile.
- Describes the importance of studying a soil profile.

Instructions for preparing the lesson:

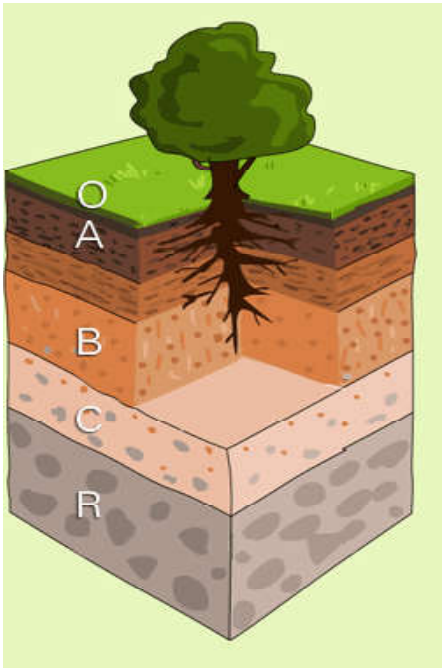
- Enter to the lesson by presenting a video scene about soil or any other suitable manner.
- By asking students' ideas highlight a definition for soil. .
  - Soil is a system found in the surface of the earth which provide dynamic substtrate for plant growth and consist of minerals organic matter various organisms air and water.
- Show that soil is a non-renewable biological unit and the energy flows inside the system.
- Lead a discussion with students about the Agricultural importance of soil.
  Eg: - Acting as a nutrient reserve, supplies a media to micro and macro organism.
- Discuss about the soil formation process.
- Indicate that there are two stages in soil formation process.
  - Weathering of rocks
  - Soil genesis
- Inquring students' ideas, highlight build a definition for a rock.
  - A rock is a solid mass that is formulate due to agglomerating minerals n a large scale
- Highlight through the students a definition for weathering of rocks
  - Rock weathering is a process of the formation of basic substances as a result of different physical, chemical and biological reactions on rocks
- (With students' answers, show that the factors that affect rock weathering can be classified as follows:-) Indicate that factor affect to weathering can be classified as fallowing by using student aswere.
  - Physical factors
  - Chemical factors
  - Biological factors
- Lead a discussion with students about the physical factors that affect for rock weathering.
  Eg: - Temperate fluctuation, rainfall
- Lead a discussion with students about the chemical factors that affect for rock weathering
  Eg: - Solution, hydration, oxidation
- Lead a discussion with students about the biological factors that affect for rock weathering
  Eg: - Growth of plant roots, boring holes by animals
- Confirn students that prenatal material is formed followed by rock weathering.

- By inquring students' views, highlight a definition for soil genesis through their responses
  - Soil genesis is the process of formation of soil along with the organic maters, as a result of the parent materials undergoing various climate conditions with the period of time
- Ask from students the factors affecting to soil genesis.
  - Parenatal materials
  - Topography
  - Climate
  - Biosphere
  - Time
- Indicate that biological factors and climate are called as active factors and others are colled as inactive factors.
- Explain students with examples that the type of the soil formed varies according to the nature of the parental material.

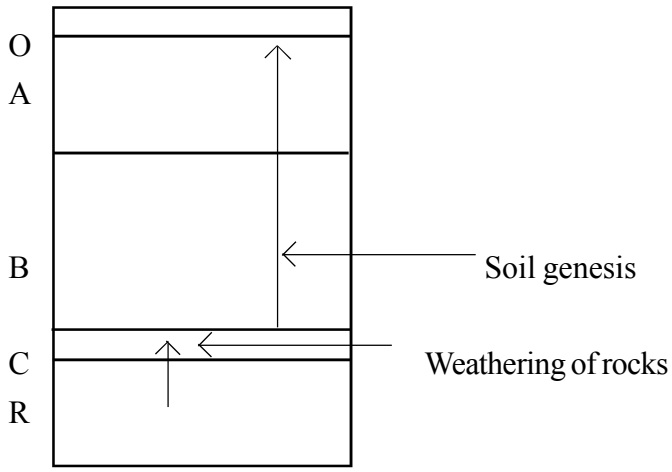
  Eg: - Sand content is high in soil that is formed by sand-stone weathering.
- Discuss through the following topics how the topography effects on the process of soil genesis.
  - Elevation
  - Slope
  - Direction to the sun
- Lead a discussion with students about the effect of climate factors on soil genesis.
  - Rainfall
  - Temperature
  - Wind
  - Humidity
  - Light
- Indicate that out of these factors, following climate factors are mostly effect on soil genesis.
  - Rainfall
  - Temperature
- Ask from students the effect of biosphere on soil genesis.
  - Plants
  - Animal and the man
- Indicate the students that soil can be classified as per the time taken for soil genesis.

  Eg: - Soils that are formed by a long term ago called as mature soils while the soil that is formed by a resently called as immature soil.
- Indicate that rock weathering and soil genesis are displayed through a soil profile.
- Highlight a definition for soil profile through the views of the students.
  - Soil profile is a vertical section from soil surface to the parental rock.
- Give opotunity to draw a diagram of soil profile and give an opportunity to identify its zones.

- O Horizon
- A Horizon
- B Horizon
- C Horizon
- R Horizon



- Lead a discussion with students about the special characters of each horizon.
  - O Horizon - contains high percentage of organic matter. Zone that contain organic matter adding newly is called as A_{00} and zone containing organic matter that decompose at some extent as A_0 and Zone that contain organic matter that was decomposed as humus zone.
  - A Horizon It is called elluvial zone and when the rain is heavy, basic iron is leached. Here, more organic matter is contained relatively.
  - B Horizon -It is called alluvial zone and basic iron leached from zone A is accumulated. Here, organic matter is relatively less.
  - C Horizon - Zone with prenatal material
  - R Horizon – Zone with prenatal rock
- Lead students to explore that various stages in soil formation are marked by a soil profile.



- Show the students that prenatal material (C) is formed by weathering of prenatal rock (R) and soil is formed by being subject to prenatal material to soil genesis process.

- Guide students to observe a soil profile.
- Give students instructions to study of soil profile.
- Explain students the way of developing soil profile with diagrams.
- Discuss the importance of studying the soil profile.

  Eg: -
  - To identify the active depth root growth.
  - To determine the tilling depth knowing the depth of soil zones.
  - To determine the crops suitable for soil acording to depth.
  - To understand the draining condition of the soil.
  - To select suitable land preparation equipment.

Key Words :

- Soil
- Rocks
- Weathering of rocks
- Soil genesis
- Soil profile

Qualitative inputs :

- A diagram of typical soil profile
- A model / diagram or true specimen of a soil profile

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To define soil and rock
- To define process that affect for soil formation
- To define weathering of rocks
- To explain the factors that affect for weathering of rocks
- To define the soil genesis
- To describe the factors that affect for soil genesis
- To define the soil profile
- To explain about soil formation with the help of soil profile
- To prepare a typical soil profile
- To explain the importance of studying soil profile

Competency Level 3.2 : Inquires into the soil components required for crop cultivation.

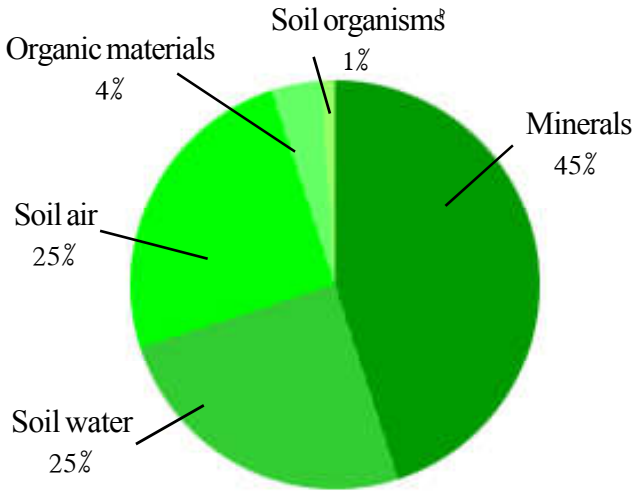
Duration : 06

Learning outcomes :

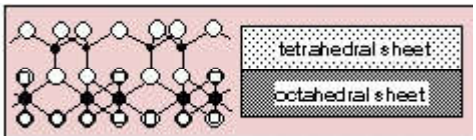
- Mentions the composition of soil components with a pie chart.
- Describes the arrangement of soil components in the soil.
- Determines the soil moisture percentage.
- Describes the effect of soil components for crop cultivation.
- Determines the field capacity of soil.
- Determines the permanent wilting point of soil.

Instructions for preparing the lesson:

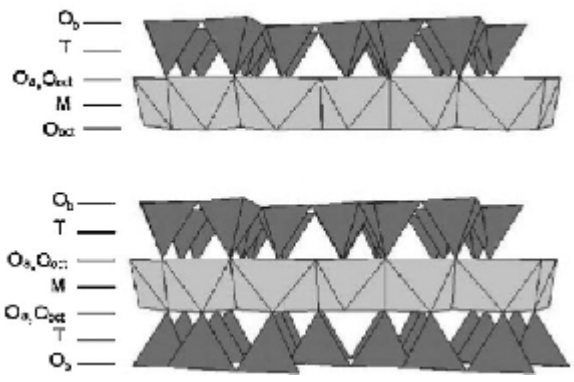
- Enter to the lesson by displaying to the class a pie chart that shows the composition of soil components Using the pie chart, lead students to name the soil constituents.
  - Solid materials
    - Minerals
    - Organic mater
    - Soil organisms
    - Soil water
    - Soil air



- Lead students to classify minerals according to origin of minerals'
  - Primary minerals
  - Secondary minerals
- Lead students to present examples for primary minerals and secondary minerals.
  - Primary minerals - quarts, feldspar

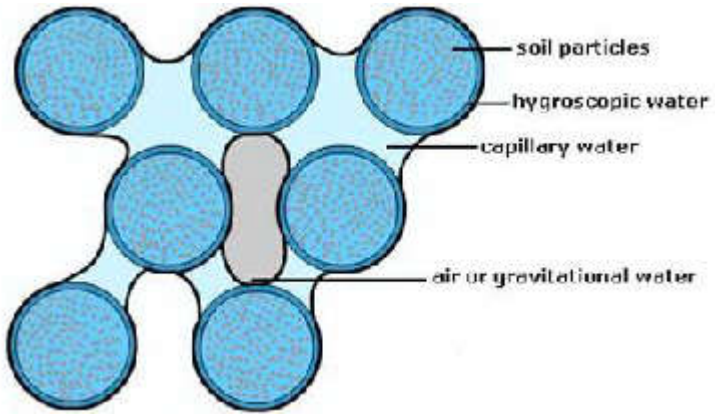


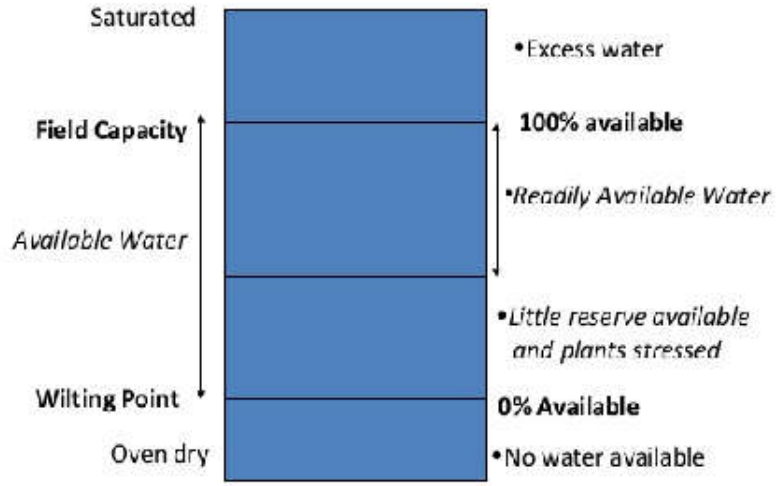
  - Secondary minerals - kaolinite, monmorilonite, elite



- Lead a discussion with students about common properties of clay minerals.
- Discuss the way that soil affects to crop cultivation.
  Eg: -
    - Retention of nutrients
    - Retention of water
- Define what soil organic materials is.
  - Organic matter is mixture materials that release by micro organisms or formed by after decomposition of plants and animals by elonging their chemical composition.
- Discuss the importance of organic materials.
  Eg: -
    - Improve physical characters of soil including soil structure
    - Improve microbial activities
    - Inquired from students examples for soil organisms
    - Leads discussion with students about how soil microbs effect to crop cultivation

      Ex:-
        - Provide nutrients
        - Act as isease caused agents
        - Improve soil properties
- Lead students to classify soil organisms according to the following criterions
  - According to the size (width of the body)
  - Ecological activity
  - Source of energy for growth
- Lead a discussion with students about the way that affect soil organisms to crop cultivation.
- Lead students to compare soil air and the composition of atmospheric air.
- Lead students to name the factors that affect to composition and capacity of soil air, lead a discussion about that.
- Discuss the importance of soil air.
  Exg -
    - To the activity of microorganisms
    - To the growth of plants roots.
- Lead students to define soil water.
- Lead a discussion with students about the effect of soil water for crop cultivation.
- Lead a discussion to highlight the points about the phenomena that affect for the retention of water in soil.
  - Cohesion adhesive power and capillary action.
  - Surface tension
  - Polarity of water
- Lead students to classify soil water according to the following criteria.
  - Physical classification
  - Biological classification
- Lead a discussion with students about various types of water.
- Explain the various moisture levels of soil through a diagram.
  - Saturation
  - Field capacity
  - Permanent wilting point





- Lead a discussion with students about the methods that are used to determine the soil water content.
  - Gravimetric method
  - Gypsum block method
  - Tensiometer method
- Lead students to calculate the percentage of moisture content in a soil sample taken from the field by gravimetric method.
- Lead students to find out the field capacity of soil by following due steps.
- Introduce the permanent wilting number and lead students to determine permanent wilting number in a soil sample.
- Ask from students the methods of transporting water to the soil.
  - Infiltration
  - Percolation
- Discuss the method of removal water from soil.
  - Deep percolation
  - Evapo-transpiration
- Discuss the inter relations among soil components.

  Eg: - It needs soil air and soil water to the activity of soil organisms.

Key Words :

- Soil minerals
- Soil organisms
- Organic matter
- Soil moisture
- Soil air

Qualitative inputs :

- Relevant diagrams
- Video scenes
- Materials and equipment required for the gravimetric method to measure soil water content.
- Materials and equipment to find soil field capacity.
- Essential materials and equipment required to find wilting number.

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To define soil components
- To classify soil minerals
- To explain common characterestics of clay minerals
- To explain the importance of soil organic mater and soil organisms.
- To compare the compositions of soil air and atmosphere air.
- To classify the soil water
- To explain various moisture levels in the soil.
- To determine the moisture content of a soil sample.
- To determine the field capacity and permanent wilting point.
- To state the inter relations among the soil components.
- To explain how the soil components are important for crop cultivation.

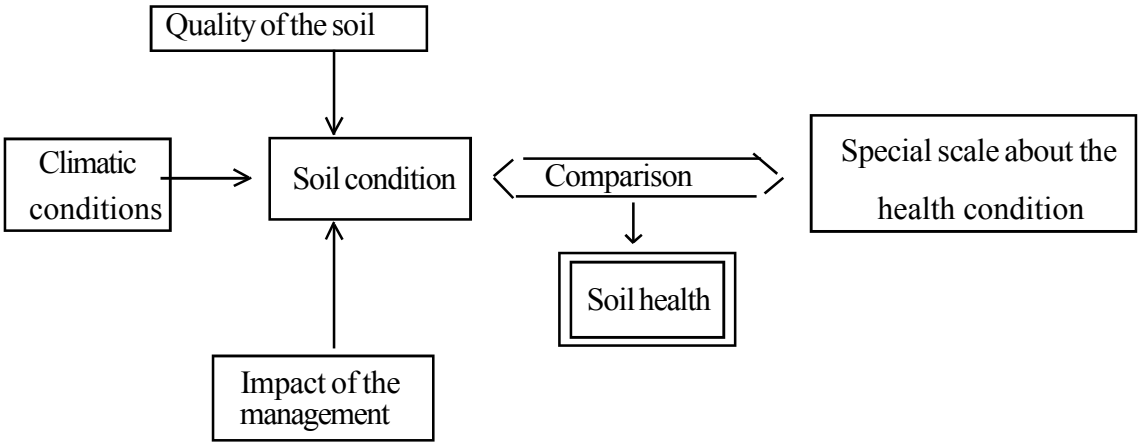
Competency Level 3.3 : Determines the factors affecting soil health.

Duration : 02

Learning outcomes :
- Defines soil health.
- Classifies the factors that affect to soil health.
- Describes the importance of soil health.

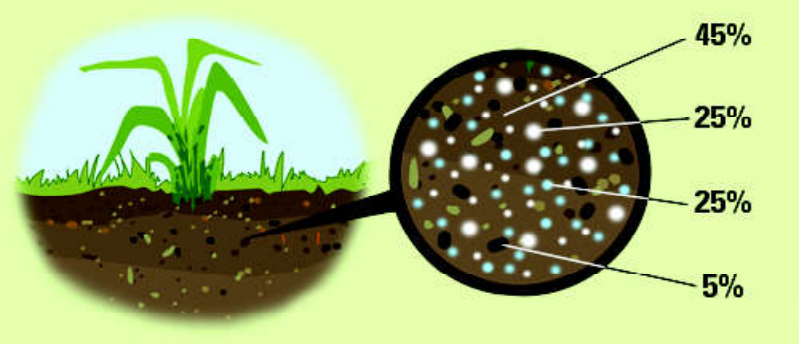
Instructions for preparing the lesson:

- Enter to the lesson by producing following text for the class.
  If some nation destroys the soil of the land where they live, it is like a destroying by themselves.
  - Franklin Roswell - (fomer president of the America)
- Accordingly, emphasize the necessity of a healthy soil.
  Eg: In 2013, the word population may increase up to more than 7 billion and it has been projected that it will be doubled by 2050. To face this situation, food production should be increased by 70%. If long term sustainable agro productions are to be increased, there should be a healthy soil.
- Lead students to build a definition for soil health.
  - A healthy soil means an animated, active and dynamic nutritious medium of where microorganisms are abundant and not a merely lifeless growth media.
  - Soil health is the ability of soil to fulfill an activity of ecological systems according to the environment.
- Explain students that soil health is often expressed by the formation of a special scale.

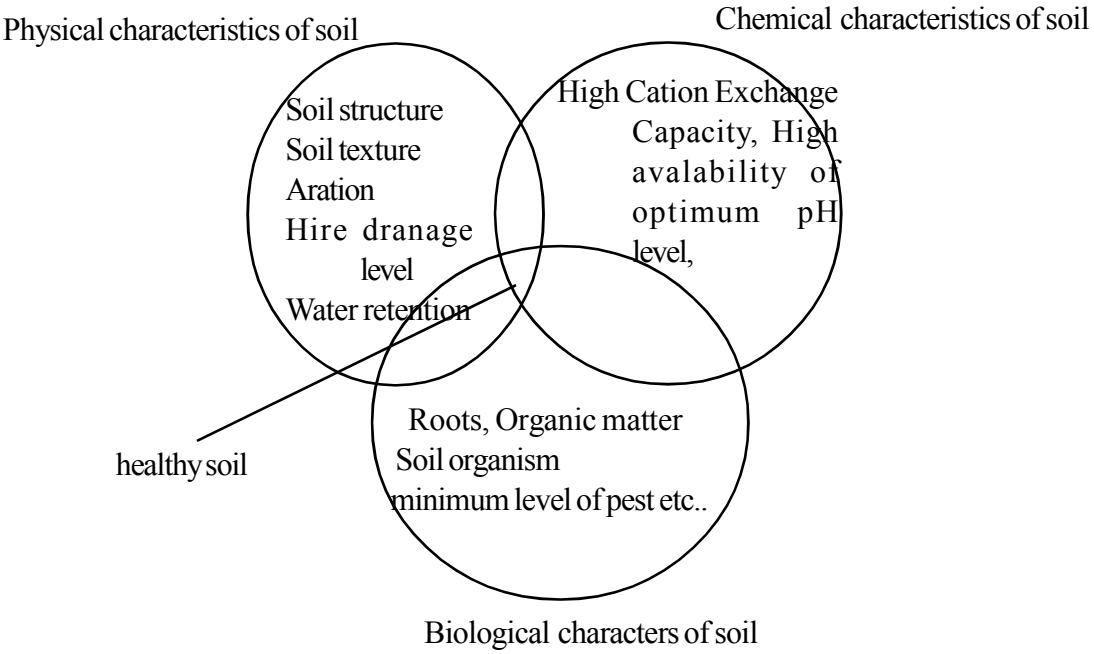


- Explain students about the essential necessities if it will be a healthy soil according to Human health analog.
  - Soil should be healthy in biochemical and physical propaties.
  - It should not have been subjected to soil degradation.
  - Soil should reach to its total product potential and srsistant to the degradation.
- Lead a discussion with students about the importance of soil health.
  Eg:
  - Maintaining the sustainable plants and animal products and biodiversity.
  - Maintaining the activities in relation to hydrosphere and atmosphere in optimum level.
  - Maintaining the activities with human health.
- Give students an opportunity to collect points about the properties of healthy soil.
  Eg: - Increasing productivity, increasing profit by decreasing cost of production, protection of natural resources, Increasing sustainability of forest and habitats.

- Explain students that space of a healthy soil should be a considerable volume from total volume and should be consist of considarable level of soil air, water and micro organisms.



- Inquir students about the factors affecting to healthy soil. and show these factors can be classified as follows.



- Lead a discussion with students about the Physical propaties affecting to the soil health.
  Eg: Soil aggregates, soil structure, making hard pan on soil surface, soil compaction, porosity, ability to retain water and ability to absorb water.
- Lead a discussion with students about the biological characters affecting to the soil health.
  Eg: Macro organisms, meso organisms, microorganisms, organic materials, soil process
- Lead a discussion with students about the chemical propaties affecting to the soil health.
  Eg: Increasing of pH value of soil and cation exchange capacity.

Key Words :

- Soil health

Qualitative inputs :

- Relevant diagrams and pictures.

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To define soil health
- To explain the importance of soil health.
- To explain factors affecting to soil health.

Competency Level 3.4 : Determines the physical properties of soil affecting on soil health and quality

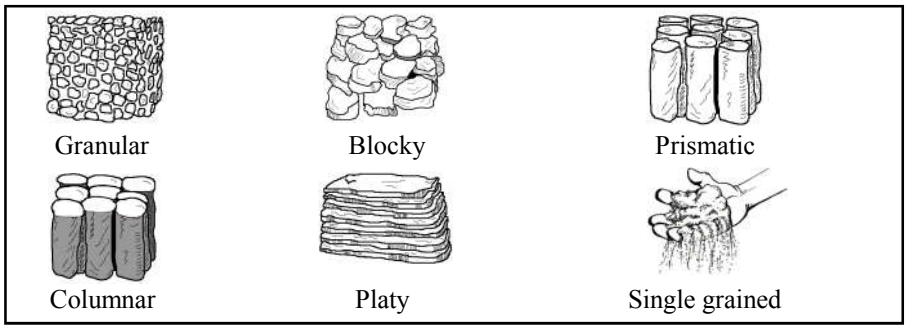
Duration : 08

Learning outcomes :
- Determines soil texture by following various methods.
- Determines soil structure.
- Determines soil colour.
- Determines bulk and true density in soil.
- Calculates the soil porosity in various soil.
- Describes how to affect physical propaties of soil to the crop cultivation.

Instructions for preparing the lesson:

- Enter to the lesson by producing a soil sample and conveyingemploying that characters like its colour, texture are changed.
- Using that, explain what the physical characters of soil are and lead students to name the physical characteristics.
- Highlights through the students a definition for soil texture.
  - Soil texture is the relative percentage of minerals sand, clay, silt etc. in the soil..
- Lead students to explain the importance of soil texture.
  Eg :
  - To select suitable crops for cultivation
  - To select suitable equipment for land preparation
  - To select a suitable irrigation method
- Lead students to determine texture of soil samples.
- Indicate that soil colour is the colour which can be observed through the naked eye
- Indicate that soil colour of a soil sample is determined by using munsell colour chart.
- Lead students to determine the colours of soil samples by using munsell colour chart.
- Lead students to state about the importance of soil colour for crop cultivation.
  - It can get a rough idea about soil nutrients.
  - It can get an idea about the drainage and aeration of soil.
  - It can express the quantity and irrigation intervals.
- Raise a definition for soil structure through the students.
  - Basic particles such as sand, clay, silt etc. of the soil are often not existed separately and, those are formed as secondary particles with bonding agents such as organic materials.
- Indicate different types of soil structures using the graphs.

  Eg:



- Lead and assist students to determine the soil structure of soil samples.
- Lead a discussion with students about how to manage the soil structure for crop cultivation.
  Eg: Adding organic materials when soil texture is poor.
- Raise a definition for soil consistency.
  - When a some stress is applied on a mass of soil and it is being gradually increased, soil layer is ruptured at a certain point. Soil consistency is the reaction of the soil mass against that rupture.
- Explain students the method of determining the consistency of a soil sample.
- Discuss with students the effect of soil consistency for crop cultivation.
  Eg:
  - To know the hardness of soil.
  - To decide suitable stage for land preparation.
  - To decide suitable equipment for land preparation
- Define the soil density.
  - Soil density is the weight of the soil in a given unit volume.
- Lead students to find the information on soil density patterns.
  - Bulk density (ρ_b)
  - True density (ρ_p)
- Define the bulk density.
  - The weight of solid materials in a unit volume of soil.
- Lead students to determine bulk density in a soil sample.
- Discuss the importance of knowing bulk density of soil.
  - Ability to get an idea about the soil hardness.
  - Ability to get an idea about water retention of soil.
  - To calculate the necessity of irrigation.
  - Ability to get an idea about the rooting space in a soil.
- Define the true density.
  - The ratio of the mass of the true materials to the volume of solid materials is called as the true density.
- Lead students to determine true density in a soil sample.
- Define the soil porosity.
  - The percentage ratio of the special volume to the total volume of a soil is called as soil porosity.
- Indicate that following equation can be used to calculate soil porosity.

$$\underset{(p)}{\text{porosity}} = 1 - \left[\frac{p_b}{p_s}\right] \times 100$$

$$P_E = \frac{V_w + V_a}{V_t} \times 100$$

$$P_E = \frac{V_t - V_s}{V_t} \times 100$$

Vt = Total volume

Va = Volume of air in soil

Vw = Volume of liquid in soil

Vs = volume of solid in soil

- Lead the students to calculate soil porosity by using soil bulk density and true density.
- Discuss the importance of soil porosity in crop cultivation.
  Eg:
  - Air and water existing in a soil retain in the space of the soil. Since the spacious volume is less in a hard soil, the porosity is low. Therefore, water absorption and water retention in such a soil is low. Such a soil is not suitable for crop cultivation.

Key Words:

- Soil texture
- Soil structure
- Soil consistency
- Soil colour
- Soil bulk density
- Soil true density
- Soil porosity

Qualitative inputs :

- Soil samples
- Necessary items and equipment to find soil texture
- Necessary items and equipment to soil find bulk density and true density.
- Diagrams depicting the pattern of soil structure.
- A Munsell colour chart

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To explain the importance of soil texture.
- To determine soil texture of soil samples.
- To explain the effect of soil consistency to the crop cultivation.
- To explain the importance of soil structure.
- To explain the importance of soil colour.
- To determine soil colour of a soil sample.
- To describe the important of true density and bulk density.
- To determine the true density and bulk density of a soil sample.
- To calculate the porosity of a soil sample.

Competency Level 3.5 : Inquires into the soil chemical properties which affect on soil health.

Duration : 05

Learning outcomes :
- Names the chemical properties of the soil that effect for crop cultivation.
- Describes the effect of chemical characteristics on crop cultivation.
- Determines pH value of the soil.
- Determines the salinity of the soil.
- Calculates the base saturation of the soil.
- Describes how to manage the chemical properties of the soil for the protection of soil health.

Instructions for preparing the lesson:

- Enter the lesson by presenting a picture that point out how to cultivate the paddy in a normal paddy field or paddy field with salinity soil or through any other access.
- With that, lead students to name the chemical properties of the soil.
  - Soil colloids
  - Soil reaction
  - Iron exchange
  - Base saturation
- Lead students to build a definition for Soil colloids.
  - Colloids is small diameter particles that are suspended in water which is a large surface area.
- Point out that there are two kinds of soil colloids and discuss the characters of those types comparatively.
  - Organic colloids
  - Inorganic colloids
- Point out that soil acidity or alkalinity is called as soil reaction.
- Point out that soil reaction is determined by pH value.
- Raise a definition for pH value through the students.
  - pH value of the soil is the is defined as the negative logarithm of the hydrogen ion concentration
- Discuss the methods of determining the pH value of soil.
- Lead students to determine pH value of soil samples by using each method.
- Lead students to determine the soil reaction according to the pH value of soil samples.
  N.B. Use the table that point out the soil reaction for various pH values.
- Discuss the importance of determining pH value of the soil.
  Eg: -
  - To know about the soil acidity or alkalinity
  - To know whether the minerals are present in the soil in an absorbable state.
- Lead a discussion with students about the reasons for soil acidity.
  Eg: -
  - Soil becomes acidic by accumulating H irons on surface soil due to eluviation of irons such as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} which added to the soil colloids particles by water that dripped to the depth over a long period.
  - Large quantity of intermediate products such as humus and organic acids are caused due to decomposition of organic materials which applied to the soil in low temperature areas. Soil becomes acidic due to accumulation of them on soil surface.
  - Soil becomes acidic due to absorption of basic cations such as plant nutrients of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} that had in the colloids as a result of continual crop cultivation over a long period and due to the release of H^{+} irons.

- Due to the use of fertilizer such as $(NH_4)_2SO_4$ over a long period, the acidity is caused by its SO_4^{--} element.
- Acidity is formed by dissolving gasses such as NO_2, N_2O, SO_2 that is released to the atmosphere in the rain water and soil becomes acidity due to absorption of this water.

- Discuss the agricultural issues that may be arisen in an acidic soil.
  Eg: -
  - When the soil becomes acidic, the growth of the crop is poor and harvest decreases due to not receiving due pH range.
  - When any soil was excessively becomes acidic, it may be poisonous for the roots.
  - Relative abundance is excess in Al^{3+}, Fe^{2+}, Fe^{3+}.Mn^{2+} ions in an acidic soil. A poisonous status may be arisen due to more absorption of these ions to the plants.
- Discuss the measures that can be taken to rehabilitate an acidic soil.
  Eg: - Applying lime materials to the soil
- Define soil alkalinity.
  - If *Na* ions includes more than 15% out of the exchangeable total cations quantity (ESP) that exists in colloids complex in any soil, that soil is introduced as alkaline soil.
- Discuss the characters of an alkaline soil.
  Eg: -
  - pH value of the soil is more than 8.5.
  - Electronic conductivity is less than Milimos 4 per centimeter. (4*mmoh/cm*)
  - Exchangeable N*a* percentage is more than 15%.
- Lead a discussion about the Agricultural issues of an alkaline soil.
  Eg: -
  - Physical characters of an alkaline soil is poor. Therefore, crop cultivation is not successful.
- Discuss the measures that can be taken to rehabilitate an alkaline soil.
  Eg: -
  - Applying $CaSO_4$ (gypsum) to the soil.
- Define soil salinity.
  - Increasing the salt concentration that has been dissolved in the soil liquid by exceeding the limits of tolerance of a crop is called as the salinity.
- Lead students to explain the reasons that form saline soil and alkaline soil.
  - Non - leaching of salt to the bottom of the soil due to low rainfall in arid and semi arid zones.
  - Releasing and passing the salts upward through the soil profile at the weathering of parental rock
  - accumulating of salts in the soil due to the increasing of surface water level during the rainfall of low arid zones.
  - Sea streaming
  - Use of saline water for irrigation
  - Use of excessive inorganicl fertilizers.
- Lead a discussion with students about the agricultural issues of a saline soil.
  Eg: - Plants die due to the exosmosis of water from roots of the crops due to the high concentration of soil solution in a saline soil. .
- Discuss the way of rehabilitating of a saline soil.
  - Soil is irrigated until the saturation and making the salts to leach through deep perculation
  - Removing a thin surface layer from the saline soil
- Lead students to determine the salinity of a soil.
- Define the cation exchange of a soil.
  - Cation Exchange is the exchange of ions in the soil solution with ions adsorped to the colloidal complex.
- Discuss how the Cation Exchange is important in crop cultivation.
  Eg : for the soil fertility□ to correct acidity and alkalinity, to clean polluted water.

- Lead students to name the two methods of cation exchange.
  - Cation exchange.
  - Anion exchange.
- Lead a discussion with students about the cation exchange and anion exchange.
- Explain students about the Cation Exchange Capasity. (CEC)
  - The amount of exchangeable cation in a unit weight of dry soil is referred as the Cation Exchange Capasity.
  - Point out that this is measured as cation centimola per one kilogram of soil (cmol(+)/kg) or miliequivalents per 100 grams of soil (meq/100g).
- Lead students to define base saturation percentage.
  - The percentage of exchangeable amount of base cations compared with total cations in the cation complex is referred as base saturation of the soil.
- Point out that base saturation percentage can be calculated by following equation.

$$\text{Base saturation percentage} = \frac{\text{Exchangeable amount of base cations}}{\text{Total cations in the cation complex}} \times 100$$

- Lead a discussion with students about how the base saturation affects for crop cultivation.
  Eg: - If base saturation percentage is 30%, that soil is infertile.

Key words :
- Soil chemical properties
- Soil colloids

Qualitative inputs :
- pH papers
- pH meters
- pH indicators

Instructions for valuation and assessing:

Pay attention on following points.
- To name soil chemical properties
- To explain about the soil chemical properties affect for crop cultivation.
- To determine pH value and salinity of soil samples.
- To describe the importance of cation exchange of the soil.
- To calculate the base saturation of soil.
- To explain the base saturation is important for crop cultivation.
- To manage soil chemical properties as protecting soil characters.

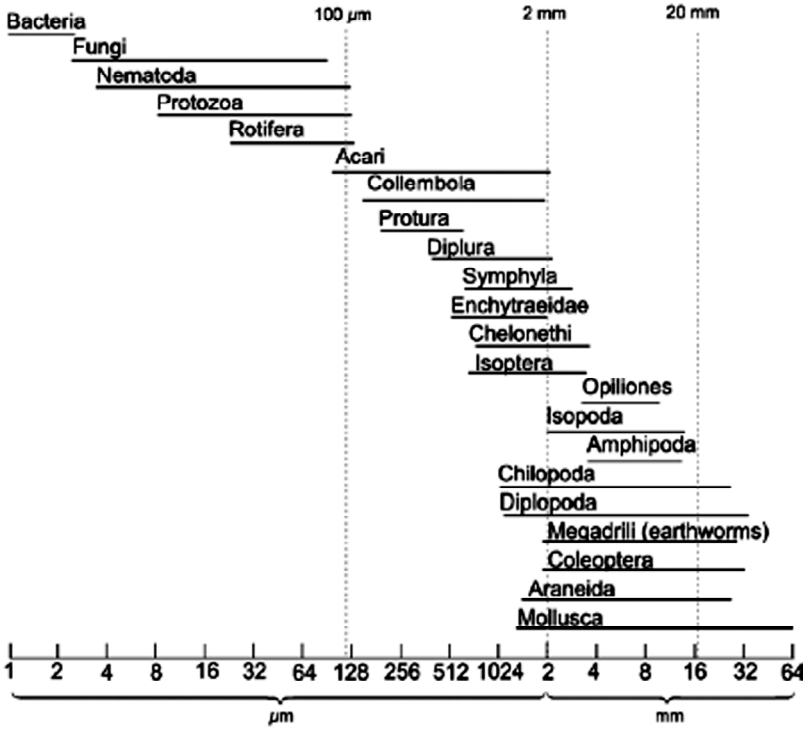
Competency Level 3.6 : Inquires into biological factors of soil which affect bon soil health.

Duration : 03

Learning outcomes :
- Classifies soil biological factors that affect for crop cultivation with examples.
- Describes how biological factors of soil affect soil health.

Instructions for preparing the lesson:

- Produce students a soil sample that has been brought from the field. Ask from students the things that can be seen in the soil sample.
- Using students' answers, go to the lesson by conducing that soil organisms are present in the soils.
- Lead students to name soil biological factors.
  - Size (with of the body)
  - of the environment
  - way of reseaving energy
- Point out students that these organisms can be classified against the body with.
  - Macro organism
  - Meso organism
  - Micro organism



Body width

- Acording, explain students that body width of the soil organisms is more than 2 mm that is organisms that can be seen by naked eye is introduced as macro organisms.
- Ask from students examples for macro organisms

  Eg : Vertibrates (Rats, reptiles)
  Athropods (beetles, ants)
  Annelida (Earth worm)
  Mollusca (snails, slugs)
  Green plants

- Point out that organisms who live in soil wiyh the body width is up to 0.2 - 2 mm are medullary organisms.
- Lead students to show examples for medullary organisms.
  Ex: Bacteria
  Cyano bacteria
  Algae
  Fungus and actinomycetes
  Protozoa
- Lead a discussion with student about the way of clasify based on there race in the environmebt
  - Depend on plant
  - Predators
  - Depend on bacteria
  - Depen on fecal matter
  - Parasites
  - Depend on fungi
- Point out that there are soil organisms that make favorable and unfavorable effects for the crop cultivation.
- Lead students to name useful organisms for crop cultivation.
  Eg: - snail, predators, bio controlling agents
  Nitrogen fixing bacteria, algae, cyanobacteria, ammonic bacteria.
- Lead a discussion with students about the activity and importance of these useful organisms.
- Lead students to identify organisms that make an adverse effect on crop cultivation.
  Ex: - organisms who live on plants
  Pathogeneses
- Lead a discussion with students about the activity and effectiveness of these organisms to crop cultivation.
- Empasise to students that a balance is necessary between favorable organisms and unfavorable organisms.
- Lead a discussion with students about the measures that should be taken to maintain soil organism's population as optimum.
  Eg; - Adding organic materials to the soil.
  improve of drainage and aeration
  Maintaining of soil temperature in optimum

Key words :

- Soil biological factors

Qualitative inputs :

- A soil sample, a picture of soil organisms.

Instructions for valuation and assessing:

Pay attention on following points.

- To name soil biological factors
- To classify soil organisms
- To explain favorable and unfavorable effects of soil organisms
- To mention strategies for the management of soil organism

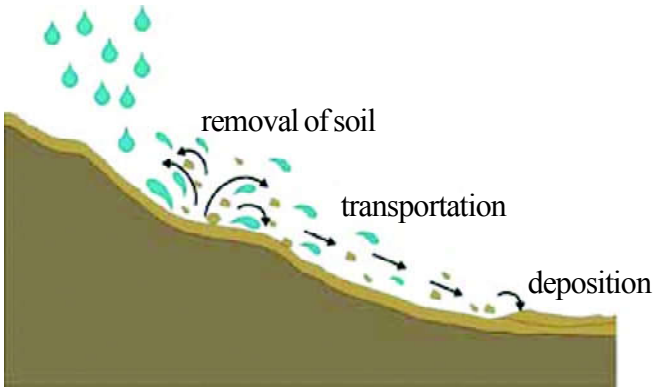
Competency Level 3.7 : Inquires into reasons for degradation of soil health.

Duration : 02 periods

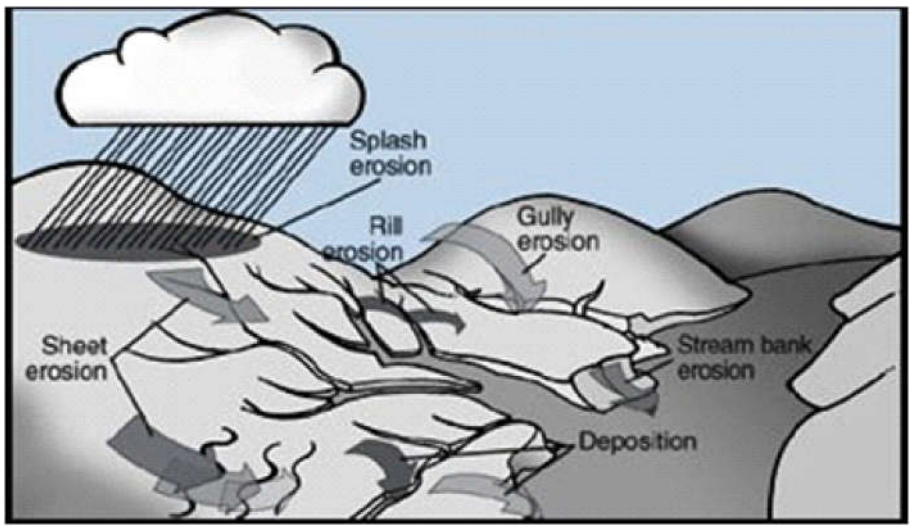
Learning outcomes :
- Explains the reasons for degradation of soil health.
- Calculates the amount of soil erosion.
- Explains the adverse effect that arise due to the degradation of soil health.

Instructions for preparing the lesson:

- Enter to the lesson by displaying students a video or picture showing how the soil health degradates or adopting any another suitable access.
- Ask students about the reasons for the degradation of soil health.
  Eg: - Soil erosion, Improper use of agro chemicals, , addition of poisons to the soil, informal water management, inability to absorb nutrients due to soil acidity, alkalinity and salinity, compaction of soil due to improper land preparation and shortage of organic materials.
- Emphasize the students that natural factors as well as human activities affect for the degradation of soil health.
  Eg: -
  - Soil erosion
  - Improper use of agro-chemicals.
  - Improper land preparation and soil compaction
  - Irregular water management
  - Deforestation
- Define soil erosion.
  - Soil erosion is the removal of soil particles from the earth transport them and deposition in another place.



- Lead a discussion with students about soil erosion process.
  - Separation of soil particles and aggregations from soil body
  - Transporting separated soil particles and aggregations in another place.
  - Depositing those soil particles and aggregations in the new place.
- Ask from students about the agents of soil erosion.
  Eg: - water, wind, waves movement and human and animals' activities.
- Lead a discussion with students about the method of soil erosion caused by rain water.
  - Splash erosion (rain drop erosion &
  - Sheet erosion
  - Stream bank erosion
  - Gully erosion
  - Rill erosion
  - Earth slip



- Lead students to find information about the adverse effect of soil erosion.
  Eg: -
  - reduction of the depth of the fertile soil layer and soil becomes infertile
  - reduction of the thickness of soil layer suitable for plants growth.
  - Degradation of physical and chemical properties of the soil due to the removal of nutrients and microorganisms.
  - Falling of trees due to the erosion in and around the root system.
  - Reduction the value of agricultural land.
- Lead students to find the amount of soil erosion in a place where soil erosion is caused.
- Lead a discussion with students about how the soil health is degradated due to the improper use of agro chemicals.
  Eg: - Microorganisms may be damaged as a result of improper use of agro chemicals.
- Lead a discussion with students about the degradation of soil health due to improper land preparation and soil compaction.
  Ex: - Soil porosity may be diminished due to soil compaction.
- Lead students to gather information about how the irregular water management is practiced and explain the students its effect for the soil health.
  Eg: - Due to the poor water drainage, soil structure gets damage thereby becoming it unsuitable for crop cultivation.
- Lead a discussion about the effect of soil acidity, alkalinity and salinity to decrease soil nutrients and crop cultivation.
  Eg: - Some nutrients of an acidic soil cannot be taken to plants.
- Discuss the effect caused by improper waste disposal for soil health.
  Ex: - Adverse effect to microorganisms.
- Discuss the effect caused for the soil health due to irregular planting. patterns
  Eg: - Since the same crop is cultivated continually for long period, nutrients are removed from soil thereby decreasing those nutrients.

Key words :

- Soil erosion
- Soil health
- Soil deterioration

Qualitative inputs :

- Video scenes mentioning how the soil health is degradated
- Pictures showing the methods of soil erosion.

Instructions for evaluation and assessing:

Pay attention on following points.

- To mention the reasons for the degradation of soil health.
- To define soil erosion.
- To explain soil erosion process.
- To explain soil erosion styles.
- To describe adverse effect of soil erosion.
- To find the amount of soil erosion in a place where soil erosion occurs.
- To explain how the soil health is degradated by using chemicals as unduly.
- To explain how he soil health degradates due to the improper land preparation and compaction of soil.

Competency Level 3.8 : Inquires into methods of improving soil health and quality.

Duration : 05

Learning outcomes :
- Describes the methodsof improving soil health and quality.
- Marks contour lines of a land by using A frame.
- Selects appropriate soil conservation methods according to the land.
- Determines soil health.

Instructions for preparing the lesson:

- Go to the lesson by conducing that natural forest can be introduced as the place where soil health has been developed and that steps should be taken to maintain agro ecological systems as a closed system like those forest.
- Discuss the necessity of developing soil health and quality.
- Inquire from students about the methods of developing soil health and quality.
  - Soil conservation
  - Soil rehabilitation
- Raise a definition for soil conservation through the students
  - Accurate and sustainable use of the soil in order to get a maximum yield by avoiding and minimizing of separation and transportation of soil particles at the soil erosion occurred by three ways namely separation of soil particles due to external causes , transportation and depositing of separated soil particles; with applying natural and artificial method is introduced as soil conservation.
- Ask from students about the methods applied to avoid soil erosion.
- Using students' ideas, point out that soil conservation methods can be classified as follows.
  - Mechanical methods
  - Agricultural methods
  - Biological methods
- Using figures and video scenes, lead a discussion with students about the mechanical soil conservation methods.
  Eg: - Digging drains along contour, preparation of soil furrows, construction of stone bants terraces
- Lead students to find information about Agricultural soil conservation methods.
  Eg: - Proper land use, preparation of land as contour, crops establishment, water control, mulching
- Discuss about the biological methods that are used for soil conservation.
  Eg: - Covering cropping, strip cultivation, Double raw Hedges (live fence)□ SALT
- Lead students to prepare A frame and lead to mark contours on a slopy land
- Give instruction to the students to select suitable crops for each location of a contours lined land map.
- Define the soil rehabilitation.
  - Bringing advance soil characteristics ;that means biological, chemical and physical characteristics in the soil to a higher status in a long term, duly protecting the productivity of the soil is introduced as soil rehabilitation.
- Lead students to find the facts about the methods used for soil rehabilitation.
  Eg: - Rehabilitation of soil using Gotahamala in tea re plantation.
- In association with the previous knowledge, ask from students how to transform acidity soil, alkalinity soil and soil with excess salinity for a suitable state for crop cultivation.

- Explain students how to avoid soil compaction by using suitable land preparation methods or other methods.
- Explain students the water management methods that protect the soil health.
- Lead a discussion with students about how to use agro chemical materials with due management for protecting the soil health.

  Eg: - Proper use of toxic chemicals, avoiding of accumilation poisons to the soil.

Key Words :

- Soil conservation methods
- Soil rehabilitation

Qualitative inputs :

- Video scenes with methods of developing soil
- Items to make A Frame.
- Pictures, video scenes showing soil conservation methods

Instructions for valuation and assessing:

Pay attention on following points.

- To define soil health improving methods.
- To explain soil conservation methods.
- To prepare A frame, and mark contour lines
- To select crops suitable to each place in a land plan with contour lines
- To define soil rehabilitation methods.
- To explain how to arrange the acidity, alkalinity and salinity to protect soil health.
- To mention the suitable land preparation methods to protect soil health.
- To explain the way of water management to protect soil health.
- To explain how to use agro-chemicals with due management.

Competency Level 3.9 : Investigates characteristics of the major soil groups in Sri Lanka.

Duration : 03

Learning outcomes :
- States the base of classification of soil groups.
- Names common soil groups in Sri Lanka
- Explains the characteristics of major soil groups.
- Status agricultural potentials of various soil groups.
- Selects the crops verities suitable to the soil group of the area.

Instructions for preparing the lesson:

- Go to the lesson by providing a map which shows the major soil groups of Sri Lanka or showing true examples of soil groups to the class.
- By using that, lead students to name the soil groups that has been distributed over the Sri Lanka.
  - reddish brown earths
    - Red yellow podzolic soils
    - Non-calcic brown soil
    - Red yellow latesol soil
    - Alluvial soil
    - Law humid glay soil
- By using the map which shows soil groups of Sri Lanka, emphasize the students that reddish brown earths is distributed in a large extent in the dry zone.
- Lead a discussion with students about the characteristics of Reddish Brown Earths.
  Eg: - Neutral pH value, ability to identify zones of soil profile easily, location of quarts layer in the B zone, the cations exchange capacity is 10-20 cmol/kg.
- Lead students to gather information about the crops that can be cultivated in the Reddish Brown Earths.
  Eg: - Grains, cereals, chilies, vegetable, onion
- Empasize to students that red yellow podzolic soils is distributed in a large extent in the wet zone.
- Lead a discussion with students about the characters of Red Yellow Podzolic soils.
  Eg: - Low pH value, base saturation is less than 35%, the cations exchange capacity 8-10 mol/kg
- Lead a discussion with students about agricultural potential of Red Yellow Podzolic soils.
- Lead students to find the information about the crops that can be cultivated in the Red Yellow Podzolic soils.
  Eg: - Plantation crops, fruits crops, spices, vegetables
- Lead students to identify the areas in which Non-calcic Brown soil.is distributed.
  Ex: - Ampara, Baticaloa, Gal-Oya valley
- Discuss with students about the characters of Non-calcic Brown soil.
  Eg: - A zone being a sandy loam soil
  Having more than 40% base saturation in B zone
  Cations exchange capacity is 5-6 cmol/kg
- Lead students to find information about the Agricultural usage of Non-calcic Brown soil.
- Explain students about the crops that can be cultivated in non-calcic brown soil
  Eg: - grains, cereals

- Guid the students to identify the areas in Sri Lanka in which Red Yellow Latesol soil is distributed by using the map.
  Eg: - It extends as a strip in the costal areas of North-East and North –West provinces.
- Lead a discussion with students about the properties of Red Yellow Latesol soil.
  Eg: - A zone of soil profile is thin, slightly acidic. Low cations exchange capacity
- Lead students to find information about Agricultural potential of Red Yellow Latesol soil.
- Lead students to name crops that can be cultivated in Red Yellow Latesol soil.
- Lead a discussion with students about agricultural potential of Red Yellow Podzolic soils.
- Lead students to find information about the crops that can be cultivated in Red Yellow Podzolic soils.
  Eg: - Plantation crops, fruits crops, spices, vegetable
- Lead students to identify the areas of Alluvial soil with using the map which shows soil groups of Sri Lanka.
  Eg: - Areas associated with rivers
- Lead a discussion with students about the properties of alluvial soil.
  Eg: - Poor water drainage
- Lead students to find information about the crops that can be cultivated in Alluvial soil.
  Eg: - Paddy
- Lead students to identify the areas of alluvium soil with using the map which shows soil groups of Sri Lanka.
  Eg: - Dry zone
- Lead a discussion with students about the properties of Alluvium soil.
  Eg: - High cation exchange value
- Lead students to find information about the crops that can be cultivated in Alluvium soil.
- Lead students to find out the soil group/ groups that is distributed in the areas where they by using a soil map and lead students to select suitable crops for relevant soil group in the area.

Key Words :

- Common soil types in Sri Lanka

Qualitative Inputs :

- The map which shows soil groups of Sri Lanka
- True examples of soil groups
- Relevant video scenes

Evaluation and Assessment :

Pay attention on following points.

- To name the soil groups that are abundant in Sri Lanka.
- To describe the properties of abundance soil groups.
- To explain the agricultural potential of each soil groups.
- To demonstrate the ability to select suitable crops for each soil groups.

Competency 4 : **Plans strategies for the management of nutrients to obtain an optimum yield.**

Competency Level 4.1 : **Classifies nutrients required for plant growth and development.**

Duration : **02**

Learning outcomes :
- Defines Plant Nutrients and plant nutrition.
- Classifies Plant Nutrients with examples.

Instructions for preparing the lesson:

- Display pictures and a video scene to the class that shows absorption of elements through the plants, removing elements as harvest. In association with this,, give students an opportunity to introduce plant nutrients and plant nutrition.
- Indicate that elements needed for plants growth are introduced as Plant Nutrients.
- Indicate that elements needed for plants growth can be classified as follows:-
  - Essential elements
  - Beneficial elements
- Lead students to provide a definition for essential elements. Accordingly. Indicate that following requirements should be fulfilled to consider any element as an essential element.
  - The plants without essential elements should neither able to grow as a usual plant nor complete its life cycle.
  - The functions performed by the essential elements cannot be fulfilled by another element. That is, essential elements should be special and should not be able to replace by another element.
  - Essential elements should be directly connected with metabolic process of the plant.
- Give students instructions to collect information about the functions of essential elements.
- Lead students to identify 17 essential elements and classify them on following criterions.
  - Essential elements
    - According to the absorption amount of nutrients to the plant and medium of absorption.
      - Macro elements / nutrients
        - Primary nutrients
        - Secondary nutrients
      - Micro elements / nutrients
    - According to the mobility showing in nutrient plant
      - Mobile nutrients
      - Immobile nutrients
- Assist students to name nutrients that are obtained from the air and water as well as from the soil.
  - From air and water - C, H, O
  - From soil - N, P, K, Ca, Mg, S, Fe, Cu, Zn, Mn, Mo, Cl, B, Ni
- Make aware students that classifying of nutrients is done according to the mobility within the plants.
- Emphasise students that elements which can be moved from old tissues to new tissues through the phloem tissues of vascular system are introduced as mobile nutrients and immovable elements are defined as immobile nutrients.
- Lead students to classify plants nutrients as mobile and immobile elements.

  Eg: -
  - Mobile nutrients - N, P, K, Mg, Cl
  - Immobile nutrients - Ca, B

- Lead students to define the beneficial elements and provide examples for that.
  - Elements that are not essential to the plant but helpful to its existence are introduced as beneficial elements and these are helpful to healthy growth of the plant.
    Ex : Sodium (Na)□ Vanadium (V), Silicon (Si), Iodine (I), Cobalt (Co)

Key Words :

- Plant Nutrients
- Essential elements
- Beneficial elements
- Immobile elements
- Mobile elements

Qualitative Inputs :

- Compact disks demonstrating absorption of plants nutrients elements, removing of elements as the harvest.
- Agricultural science reference book and other books.
- Internet

Evaluation and Assessment:

Pay attention on following points.

- To define plants nutrients and plant nutrition.
- To classify nutrients elements that are importance to the plants.
- To explain the functions of Essential elements.
- To define and name the beneficial elements.
- To define mobile and immobile elements.

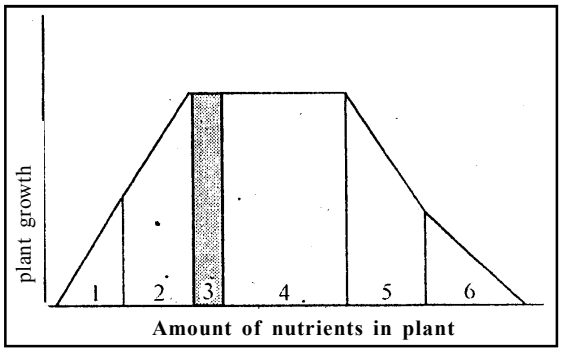
Competency Level 4.2 : Inquires into the impact of soil nutrients on plant growth and development.

Duration : 05 periods

Learning outcomes :
- Explains the methods of absorption of nutrients by the plants.
- Explains the relationship between the plants nutrients and growth by using graphs
- Describes visible symptoms of plants due to deficiency of nutrients
- Identifies symptoms of plant nutrient deficiencies.
- Describes symptoms of plants when the nutrients are in excess.
- Describes the supply of nutrients to the plants by using Leibig's Law

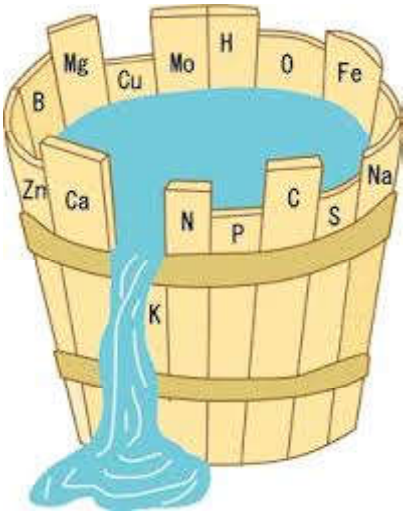
Instructions for preparing the lesson:

- Present animated video scenes or pictures which show the absorption or use another suitable access.
- Ask students' ideas about the plant nutrients absorption process.
- Indicate that tall plants mainly absorb elements from roots and elements are absorbed through the stomata of leaves also.
  Eg: - Intake of CO_2 and O_2 through the leaves.
- Indicate that minerals which have been dissolved in the soil solution are taken through the roots at the absorption of nutrients .
- Indicate that there are two main methods of nutrients absorption by plants
  - Active absorption
  - Inactive absorption
- Indicate that in active absorption, salt is absorbed against concentration gradient.
- Indicate that there, energy (ATP) is consumed.
- Indicate that, moving nutrients across the cellular membrane through a concentration gradient is occurred in inactive absorption and energy is not consumed in this process.
- Discuss how the essential elements affect for the plants growth.
  Eg: -
  - Phosphorous – to divisions of cells□ to grow divided tissues to form cellular walls and to make Calcium spectate
  - Potassium - to open and close stomata, to control osmotic pressure of cells
- Indicate that when plants are lack of nutrients, it can be identified by changes that is indicted by the plant and that those are named as nutrients deficiency.
- Lead students to identify the nutrients deficiency that is caused due to the lack of essential elements for the plants. For this, use true examples, video scenes, pictures etc.
  Eg: -
  - When Nitrogen is deficit, matured leaves may be yellow.
  - When Phosphorous is deficit, matured leaves become dark green and later purple.
    Ex: - Maize
- Indicate that plants growth gets weakened due to imbalance of another nutrient as a result of excess absorption of essential elements.
- Lead a discussion about the characteristics caused by increase of nutrients.
  Eg: - Due to the increase of nitrogen, succulence of plants tissues
- Give the students an opportunity to explain the relationship between the plant nutrition and growth by using a graph.



Zone 1 - Plant expose to several deficiencicies show deficiency symptoms. plants are highly response to fertilizer.
Zone 2 - Plant show mild deficiency symptoms. still plants response to fertilizer.
Zone 3 - Plant gets optimum amount of fertilizer plant show maximum yield and growth
Zone 4 - Plant absorb more than required . but yield will get increase. this is call ....
Zone 5 - due to exess fertilizer they toxic to plant and more sensitive to plant yield will reduces.
Zone 6 - Due to too much nutrient they toxic to plant and plant dies.

- Lead a discussion about the importance of the Leibig's law of the minimum when nutrients are supplied to the plant.
- Define the law of the minimum as a guide to explain about the response of the plant to the fertilizer applied
- Make aware students that it can be explained by the Leibig's law of the minimum that when the harvest of a crop is increased, it may be determined on the (limited) nurient / factor that is received at minimum.



Key Words :

- Nutrient absorption in plants
- Active absorption of nutrients
- Passive uptake of nutrients
- Leibig's law of the minimum

Qualitative Inputs :

- Pictures to explain the intake of water with minerals through the roots hairs
- Videos including animations to explain plant nutrients absorption.

Evaluation and Assessment:

Pay attention on following points.

- To explain the method of absorption nutrients to the plants.
- To explain the relationship between the nutrients absorption and growth.
- To identify the characteristics of nutrients deficiency.
- To identify the characters that is indicated by plants at the nutrients excess
- To explain the supply of nutrients to the plants by using Leibig's law of the minimum.

Competency Level 4.3 : Inquires into different types of fertilizer used for the crop cultivation .

Duration : 02

Learning outcomes :
- Defines the term fertilizer.
- Classifies the fertilizer.
- Indicates the necessity of fertilizer application
- Defines organic manure, inorganic fertilizer and bio fertilizer.
- Defines direct and mixed fertilizer.

Instructions for preparing the lesson:

- Give students an opotunuty to observe the samples of direct fertilizer, mixed fertilizer various organic fertilizer.
- Discuss about the nutrients and amount of nutrients received by each kind of fertilizer.
- Ask from students about their idears about the necessity of applying fertilizer to the soil.
- Emphasize students that nutrients are removed from the soil due to various reasons, and that supplying of nutrients is essential to re supply those removed nutrients.
- Lead students to gather information about the ways that are removed soil nutrients from soil.
  - Absorption by crops
  - Soil erosion
  - Removal by leaching
  - Vaporization
  - Activity of anaerobic bacteria.
  - Compaction of nutrients physically and chemically
  - Absorption of nutrients by weeds and microorganisms.
- Make aware students that fertilizer is the material added to the soil to give essential elements needed to the plants growth due to above reasons.
- Assist students to classify various fertilizers that are applied to the soil.
  - Organic fertilizer
  - Chemical fertilizer
  - Bio fertilizer
- Define students the organic manure.
  - Organic manure is the materials supplying nutrients to the soil for plants growth subsequent to the formation with plants and animals parts and subjecting to direct digestion or decomposition
  - Ask from students the examples for organic manure.
  - Give students the instructions to gather information about the advantageous and disadvantageous of using fertilizer.
- Indicate that chemical fertilizer is introduced as an inorganic material with a full or partial artificial origin and applied to the soil for a sustainable crop growth.
- Indicate that there are two kinds of chemical fertilizers in the crop cultivation.
  - Direct fertilizer (unmixed fertilizer)
  - Mixed fertilizer
- Indicate that the fertilizer that is used to give only one nutrient to the soil is introduced as a direct fertilizer.
- Ask from students the examples for direct chemical fertilizer.
  Eg: - Urea, Ammonium Sulfate

- Indicate that fertilizer prepared by mixing two or three kinds of nutrients is introduced as mixed fertilizer.
- Ask from students the examples for mixed fertilizer available in the market.
  Eg: - 'V' mixture or mud paddy fertilizer that is the based fertilizer mixture applying in the paddy cultivation, CRI mixture that is the based drassing and top dressing fertilizer mixture applyied in the coconut cultivation.
- Indicate that compound fertilizer is also a mixed fertilizer, and it is prepared by mixing N, P, K, and then couting it.
- Introduce students the Bio-fertilizer.
  - Bio-fertilizer is an organic material that consists of microorganisms who can improve the ability of intake essential nutrients to the crops when applying to the field of cultivation.
  - Ask from students the examples for Bio-fertilizer.
    Ex: - *Anabaena azollae*

Key Words:

- Fertilizer
- Organic Fertilizer
- Chemical fertilizer
- Bio-fertilizer

Qualitative Inputs :

- Various fertilizer samples

Evaluation and Assessment:

Pay attention on following points.

- To define the fertilizer
- To define organic manure and chemical fertilizer.
- To explain the necessity of applying fertilizer to the soil.
- To list the methods of removing nutrients from the soil.
- To define direct and mixed fertilizer.

Competency Level 4.4 : Inquires into the various methods of making chemical fertilizer mixtures.

Duration : 06 periods

Learning outcomes :
- Classifies the Chemical fertilizer.
- Mentions the physical and chemical properties of direct chemical fertilizer.
- Makes necessary calculation for preparing fertilizer mixture.
- Lists out the factors to be considered in the preparation of fertilizer

Instructions for preparing the lesson:
- Go to the lesson by displaying several chemical fertilizer samples to the class.
- Lead a discussion about necessity of applying chemical fertilizer to the soil.
- Present the examples for direct chemical fertilizer consisted of N,PK, and ask from students about the properties of those samples.
  - Nitrogen supplying chemical fertilizer
    Urea
    Ammonium sulfate
    Sodium nitrate
  - Phosphorous supplying chemical fertilizer
    Concentrated super phosphate
    Triple super phosphate
    Eppawala appetite
  - Potassium supplying chemical fertilizer
    Muriate of potash
    Sulfate of potash
    Potassium nitrate
- Lead students to a practical to identify the physical and chemical properties of these fertilizers and give instruction to record them.
  Eg: - Colour, shape, water liquidity□ pH value
- Give instruction to do necessary calculation for preparation of fertilizer according to the requirement of the crops. Here, pay attention to following points.
  - The factors to be considered in the preparation of fertilizer mixture.
  - Amount of nutrients required for crops.
  - Fertilizers that should be used for the mixtures.
  - Amount of nutrients contained in selected direct fertilizer.
    Eg: -
    - Calculation of nitrogen percentage in Urea (N-46)
    - Calculation of P_2O_5 quantity in Diammonium phosphate
    - Calculation of K_2O quantity in Muriate of potash
  - Make aware of nutrients ratio of fertilizer mixtures and fertilizer grade
  - Obtaining direct fertilizer requirement through the calculations.
  - Preparing fertilizer mixtures
- Make aware that a supplementary material can be added to complete the weight of necessary fertilizer by calculating the amount of fertilizer to be mixed according to the fertilizer grade.
- Ask from students the material that can be used as supplementary materials.
  Eg: - Chips, clay, choline, sea sand
- Lead students to prepare a fertilizer mixture by giving an opportunity to mix relevant quantity of fertilizer after calculation.

Key Words :

- Fertilizer mixture
- Direct fertilizer

Qualitative Inputs :

- Chemical fertilizer samples.

Instructions for Evaluation and Assessment:

Pay attention on following points.

- To identify physical and chemical properties of chemical fertilizer
- To make calculation for the preparation of fertilizer mixtures
- To list out the factors to be focused in the preparation of fertilizer mixtures

Competency Level 4.5 : Inquires into the preparation methods of different types of organic manure.

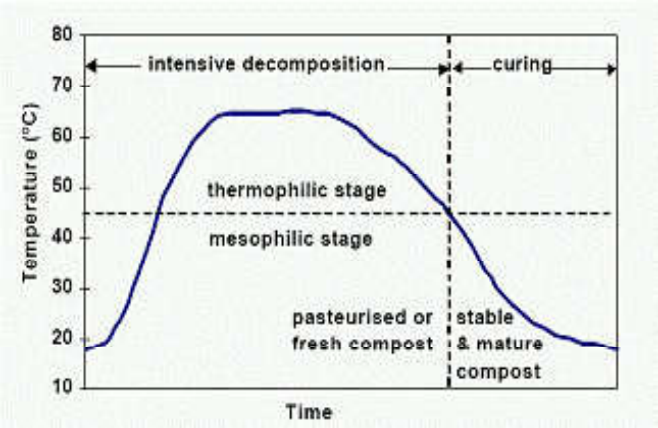
Duration : 04 periods

Learning outcomes :
- Presents examples for organic manure
- Explains the importance of using oraganic manure.
- Describes the method of preparing organic manure
- Prepares compost fertilizer.

Instructions for preparing the lesson:

- Present students several samples of organic manure and animals and plants waste samples.
- Ask from students how they can be used for successful crop cultivation.
- Emphasize through the discussions that organic manure can be produced in eco-friendly manner by using animal and plant wastes.
- Give students an opportunity to prepare a list of other organic manures including organic manure presented to the class.
- Lead a discussion about the methods of preparing each organic fertilizer.
  - Compost fertilizer
  - Green fertilizer
  - Organic liquid fertilizer
  - Farm yard fertilizer
- Define compost fertilizer.
  - Compost fertilizer is a fertilizer that supplies necessary nutrients for plants growth by partial digestion of organic matters by microorganisms with human intervention under controlled conditions.
- Discuss with students about factors that affect to compost preparation process.
  - C/N ratio of raw material
  - Tempareture
  - Moisture
  - Areation
  - Size of the raw materials
- Explain students the scientific process of preparation of compost fertilizer.
  - Explain students that the raw materials used for making compost is mechanically decomposed by grinding and chopping into small pieces by earth-worms, nematodes, and insects present in the soil (Ex: - mites, saw worms, ants, beetles) under natural ecological conditions.
  - Explain students that compost preparation process is started by colonizing Mesospheric microorganisms such as soil bacteria, fungus, actinomycetes and protozoa closed to the organic materials when the heap of compost reaches to the optimum physical condition.
  - Convince students that this Mesophilic organisms are well active under the temperature condition such as 10 - 45 ^{0}C.
  - Explain students that active phase of composting will then be started and its process using graphs.
  - Convince students that when the temperature of compost heap is increased, Thermophiles will be active at the temperature of 45 ^{0}C.
  - Explain students after 24 – 72 hours of making the heap of compost, its temperature will rapidly increase up to 54.4 - 65.5 ^{0}C and that it is maintained over few weeks in the process of composting.

- Explain students that this is the active phase of composting, and describe students that process.
  - Death of plant pathogens and weeds seeds
  - Decomposition of Phytotoxic compounds
- Guide students to name the common pathedens died during this stage.
  Eg: - *Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Clostridium botulinum*
- Convince students that during this phase, aeration or turning the compost heap can be done to counterpart the oxygen of compost heap.



- Explain students that after that, curing phase will take place.
- Explain students that the temperature will gradually decrease up to 45 ^{0}C by the end of active phase.
- Empasize students that in this phase, Mesophilic organisms are colonized in the heap, and, unless it is turned in this phase, the rate of oxygen consumption gets decreased.
- Explain students that decomposition of phytotoxic compounds is further occured in the weathering phase and it becomes biologically stable humus and it is the matured or final stage of compost.
- Convince students that weathering phase is an important phase in the preparation of compost.
- Explain students that if prepared compost is in the immature status, or compost has not been made, curing phase is very long.
- Lead a discussion with students about the reasons for not preparing the compost properly.
  Eg: -
  - Receiving a low amount of oxygen amount to compost heap
  - Very low or very high moisture content of the compost heap.
- Lead a discussion with students about the characteristicsof immature compost.
  - Abundance of carbonic acids
  - Low or high pH value
  - High concentration of salts
- Convince students that plants may die by the application of immature compost.
- Explain students that though there is no a specific period for curing phase, the time taken for the preparation of commercial compost may vary from 1-4 months.
- Convince students that maturity of compost is defined as the Degree of humification (that is, the quantity that become organic material to humus material)
- Lead a discussion with students about the methods used to determine whether the compost heap has been made as stable and proper manner.
  Eg: - When the temperature of the compost heap is close to ambient environment temperature.
- Discuss the various methods of preparing compost.
  - Pit method
  - Heap method
  - High temperature method
  - Barrel method
  - Small method (basket method)

- Discuss the compost preparing process.
  - Collection of suitable material to prepare compost.
  - Chopping of organic materials to small pieces.
  - Preparation of inoculum
  - Covering of compost heap.
  - Inserting a pole into the compost heap.
  - Turning compost heap.
- Demonstrate the method of preparing compost.
- Instruct the students to gather information about new trends for preparing compost.
  - Pospho compost
  - Wormi compost
- Indicate that various foliage parts can be used for providing necessary nutrients for the plants in] crop cultivation and those are considered as green manure.
- Give students the instructions to gather information about the plans for which green manure can be] used.

  Ex: - Glerisidia, jungle sun flower, Thora, Ipil Ipil, Cappetiya, Gamsooriya, Erabadu, Sun hemp
- Guide students to build a definition for Farm yard manure.
  - Farm yard manure is the manure that is formed by decomposing animal excrements, food remains such as grass along with the mulching materials in cattle sheds.
- Indicate that decomposed farm yard manure can be used as a rich organic manure.
  - Indicate that organic liquid fertilizer is used in the plants nutrition.
  - Lead a discussion about how to prepare organic liquid fertilizer.
- Guide students to prepare a manual including the way of preparing each organic manure.
- Give students an opportunity to present the importance of using organic manure.

  Eg: - Increase of soil organisms
  Improvement of soil texture
  Retention of heavy metal

Key Words :
- Compost fertilizer
- Green manure
- Organic liquid fertilizer
- Farm yard manure

Qualitative Inputs :
- Samples for organic manure
- Materials to prepare organic manure

Evaluation and assessment:

Pay attention on following points
- To present examples for organic manure
- To describe the importance of using organic manure
- To describe the way of preparing organic manure
- To prepare organic manure

Competency Level 4.6 : Inquires into different types of bio fertilizer.

Duration : 04

Learning outcomes :
- Presents examples for the types of bio fertilizer.
- Explains the way of preparing bio fertilizer.
- Prepares bio fertilizer.

Instructions for preparing the lesson:

- Enter the lesson by presenting a video scene about bio fertilizer or using any other access.
- Lead a discussion with students about the importance of bio fertilizer.
  Eg:
  - Profitability
  - Cutting down the cost for crop cultivation
  - Due to the availability of nitrogen in the soil through the process of nitrogen fixation, , ability to get that nitrogen.
  - Increasing crops yields by 4-5%.
  - Improving soil properties.
  - Sustainability of soil fertility.
  - Improving the phosphorous liquidity of the soil, thereby transforming to available status for the plant.
  - Stimulating the plant growth by producing crop growth stimulant substances.
  - Minimizing the use of chemical fertilizer.
  - Gaining the organic manure for the soil by activating the natural nutrient cycle mechanism by the bacterias present in bio fertilizer.
  - Getting healthy plants
  - Improving soil health
- Guide students to classify biological manure as follows:-
  - Types of nitrogen fixing
  - Phosphate biological manure
- Indicate that microorganisms producing nitrogen fixing bio fertilzers can be classified as follows: -
  - Bacteria
    - Free living forms - Ex - Azotobacter, Clostridium
    - Symbiotic forms - Ex: - Rhizobium, Azospirillum
  - Blue green Algae
    - Free living forms - Ex: - Nostoc
    - Symbiotic manner - Ex: - *Anabaena azollae*
- Explain students that Rhizobium live symbiotically with the roots of leguminous plants and form root nodules thereby fixing nitrogen.
- Explain students that Azotobacter is also a bacteria fixing nitrogen and lives under aerobic soil conditions.
- Indicate students that Blue green Algae is present both in free living forma and symbiotic forms and fix nitrogen.
- Indicate students that Azospirillum is also a symbiotic nitrogen fixing bacteria and live symbiotically with the plants in Poaceae family
- Explain students that by creating asymbiotic *Azolla, Anabaena azollae; a fern which is* floating freely on water fix nitrogen through a symbiotic relationship with blue green algae
- Guide students to experiment how to grow *Azolla* in the field practically.

- Indicate students that phosphate Bio-fertilizer can be classified as follows:-
  - Bio-fertilizer increasing phosphorus liquidity
  - Bio-fertilizer increasing phosphorus motility
- Lead a discussion with students about the importance of Bio-fertilizer increasing phosphorus motility.
  Eg: -
  - Transforming illiquid phosphate into liduid form from organic and inorganic fertilizer sources
  - Releasing the illiquid phosphate from the soil and fixing in clay minerals
  - Dissolving solid bound phosphate by draining organic acids to decrease pH value.
- Guide students to name microorganisms used to make Bio-fertilizer increasing phosphorus liquidity.
  - Bacteria - Ex: - *Bacillus spp.*, Pseudomonas
  - Fungus - Ex: - Penicillium, Aspergillus
- Lead a discussion with students about the importance of Bio-fertilizer increasing phosphorus motility.
  Eg: -
  - By this, phosphorus flows from soil to the cortex of the root.
  - Stimulating the metabolic activities due to the increse of root surface area by entering fungus in to cortex of the root.
  - Absorption of fungi to root system.
- Guide students to state examples for microorganisms used to make Bio-fertilizer increasing phosphorus motility.
  Eg: - Arbuscular mycorrhizal (AM) fungi

Key Words :

- Bio-fertilizer

Qualitative Inputs :

- Pictures showing Bio-fertilizer
- Video scenes showing preparation of Bio-fertilizer

Evaluation and assessment:

Pay attention on following points.

- To define Bio-fertilizer
- To explain the importance of Bio-fertilizer
- To present examples for Bio-fertilizer
- To produce Bio-fertilizer

Comptency level 4.7 : Plans different methodologies for the effective use of fertilizer.

Duration : 04

Learning outcomes :
- Emphasises the necessity of applying fertilizer productively for the maximum profit
- Differentiates favorable and unfavorable impacts of the fertilizer usage
- Explains how fertilizer are used effectively and efficiently.
- Performs experience the methods of fertilizer usage.

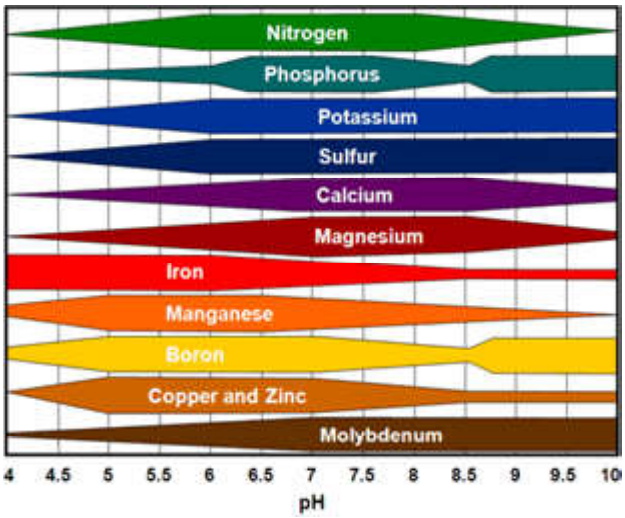
Instructions for preparing the lesson:

- Start the lesson by displaying the posters showing fertilizer usage/ videos showing fertilizer usageand good harvests or by using any other approach
- Explain students the 4R concept in the fertilizer usage.
  - Right Time
  - Right Place
  - Right Source
  - Right Rate
- Guide students to gather information about the method of applying fertilizer to the soil. Give students an opportunity to experiment these methods.
  - Broadcasting - Ex: - In paddy cultivation
  - Deposition
    - Placement between two plants rows.
    - Application as a band between two plants rows.
    - Circular method
    - Semi circular method
    - placement in several locations
    - Application to the plant directly (as a spray)
    - Mixing with irrigation water.
- Give students an opportunity to present examples for each method of applying fertilizer.
  Eg: -
    - Broadcasting - Ex: - in paddy cultivation
    - Placement between two plants rows. – Sorghum
    - Circular placement Ex: - mango
- Give the opportunity to present advantageous and disadvantageous of each method.
  Eg: -
    - Increasing the efficiency of the fertilizer by applying directly to the plant (as a spray)
    - Saving time and labour by applying after mixing with irrigation water
- Give students an opportunity to state adverse effects of the improper use of fertilizer. Here, guide students to present about the effects to the soil and the water.
  Eg: -
    - To the soil
      - soil becomes acidic
      - Accumulation of toxic chemicals in the soil
      - Decreasing the population of soil organisms
    - To the water
      - Eutrophication

- Explain through the discussions that fertilizer applying for plants may be wasted due to various reasons, and the fertilizer as well as labour and the money may not be wasted by applying fertilizer effectively thereby gaining a optimum yield
- Assist students to introduce the fertilizer use efficieny.
  - Fertilizer use efficiency is the percentage of truly used amount of fertilizer by the plant from the applied amount of fertilizer.
- Explain with using graphs that maximum profit can be gained in the maximum level of fertilizer use efficiency.
- Emphasize that maximum profit cannot be gained by the excessive use offertilizer.
- Accordingly, give students an opportunity to present ideas about the strategies to increase fertilizer use efficiency

  Ex: - Creating a suitable soil environment for absorption of fertilizer.
  - pH value, moisture content, air, texture and structure.

    Eg: -
    - Nutrients which can be absorbed by the plants will be changed according tothe pH value of the soil.



    - When soil moisture reaches up to the permanent wilting number, fertilizer use efficiency dicreases.
    - When soil structure is satisfactory, fertilizer use efficiency increases due to the satisfactory water retention ability.
    - Increasing the retention of nutrients by adding organic materials to the soil.
    - Using recommended fertilizer.
    - Applying recommended fertilizer several times.
    - Applying fertilizer after a soil test.
    - Applying fertilizer after observing the factors.

      Ex: - When applying nitrogen fertilizer to the paddy plant, applying after comparing with the leaf colour chart
    - Application of organic manure and chemical fertilizer together according to the concept "Integrated plant nutrient system"
- Raise a definition through the students an introduction for integrated plant nutrient system.
  - This is a plant nutrient system suited for ecological conditions that is accepted as social and considered as effective economically to produce plants by using organic and inorganic plants nutrients and maintaining soil fertility as stable.

Key Words :

- Fertilizer application
- Fertilizer use efficiency

Qualitative Inputs :

- Compact disks including video scenes showing application of fertilizer.

Evaluation and assessment:

Pay attention on following points.

- To define the fertilizer use efficiency
- To explain importance of applying fertilizer to get maximum profit.
- To explain strategies for applying fertilizer effectively.
- To describe methods of applying fertilizer.

Competency 5 **Exhibits the readiness for establishment of crops in a suitable soil environmenrt.**

Competency Level : **Inquires into the need for land preparation.**

Duration **: 02**

Learning outcomes :
- Describes objectives of land preparation.
- Describes physical, biological and chemical changes of physical properties of soil due to land preparation.

Instructions for preparing the lesson:

- Enter into the lesson by presenting to the class the pictures, video scenes which shows land preparation or by using any other approach.
- Lead a discussion to introduce the term land preparation.
  - Preparing soil physically for seed germination and for a subsequent crop growth.
- Lead a discussion on how to build a proper soil environment through land preparation.
- Discuss with students about the objectives and advantages of land preparation.
  Eg: -
  - preparing a suitable sowing land for crop cultivation.
  - controlling weed
  - controlling decease and pest
  - mixing organic materials with soil
- Give students an opportunity to identify the changes in the physical and biological properties of soil after the land preparation.
  Eg: -
  - Occurrence of random roughness
  - Reduction of bulk density
  - Improvement of soil porosity
  - Development of soil aeration.
  - Increasing the population of soil organisms
- Discuss with students about the changes in the physical and chemical properties of soil after the land preparation.
  Eg: -
  - Increasing CEC

Key Words :
- Land preparation

Qualitative Inputs :
- Pictures and video scenes showing land preparation.

Evaluation and assessment:

Pay attention on following points
- To describe the objectives of land preparation.
- To mention the changes in the physical, biological and chemical properties of soil due to land preparation.

Competency Level 5.2 : Inquires into the land preparation steps and methods.

Duration : 04 periods

Learning outcomes :
- Defines the basic land preparation and inter cultivation.
- Explains the steps in basic land preparation.
- Explains with examples that special land preparation techniques are used according to the various requirements
- Selects appropriate methods of land preparation suit for the crop and the stage.
- Describes the method of land preparation for paddy cultivation.

Instructions for preparing the lesson:

- Take a suitable access for the lesson displaying students the pictures or video scenes showing the method of land preparation using various equipment according to various patterns/ various method for crop cultivation
- Indicate that land preparation is made under two main stages
  - Basic land preparation
  - Inter cultivation
- Explain students that Basic land preparation is the process of preparing soil to make it suitable for crop growth and discuss the steps of Basic land preparation.
  - Primary tillage
  - Secondary tillage
- Indicate that at the primary tillage, opening or loosening of compacted soil takes place and during this a surface soil with large soil aggregates is formed burying weeds and stubbles
- Discuss the methods of primary tillage.
  - Deep tillage
  - Loosening tillage
  - Land preparation throughout the year.
- Define that secondary tillage is the soft and smooth preparation of soil after the primary tillage.
- Indicate that partitioning of large soil aggregates into smaller particles removal of remaining weeds and stubbles and the leveling of the soil is done at this stage.
- Indicate that inter cultivation is various land preparation actions carried out in the soil after the crop establishment.

  Eg: -
  - Mixing fertilizer to the soil
  - Loosen soil around the tree.
  - Adding soil to the plant root
- Discuss the methods of land preparation applied according to various requirement.
  - Maximum tillage.
  - Minimum tillage
  - Zero tillage
- Guide students to list advantages and disadvantage on those methods.

  Eg: -
  - decreasing soil erosion of slopy land due to minimum tillage
  - Seed germination is low in a zero tillage field.

- Discuss the methods of land preparation for paddy cultivation.
  - Preparing muddy land
    - First tillage
    - Second tillage
    - Levelling and puddling
  - Preparation of dry land
- Indicate that the muddy land preparation is the common land preparation method now.

Key Words :

- Steps of land preparation
- Methods of land preparation

Qualitative Inputs :

- Photographs, video scenes related to skills level

Evaluation and assessment :

Pay attention on following points

- To define the primary land preparation and inter cultivation
- To describe proposes related to land preparation methods.
- To describe the steps of land preparation.
- To describe the way of land preparation for paddy cultivation
- To select the methods of land preparation according to the stage.

Competency Level 5.3 : Inquires into the equipments used in land preparation.4

Duration : 05

Learning outcomes :
- Classifies theland preparation equipment according to the various determinants.
- Selects the land preparationequipment according to the soil and the crop.

Instructions for preparing the lesson:

- Enter the lesson by presenting land preparationequipment or the pictures of equipment to the class.
- Indicate that land preparationequipment could be classified in to two major groups according to the stage of land preparation and power applied for operation
- Discuss with examples land preparationequipment according to the stage of land preparation.
  - Primary land preparationequipments
    Eg: - Fork, ploughs, mammoty, sub-soilerequipment
  - Secondary land preparationequipment
    Eg: -Mammoty, harrows□ rake, rigger, rotavator
  - Intercultivators
    Eg: -Mammotties, or equipment, weeders
- Give students an opportunity to classify land preparationequipmenst according to the power applied to operate them.
  - Equipment that are operated using man power
    Eg: -
    - Mammoty
    - Fork
    - or equipment
    - Japanese rotary weeder
    - Hand fork
  - Equipment that are operated using animal power
    Eg: -
    - Country plough
    - Light iron plough
    - Level plough
  - Equipment that are operated using mechanical power
    Eg: -
    - Disc plough
    - Rotervator
    - Tine tiller
    - Sub-soilerequipment
    - Japanese reversible plough
    - Disk harrow
    - Mould board plough
- Discuss with students the impact caused to the soil and the environment by the use of machineries in land preparation
  Eg: -
  - soil compaction due to heavymachinery.
  - Emission of harmful gasses by the use of machineries using fuel, Noise pollution

Key Words :
- Land preparation equipment

Qualitative Inputs :
- Land preparation equipment and their pictures

Evaluation and assessment:

Pay attention on following points.

- To classify land preparationequipment according to the stage of land preparation.
- To classify land preparationequipment according to thepower applied to operate them.
- To explain the impact caused to the soil by using machineries in the land preparation.

Competency Level 5.4 : Inquires into different methods of crop establishment.

Duration : 05

Learning outcomes :
- Describes the methods of crop establishment.
- Names the equipment used in crop establishment.
- Describes the methods of operating crop establishmentequipment.
- Engages in the crop establishment following various methods.

Instructions for preparing the lesson:

- Enter the lesson by using relevant approach for sowing seeds and planting seedlings.
- Lead a discussion with students to explain the crop establishment.
  - Crop establishment is planting seeds, seedlings or other planting material and allowing them to grow as a crop.
- Indicate that seeds and seedlings are commonly established.
- Indicate that when crop establishment is through the seeds, time of planting seeds and depth of seedplanting should be considered.
  Eg: -
  - When the crop is established by the seeds, the harvest increases due to receiving suitable environment conditions for all stages in the crop growth
  - Keeping an equal depth while planting seedswill lead for a uniformly matured cultivation.
- Discuss the methods of planting seeds
  - Regular method (planting seeds)
    - planting seeds in the holes
    - Planting seeds in rows
  - Irregular method (random sowing)
- Discuss the methods ofplanting seedlings
  - Irregular methods
    - Sowing - Ex: - sowing seedlings in paddy cultivation. (Parachute method)
    - Random planting
  - Regular methods
    - Planting in rows
      - Single row planting
      - Double row planting
      - Square planting
      - Triangular planting
- Give students instructions to list advantageous and disadvantageous of each methods of cropestablishment.
  Eg: -
  - sowing - Required seeds quantity is high
    Less labour and time
  - Planting in rows - easy for mechanizing and inter cultivation activities.
    Need to prepare a nursery
- Indicate that various equipment are used for crop establishment.
- Indicate that the seeder is used for planting seeds and transplanting machines are used for transplanting.

- Point out thatseeders can be classified as follows:-
  - According to the land use.
    - Used for upland crops
      Eg: - • Single row seeder
      • FMRC double raw seeder
    - Seeders used ininMuddy crops (paddy)
      Eg: - • Wickramasekara seeder
      • Johnpulle seeder
  - According to the mechanization
    - Operate in manual
      Eg: - • Johnpulle seeder
    - Operate by machines
      Eg: - • Imported seeder
- Emphasize thatvarious equipment have been prepared for planting seeds.
  Eg: - • paddy seedlings planting machine (FMRC)

Key Words :

- Crop establishment
- Crop establishment methods
- Crop establishment equipments

Qualitative Inputs :

- Pictures of seeds orseedlings planting machines

Evaluation and assessment :

Pay attention on following points.

- To name the methods of crop establishment
- To describe the various methods of crop establishment
- To name the equipments used in crop establishment
- To describe the activities by identifying crop establishment equipment

Competency Level 5.5 : Engages in production of seedlings using different types of nurseries.

Duration : 08

Learning outcomes :
- Names various kinds of nurseries.
- Selects the suitable nursery according to the seeds.
- Prepares various types of nurseries
- Establish seeds in nurseries andmaintain them.

Instructions for preparing the lesson:

- Display pictures or video scenesof a nursery and take a suitable approach to the lesson.
- Ask students what a nursery is.
  - Nursery is the place where new plants are generated by planting materials within a short time period and, produce healthy seedlings which can resists the prevailing environment and prepare to plant for field establishment.
- Lead a discussion with students about the importance of preparing a plant nursery.
  Eg: -
  - Ability to get suitable healthy andstrong plants for planting.
  - Ability to get a uniform plant population.
  - Reducing the wastage of seeds by minimizing losses caused due to direct field establishment
- Ask from students the examples for types of nurseries.
- Taking into consideration the replies of the students, indicate that nurseries can be classified as follows: -
  - According to Agro-climatic zones
  - According to nursery containers
  - According to nursery medium
- Indicate that according to the climatic zone, the type of nurseryis different. Accordingly, indicate that raised nurseries are suitable for wet zone and sunken nurseries are suitable for dry zone.
- Indicate that various containers are used to prepare nurseries.
  Eg: -vessels, pans, Compots
- Explain students that according to nursery medium, types of nursery may be deferent.
  Eg: - Noridoko nurseries, sand nurseries, muddy nurseries, dapog nurseries
- Assist students to prepare various types of nurseries focusing about techniques to be considereding preparing nurseries.
  Eg: - Selecting a suitable place for the nurseries.
- Lead a discussion with students about way of maintaining a nursery through the following tropics.
  - Supplying shade
  - Irrigation
  - Controlling decease and pest
  - Hardening seedlings
- Discuss about the various methods of sterilization of plant nurseries.
  - Burning nurseries
  - Applying pesticides to the nursery
  - Exposing to the heavy sun heat
  - Fumigation of the nurseries
  - Applying boiled water
- Give students an opportunity to fumigate by burning a nursery.

Key Words :

- Nursery
- Nursery mixture

Qualitative Inputs :

- Pictures of various types of nurseries
- Equipment required for preparing nurseries
- Organic manure and surface soil required for nursery mixture
- Various types of seeds required for preparing nurseries

Evaluation and assessment :

Pay attention on following points.

- To name types of nurseries
- To describe various nursery techniques
- To indicate the methods of maintaining nurseries

Competency 6 : **Plans suitable irrigation and drainage methods for successful crop cultivation.**

Competency Level 6.1 : **Inquires into various water sources.**

Duration : **04**

Learning outcomes :
- Define water sources.
- Classifies water sources.
- Describesthe importance of nurturing water reserves.
- States the importance of recharging ground water and describes strategies to develop it.

Instructions for preparing the lesson:

- Go to the lesson by displaying pictures and photograph of various water sources.
- Define water source highlighting that a water source is defined as a body of water that can provide the required amount of water for crop cultivation.
  - Water bodies from which water can be obtained throughout the year or in a certain period of the year is introduced as a water source.
- Give the opportunity to list the various water sources.
- Guide students to classify those water sources according to various criterions.
  - According to nature
    - Natural - Ex: - stream, rivulet, rivers, shallow lake
    - Artificial - Ex: - Tanks, Agricultural wells, artesian wells
  - According to location
    - Surface Ex: - stream, rivulet, rivers, tanks, ponds
    - Ground Ex: - Agricultural wells, artesian wells, ground wells
- Discuss factors to be considered in the selection of water source suitable for the cultivation.

  Eg: -
  - Ability to get enough water for the cultivated crops/crop factors
  - Quality of water and free of waste materials
  - Physical features (topography)
  - Cost needed for the preparation of water source and lifting water to cultivated land.
  - Compatibility of thewater source with the existing irrigation system
  - Distance between the cultivated land and the water source
- Define the ground water recharging and discuss with students the methods of developing them.
  - Groundwater recharge is the process of moving down the surface water through infiltration or deep percolation and added to the groundwater.
- Discuss the methods of developing ground water recharging.

  Eg: -
  - Construction of rain water tanks
  - Building ponds in the farm
  - Conservation of catchment areas
  - Increasing water infiltration and percolation
  - Improving soil texture
  - Adding organic materials to the soil
  - Decreasing surface run off by cultivating plants
  - Developing drainage of the soil
  - Construction drainage drain, basins, pits

Key Words :

- Water sources
- Ground water recharge

Qualitative Inputs :

- Diagrams or pictures of various types of water sources

Evaluation and assessment :

Pay attention on following points.

- To introduce water source
- To classify water sources according to the various criterions.
- To point out the factors to be considered in the selection of water source for irrigation
- To indicate the methods that are used to nurture the ground water

Competency Level 6.2 : Inquires into suitable water lifting methods to increase water potential.

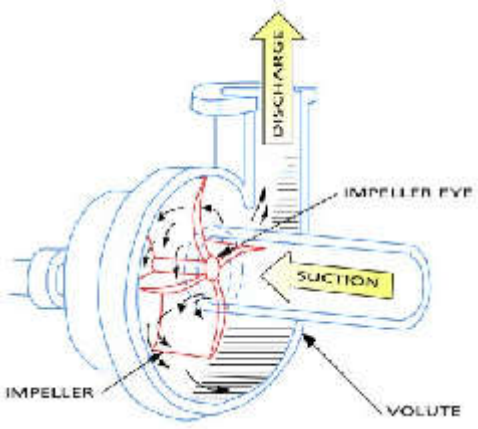
Duration : 06

Learning outcomes :
- Lists various water-lifting methods.
- Explain the principles used for water-lifting.
- Explain the mechanismof water pumps.
- Describes methods of installation and maintenance of water pumps.

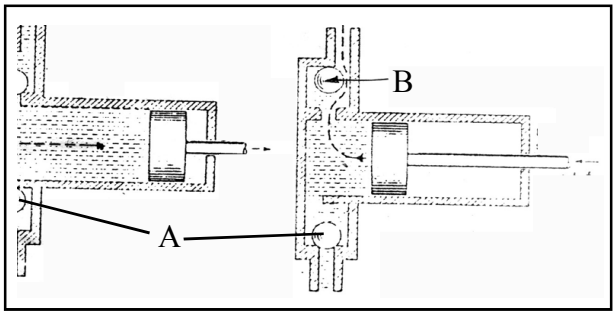
Instructions for preparing the lesson:

- Enter in to the lesson by asking the methods of obtaining water for domestic activities or using any other suitable approach.
- With student's answers highlight water lifting from the water source.
- Ask from students the requirement of water-lifting.
  - Water has to be transported from water source to the field when the artificial irrigation is needed for a cultivation land. In such occasions, water-lifting methods are used.
- Ask from students water-lifting methods. With that, indicate that water-lifting methods can be classified as follows.
  - Traditional method
  - Nontraditional method
- Guide students to list traditional water-lifting method by asking about that.
- Discuss with students how the water is lifted from water source by using each method.
  - Using pulleys
  - By string pump and Yoththa
  - By Andiya wells
  - Use water wheel
- Give students the opportunity topoint out advantages and disadvantages of eachmethod.

  Eg: -
  - Pulleys - advantages – not fuel consumption
    disadvantages – less efficiently
  - Water wheel - advantages - not consume the fuel
    non-occurrence environment pollution
  - Yoththa - disadvantages - less efficiently
    unsuitable for largecultivation lands
- Ask from studentsabout the nontraditional water-lifting methods.
- Make students aware that water pumpis not a nontraditional water-lifting method.
- Ask from students about the water-liftingmethods that are used for Agricultural activities.
- With that, indicate that the water-liftingmethods used for Agricultural activities can be classified as follows.
  - Centrifugal pumps
  - Displacement pumps
- Discuss the performance of centrifugal anddisplacement pumps with real examples /Models.



Centrifugal water pump



Piston type water pump

- Give students an opportunity to list advantages and disadvantages of displacement pumps and centrifugal pumps.

  Eg: -
  - Displacement pumps
    - Advantages :
      - Strong and durable
      - No cost for fuel
    - Disadvantages:
      - High initial cost
      - Unsuitable to pump water with sediment and waste materials
  - Centrifugal pumps
    - Advantages -
      - Regular and continual water supplying
      - Ability to pump water with sand and mud
    - Disadvantages:
      - Air bubbles have to be removed from non-self- pump (priming)
      - Inefficient when pumping water to a high level
- Discuss the measures that are followed in the installation and maintenance of water pumps.

Key Words :

- Water lifting
- Methods of water lifting

Qualitative Inputs :

- Real examples/ models pictures of various water lifting methods.

Evaluation and Assessment :

Pay attention on following points.

- To define the water lifting
- To describethe water lifting methods
- To mention advantages and disadvantages of water lifting
- To describe the performanceof water lifting
- To indicate the installation and maintenance of water lifting

Competency Level 6.3 : Carries out necessary calculations for ensuring effectiveness of irrigation.

Duration : 05 periods

Learning outcomes :

- Defines the irrigation.
- Describes the objectives of irrigation.
- Calculates the irrigation requirement
- Describes the factors of determining irrigation interval.
- Calculates the irrigation interval.
- Calculates theevapo - transpiration of plants.
- Defines the irrigation efficiency.
- Describes strategies for increasingirrigation efficiency.

Instructions for preparing the lesson:

- Give instructions to a student to supply water for the flower plant that is close to the classroom. Go to the lesson by asking about the amount of water supplied by the student or using any other approach.
- Build a definition for irrigationby discussing with students.
  - Irrigation is the artificial water supply when rain water is not sufficient to meet the water requirement of a crop.
- Guide students to list the purposes of irrigation.
  Eg: -
  - Easy for the land preparation activities
  - Giving an optimum growth for crops.
  - Giving necessary moisture content for seeds germination.
  - Controlling weed
- Point out that understanding of irrigation requirement is important in the irrigation.
- Point out that irrigation requirement can be calculated in two main methods.
  - Net irrigation requirement
  - Gross irrigation requirement
- Define the net irrigation requirement.
  - Expression of water requirement as a height that should be supplied from outside to bring the soil up to the field capacity under existing condition.
- Give students the equation relevant to calculate Net irrigation requirement and explain it.

$$I_n = \frac{(FC_w - P_wP)}{100} \times P \times D \times MADL$$

In = Net irrigation requirement (in centimeter)
FCw = Water percentage at field capacity (as a gravimetric rate)
P_wP = Gravimetric water content of the soil at the point of irrigation (as a rate) Here, the percentage of water is under the prevailing condition is mentioned since re-irrigation is done before fading coefficient.
P = Bulk density of the soil (To avoid the problem with measuring units, apparent specific gravity is used))
D = Depth of root zone (depth of soil layer in centimeter)
MADL = Management Allowed Depletion Level

- Guide students to calculate the net irrigation requirement in association with a problem.
- Define the Gross irrigation requirement.
  - Gross irrigation requirement is the amount of water needed to maintainthe soil in the field capacity.
- Give student a formula tto calculate the grossirrigation requirement.

$$\text{Gross irrigation requirement} = \frac{\text{Net irrigation requirement}}{\text{Irrigationefficiencys}}$$

- Guide students tocalculate the gross irrigation requirement in association with a problem.
- Point out that understanding of irrigation interval is important for irrigation.
- Point out that crop water requirement is same for theevapo- transpiration value.
- Accordingly, point out thatfollowing equation can be used to determine the irrigation interval.

$$Ii = \frac{I_n}{ETc}$$

ETc = Crop evapo-transpiration

- Discuss about the methods of improving the irrigation efficiency
  - Supplying water according to the soil moisture content
  - Using crop as an indicator
- Discuss about each method.
- Define the irrigation efficiency.
  - Irrigation efficiency is mentioned as a percentage of water absorbed by the crop from supplied water.
- Point out that following equation can be used to calculate the irrigation efficiency.

$$\text{Irrigation efficiency} = \frac{\text{Amount absorbed by the crop}}{\text{Amount of irrigated water}} \times 100$$

- Point out thatfollowing equation can be used to calculate the irrigation interval.

$$\text{Irrigation interval} = \frac{\text{Water content used by the plants}}{\text{Supplied water content}} \times 100$$

- Discuss about the methods for increasing irrigation efficiency.

  Eg: -
  - Minimizing adverse effect of climatic factors.
  - Minimizing infiltration by managing soil characters.
  - Planting suitable crops for cultivating field.
  - Minimizing infiltration in the places such as water canals
  - Selecting high efficientirrigation methods.
  - Selecting cultivation methods and cropping patterns tin order to meet water requirement.
  - Controlling weed.
  - Use of suitable equipment.

Key Words :

- Irrigation
- Net irrigation requirement
- Gross irrigation requirement
- Irrigation efficiency
- Irrigation interval

Qualitative Inputs :

- Planted seedlings, relevant pictures, video scenes

Evaluation and Assessment :

Pay attention on following points.

- To introduce the irrigation and mention its purposes
- To introduce the irrigation requirement
- To calculate net irrigation requirement and gross irrigation requirement
- To calculate the irrigation interval
- To calculate the irrigation efficiency
- To describe the methods of increasing the efficiency of irrigation systems.

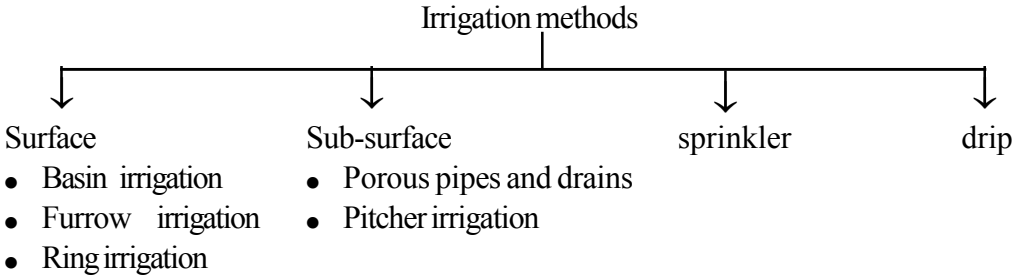
Competency level 6.4 : Inquires into different irrigation methods.

Duration : 06

Learning outcomes :
- Describes various irrigation methods for crops
- Draws diagrams of various irrigation methods.
- Names the componentsof sprinkler and drip irrigation systems
- Performs experiments different irrigation methods.
- Lists advantageous and disadvantages of irrigationmethods.
- Selects irrigation method suitable for the stage

Instructions for preparing the lesson:

- Go to the lesson presenting a picture of various irrigation methods to the class or using any other suitable approach.
- Ask from students about the methods used for irrigation.
- Guide students toclassify irrigation methods.



- Define that supply of water to the crops through the soil surface is called surface irrigation.
- Lead a discussion about the surface irrigation methods.
- Discuss the occasions usingeach surface irrigation methods and guide students to list advantages and disadvantages of them.
- Introduce Sub surface irrigation.
  - Supply of water under the soil surface.
- Discuss the advantages and disadvantages of sub-surface irrigation.
- Discuss with students about advantages and the disadvantages of those methods.
  Eg: - Advantages :
    - Decreasing evaporation loss as the soil surface is dry.
    - Increasing land extent for crop cultivation and easy to use machineries

    Disadvantages :
    - Difficult for maintenance
    - pumping system can be damaged at the deep tillage
- Point out that Sub surface irrigation cannot be commonlyseen in Sri Lanka.
- Define students about the sprinkler irrigation.
  - Applying water on the crops as a spray by pumping water under a heavy pressure against the gravitational force using a water pump through the air-tight pump system.
- Give students an opportunity to identify the various parts of sprinkler irrigation system.
- Guide students to prepare a sprinkler irrigation model to irrigate a small field.

- Guide students to list out advantages and disadvantages of sprinkler irrigation.
  Eg: - Advantages
    - Uniform water supplying for the field
    - No soil erosion due to less surface run off.

    Disadvantages
    - Not suitable for places with high wind.
    - cost for fuel and electricity.
- Define students the term drip irrigation.
  - Maintaining root zone soil in field capacity continuously by supplying water as droplets to the root system of the crop.
- Guide students to draw a diagram of a drip irrigation system and name its parts.
- Give students an opportunity to identify various componentsused here.
- Give students an opportunity to prepare adrip irrigation model in a small field.
- Discuss the situations where the drip irrigation is used.
- Discuss the advantages and disadvantages of drip irrigation.
  Eg: - Advantages -
    - No soil erosion due to less surface run off
    - Saving large amount of water due to supplying water only to the root system.

    Disadvantages -
    - Blocking the small water dripping pores of emitters due to water wastes
    - Need a high tech-knowledge
- Discuss the factors tobe considered in the selection of an irrigation method.
  Eg: -
    - Crop factors
    - Nature of the land
    - Climatic factors
    - Cost

Key Words :

- Surface irrigation
- Sub-surface irrigation
- Sprinkler irrigation
- Drip irrigation

Qualitative Inputs :

- Pictures showing various irrigation methods.
- Various componentsof the sprinkler irrigation system.
- Various componentsof the drip irrigation system

Evaluation and Assessment:

Pay attention on following points.

- To define about the irrigation
- To explain the purposes of irrigation
- To classify irrigationmethods
- To define surface irrigation and mention its advantages and disadvantages.
- To mention advantageous and disadvantages of sub surface irrigation.
- To define various components of drip irrigation methods and mention its advantages and disadvantages
- To define and mention advantages and disadvantages of sprinkler irrigationmethods.

Competency Level 6.5 : Prepares plans to minimize the problems arising in improper irrigation.

Duration : 02 periods

Learning outcomes :
- Describes the issues arising through improperirrigation.
- Describes strategies used to minimizethe problems of irregular irrigation.

Instructions for preparing the lesson:

- Enter the lesson by awakening the memory of students about the various methods ofirrigation to the crops.
- Point out that irrigationto a field should be carried out with a due management.
- Discuss with students about the problems arisen by excess irrigation.
  - Environment pollution
  - Degeneration of soil characteristics
  - Subsidence
  - Spreading decease and pests.
  - Soil erosion
- Discuss the measures thatcan be taken to minimize the problems of excessive irrigation.
  Eg: -
  - Irrigation up to field capacity only
  - Adding organic materials to the soil
  - Following irrigation such as drip irrigation

Key Words :
- Over/ Improper irrigation

Qualitative Inputs :
- Photographs, pictures indicating improper irrigation

Evaluation and Assessment:

Pay attention on following points.
- To describe the issues of excess irrigation to the field than the required amount
- To indicate the measures thatcan be taken to minimize the issues of improper irrigation.

Competency Level 6.6 : Plans suitable drainage methods.

Duration : 04

Learning outcomes :
- Defines the term drainage.
- Describes adverse effects of poor drainage.
- Describes the reasons for poor drainage.
- Describes the strategies that can be used to improve drainage.
- Draws drainage systems.

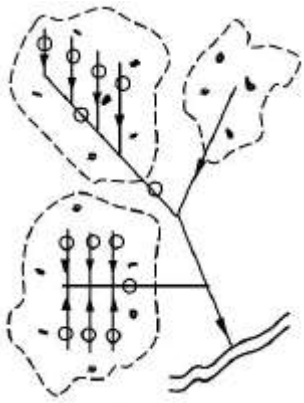
Instructions for preparing the lesson:

- Go to the lesson by presenting a picture showing a field of cultivation where the drains have been prepared a , and asking the reasons for preparing drains like that
- Indicate that removing of excess water in crop profile naturallyis called as drainage.
- Point out that waterdoes not clear off naturally from soil profile in some fields.
- Point out that sucha soil is the soil with poor drainage, and drainage should be done in such situations
- Ask from students that what the meaning of drainage is?
  - When excess water in the soil does not remove from the soil profile, artificial methods have to be used to remove that water. This is called as drainage.
- Discuss the reasons for a poor drainage of a soil.

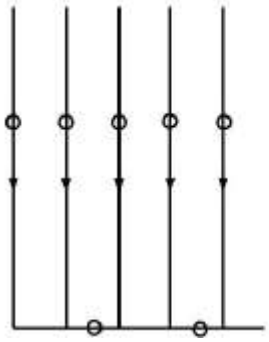
  Eg: -
  - Ground water level is high
  - Accumulation of water in low lands
  - Compaction of sub soil
  - Frequent tillage for a definite depth
  - seepage of water from various water sources to Agricultural fields..
- Discuss with students about the adverse effects arisen due to a poor drainage.

  Eg: -
  - Yellowing of leaves (chlorosis)
  - Interfering for plants growth
  - Causing toxicity for the plants by the toxic substances resulted due to anaerobic respiration
  - Being subjected to felling plants easily due to not shallow root system.
  - Soil toxicity due to the toxic gasses caused by anaerobic respiration (hydrogen sulfide, carbon dioxide) and decreasing aerobic microorganisms' activities by increasing anaerobic microorganisms'activities.
  - Developing the soil salinity
  - Difficulty in land preparation activities.
- Point out students that crop cultivation can make success by removing poor drainage conditions.
- Discuss with students that various methods are used to develop drainage.
  - Use of surface drainage methods - open ditches
  - Useof sub surface drainage methods - porous pumps, wooden ditches, stones ditches
  - Use of water pumps
  - Use of plants with high evapor- transpiration
- Explain students that drainssystem should be duly planned for an efficient drainage.

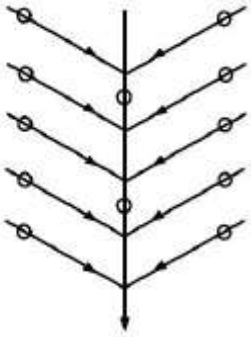
- Assist students to draw how to plan drains systems for drainage.
  - Random method
  - Parallel grid method
  - Herring bone method



Random method



Parallel grid method



Herring bone method

Key Words :

- Drainage
- Methods of drainage
- Drainage systems

Qualitative Inputs :

- A picture showing the drains system of a cultivation field

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define the poor drainage and mention its adverse effects.
- To explain the reasons for poor drainage.
- To describe how to use various drainage methods.
- To depict using the diagrams, the methods of planning drains systems for drainage.

Competency 7 : Exhibits the readiness to obtain a high yield by optimizing plant physiological processes.

Competency Level 7.1 : Plans to optimize the process of photosynthesis.

Duration : 02

Learning outcomes :
- Defines the photosynthesis.
- Indicates the steps of photosynthesis process.
- Describes the factors affecting on photosynthesis.
- Explains the strategies to improve theefficiency of photosynthesis.

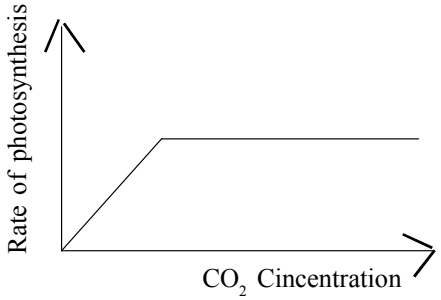
Instructions for preparing the lesson:

- Present a picture of a foods chain, and ask from students about its producer. Enter the lesson by discussing with students about the role of the producer ina foods chain.
- Point out that food production of a plant occurs inside the plants leaves and that process is called as photosynthesis.
- Give students an opportunity to define photosynthesis with the previous knowledge and present that process by a simple equation.
  - Photosynthesis is a bio chemical process in order to retain the solar energy in organic food as the chemical energy; producing organic foods utilizing light intensity in live cells bearing chlorophylls and using inorganic raw materials such as carbon dioxide (CO_2)and water

$$6\,CO_2 + 6\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Solar energy}} C_6H_{12}O_6 + 6O_2$$

- Point out that photosynthesis process is consisted of major two consecutive phases.
  - Light reaction requiring light intensity
  - Dark reaction not requiring light intensity
- Give students instructions to search and present the information about the process that occurs in each phase of photosynthesis process.
- Ask from students the factors affecting photosynthesis.
- Guide students to classify those factors as external factors and internal factors.
  - External factors : Light, temperature, carbon dioxide concentration, water, pollutants
  - Internal factors : Chlorophylls, mesophyll, water content, leaf anotomy, width of the leaf blade, number of stomata, inter-cellular spaces, leaf maturity
- Discuss the impact of those factors on photosynthesis using the diagrams.

Eg: -



- Indicate that a high yield could be obtained by making the photosynthesis process efficient.
- Discuss the strategies that can be used to enhancethe efficiency of photosynthesis.
  - Keeping spacing between the plants
  - Removing unnecessary branches
  - Removing shade plants
  - Supplying nutrients properly
  - Management of diseases and pests
  - Regular drainage
  - Using correct pruning methods.

Key Words :

- Photosynthesis

Qualitative Inputs :

- A picture of foods chain
- Graphs and diagrams showing the effect of photosynthesis factors

Evaluation and Assessment :

Pay attention on following points.

- To define the photosynthesis
- To name the steps of photosynthesis process
- To describe the factors that affectphotosynthesis
- To describe the measures that are applied to enhance the efficiency of photosynthesis.

Competency Level 7.2 : Inquires into how the respiration is important for cultivation of crops.

Duration : 03

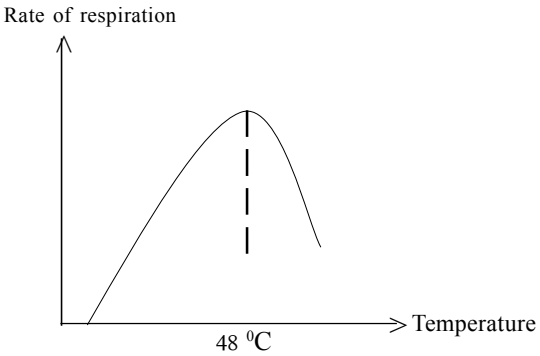
Learning outcomes :
- Defines the plant respiration
- Names the steps of respiration process.
- Indicate the factors thataffect for plantsrespiration

Instructions for preparing the lesson:

- Enter the lesson by asking students about the process that occurs in live plant cells
- Highlight the respirationprocess through answers receiving for that question, .
- Raise a definition for respiration from the students
  - Respiration is the process of breaking down organic compounds subjecting to a series of enzyme reactions in order to release the energy.

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{Enzymes}} 6CO_2 + 6H_2O + \text{Energy}$$

- Point out that respiratory mechanism consists with following steps.
  - Glycolysis
  - Krebs circle
  - Electron transportation
- Give students instructionsto find and submit information about the process that occurs in each step of respiratory mechanism.
- Ask students about the factors affecting for respiration.
- Guide students to classify those factors as external factors and internal factors.
  - External factors: temperature, oxygen concentration
  - Internal factors: enzyme, cellular compounds
- By using graphs and diagrams, discuss the effect of those factors for the respiration.
  Eg: -



Key Words :
- Respiration process

Qualitative Inputs :
- Relevant graphs and diagrams

Evaluation and Assessment :

Pay attention on following points.

- To define the respiration process.
- To name the main three steps of respiration process.
- To describe how external factors and internal factors effect for respiration.

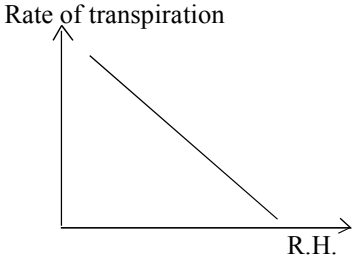
Competency Level 7.3 : Plans strategies to maintain optimized transpiration in plants.

Duration : **04**

Learning outcomes :
- Defines the transpiration process.
- Indicatesthe factors affecting to the transpiration.
- Explains the controlling methods of the transpiration process.
- Measures the rate of transpiration.
- Determines that the transpiration occurs through stomata.

Instructions for preparing the lesson:.

- Present an example to the class keeping a pot with a branch/seedling by covering with a discolored polythene bag under the sunlight for about one hour.
- Enter the lesson by asking the reasons to present water drops in the polythene bag of the above example.
- Emphasize students that the reason for the presence of water drops in the polythene is the transpiration process.
- Point out thatemission of water as vapor from aerial parts of the plants is called transpiration.
- Point out that there are three transpiration methods.
  - Stomata transpiration
  - Cuticular transpiration
  - Lenticular transpiration
- Point out that emission of water as vapor through the microscopic hole or stomata which is centered between two controlling cells of a plant leaf is called as stomata transpiration.
- Point out that about 98% out of water emission occurs through the stomata.
- Guide students to observe that transpiration occurs through the stomata.
- Point out that water in cuticularcells ofleaves and immature stems is emitted as vapor through the epidermis is called as cuticular transpiration and it is relatively a very small amount.
- Point out that the lenticel isa loosely packed point of the bark , and water evaporation through that is called as lenticular transpiration.
- Point out that lenticular transpiration occurs in a very small quantity.
- Ask students about the factors affecting the transpiration.
- Guide students to divide those factors as external factors and internal factors.
  - External factors : Intensity of light, temperature, humidity, wind
  - Internal factors : Surface area of leaves , direction to the sunlight, thickness of cuticular, location of hairs on leaves, presence of sunken stomata, distribution and number of stomata, number of palisade parenchyma
- Dscuss about the effects of those factors for transpiration using graphs and diagrams.
  Eg: -



- Ask students about the rate of transpiration. Point out that transpiration in any given time period is called as rate of transpiration.
- Discuss about how to measure the rate of transpiration.
  - By using the whole plant
  - By using a potometer
- Guide students to measure the rate of transpiration by using the photometer and a whole plant.
- Discuss the importance of transpiration.
  Eg: -
  - Cooling of plant due to absorptionof heat at the water evaporation.
  - Important to give(transpiration pull) necessary energy for cellular transportation.
  - Important to absorb water and minerals necessary to plants and transport upward
  - Contribution to maintain natural water cycle.
- Discuss the necessity of controlling transpiration process of plants.
  Ex: -when atmosphere humidity and soil water content is less, the plant cannot absorb water compared to the amount of water removed by plants transpiration. in such occasions, plant may be withered. When water absorption is dimidiated, nutrients absorption may also dimidiate. Then the yield of the crops may decrease.
- Discuss the methods used to control the transpiration.
  - Usinganti-transpiring agents
    Eg: -
    - Stomataclosing agents Ex:- absisic acid (ABA)
    - Agents forming thin membranes on leaves - Ex: - such as wax, polythene
    - Metabolically toxic agents
  - Giving shades for plants
  - Partial trimming of laves in transplantingseedlings and branches
  - Growing crops in protected houses

Key Words :

- Transpiration
- Rate of transpiration

Qualitative Inputs :

- A plant pot and a discoloredpolythene bag that can cover it properly.
- Five filter papers soaked in $CoCl_2$ and dried
- Two slides
- Two clips
- Potometer and asuitable branch

Evaluation and Assessment:

Pay attention on following points.

- To define the transpiration.
- To indicatemain three methods of plant transpiration from plants.
- To indicate the external and internal factors affecting transpiration.
- To measure the rate of transpiration.
- To indicate the strategies followed to control the transpiration.

Competency Level 7.4 : **Plans strategies to regulate the absorption and translocation of materials in plants.**

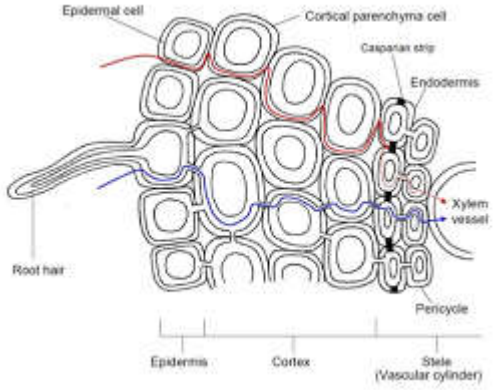
Duration : 03 periods

Learning outcomes :

- Explains absorption of materials into plants.
- Explains transportation of materials in plants.
- Points out that foods translocation is occurred through the phloem.
- Describes the way of obtaining maximum yield through the efficient absorptionand transportation.

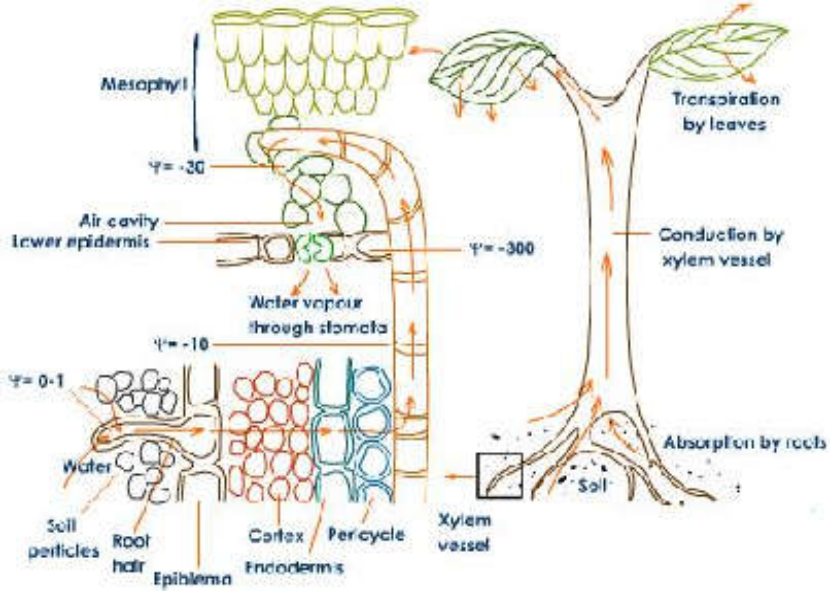
Instructions for preparing the lesson:

- Enter into the lesson by giving students the opportunity to observe a Bolsom (Koodalu) plant placed on a dark red colored water pot approximately for one day.
- Point out students that materials dissolved in water are absorbed by the plant through the root system and translocation throughout the plant.
- Point out that materials are absorbed by the plants through two main methods.
  - Active absorption
  - Passive absorption
- Point out that active absorption is the means of movement of substances against the concentration gradient using metabolic energy and this is the main process of absorbing minerals.
- Point out that passive absorption is the process of absorbing of minerals through the concentrationgradient without using metabolic energy.
- Discuss the main methods of passive absorption.
  - Diffusion
  - Imbibition
  - Osmosis
  - Facilitated diffusion
- Emphasize that under the normal condition, water absorption in to the plants occurs through passive absorption.
- Point out that water absorbed by plant roots is translocatedby radial movement from roots hairs to toot xylem
- Using a diagram, discussthe radial movement of roots.

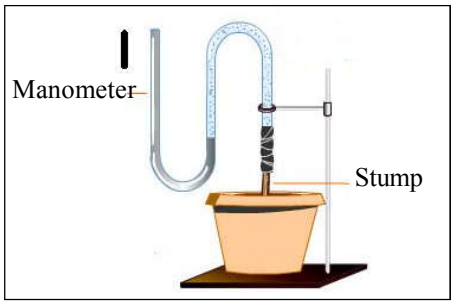


- Emphasize students that water moved up to xylem tissues by radial movement istranslocatedvertically upward through the plant stem and this process is called as ascent of sap.

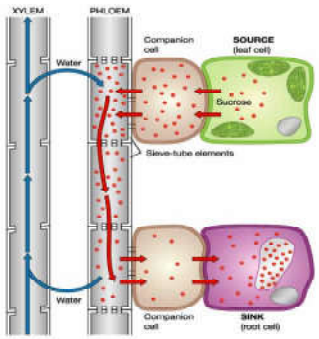
- Point out that this occurs by mass flow, and necessary pressure/ energy is given by following two methods.
  - Transpiration pull energy
  - Root pressure
- Using diagram, explain that transpirationpull energy mainly contributes forAscent of sap process.



- Discuss with examples about the process of root pressure occurring in plants.



- Emphasize students that transportation of food produced in plant leaves in to vegetative shoots and food storage parts is called phloem translocation.



- Discuss how to show that the translocation of substances occurs through the phloem
  - Removal of bark as a ring
  - Using radiant isotopic.
- Discuss the advantages and disadvantages gained by regulating phloem transportation.
  Ex: -
  - Stimulating florescence of plants
  - Breeding new plants by air layering

Key Words :

- Passive absorption
- Active absorption
- Mass flow
- Ascent of sap
- Translocation

Qualitative Inputs :

- Water dish colored with dark red and a white bolsom plant.

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To indicate the main two methods of material absorption.
- To describe the ascent of sapand radialmovement
- To describe the phloem transportation.
- To indicate trategies taken to regulate phloem transportation.

Competency Level 7.5 : Plans to improve crop production by using growth regulators.

Duration : 04

Learning outcomes :
- Defines the plants hormones.
- Explains the functions of plants hormones.
- Explains how to improve the productivity of agricultural crops by using growth regulators.

Instructions for preparing the lesson:

- Present two ripe and unripe fruits of the same variety to the class.
- Allow students to observe these two fruits. Ask students about the main deference of these two fruits. Highlight that deference is ripeness and unripe.
- Point out that the reason for ripeningthe fruits is a plant hormones.
- Define the plant hormones.
  - Plants hormones is an organic substance produces naturally in plants and important in small quantities to regulate physiological functions in places away from the places of production.
- Discuss with students that plant hormones can be divided in to five major groups.
  - Auxins
  - Cytokines
  - Ghibelline
  - Abscisic acid
  - Ethylene
- Point out that in general, plants hormones functions as follows: -
  - To increase the plasticity of the shoot cell walls and elasticity of the root cell walls.
  - To increase the permeability of water and water retention capacity.
  - To absorb water actively even against the osmotic gradient.
  - To increase respiration rate
  - To increase the amount of pectin and cellulose in cell wall.
  - To stimulate the enzymes.
  - To synthesis proteins that have low levels of free amino acid.
- Make students aware that the auxins is the group of hormones discovered first and the group that was researched more.
- Emphasize students that auxins is normally synthesized in the shoot tip.
- Point outthat auxins regulate some metabolic activities that affect crop productivity.
  Eg: -
  - Elongation of cells
  - Secondary growth
  - Epical dominance
  - Parthenocarpy
  - Spiral movements
- Discuss the activities that are followed to test cell division, expansion, elongation by auxins.
- Discuss about the activities that carried out by Ghibelline in plants.
  Eg: - Prevent stunning of plans
- Discuss about the activities that carried out by Cytokines in plants.
  Eg: - Seed germination and seedling growth
  - Cell division and differentiation of cells
  - Controlling leaf senescence
  - Root-shoot interactions

- Discuss about the activities that carried out by Abscisic acidin plants.

  Eg: -
  - Closing stomata
  - Negation plant growth
  - Creating shoot dormancy and seed dormancy
  - Abscission
  - Formation of irregular leaves
- Discuss about the activities that carried out by Ethyleneacidin plants.

  Eg: -
  - Fruits ripping
  - Stimulation of germination
  - Induction of female flower
  - Prevention of lodging
- Ask students the difference between the plant growth regulators and plant hormones.
- Discuss the situations that use growth regulators effectively in agricultural activities.

  Auxines

  Eg: - To improve seed promotion by IBA, NAA, NBA
  - To rootthe shoots- Ex: - NAA, IBA
  - To increase the formation of female flower - IAA
  - To stimulate flowering in pineapple plants.
  - To increase the parthenocarpy- IBA, NAA
  - To increase the fruitsbearing percentage-IAA, IBA, NAA
  - To control the falling of leaves
  - As a weedicide- 2,4 D
  - In tissue culture

  Cytokine

  Eg: - To control the roots growth
  - Phenotyping the shoots and roots in the tissue culture medium.
  - To stimulate the growthof lateral buds

  Ghibelline

  Eg: - To broaden the leaves and enlarge the fruitsEx: - cabbage or sweet corn fruits
  - To create parthenocarpy
  - To delay the falling of leaves
  - To control the falling of fruits
  - To prevent stunning of plants
  - To remove seeds dormancy

  Ethylene

  Eg: - To ripen the fruits
  - To stimulate the efflorescence

  Abscisic acid

  Eg: - To secure from decease agents when the tissues get wounded
  - To stimulate the production of protease enzymes inhibitors
  - To activate ribonuclease
  - To increase permeability of tissues
  - To stimulate the abscission of leaves and fruits

Key Words :

- Plant growth regulators
- Plant hormones

Qualitative Inputs :

- Ripe and unripe fruits of the same variety

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define plant hormones
- To state the effect of plant hormones on physical activity
- To define growth regulators
- To state the agricultural use of growth regulators

Competency Level 7.6 : Determines the plant development using growth parameters.

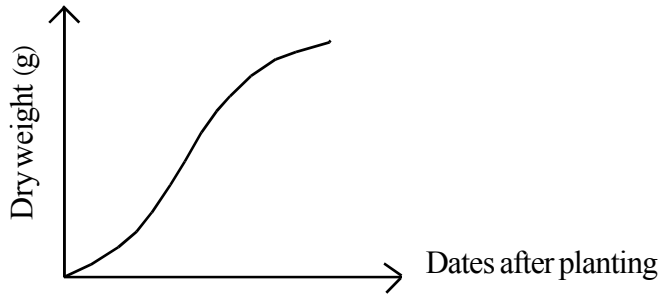
Duration : 04 periods

Learning outcomes :

- Names the growth parameters of plants.
- Takes the necessary measurements to measure the plant growth.
- Draws plant growth curves.
- Determines the leaf area index.

Instructions for preparing the lesson:

- As planned before, plant two seedlings such as long bean or bean and keep it to grow in the classroom.
- Give students an opportunity to observe the growth of those plants.
- Inquire students the characteristics that are used to observe that plant growth has taken place.
- Using students' answers, name plant growth parameters.
  - Height of the plant
  - Circumstance of the plant
  - Number of leaves
  - Number of branches
  - Leaf area
  - Dry weight of the plant
- Define the plant growth.
  - Increasing volume and weight due to cell division and sell expansion of a plant.
- Discuss the how to use growth parameters to measure the plant growth.
- Guide students to draw plant growth curves by using the gathered data.



- Point out that growth curves take sigmoid shape.
- Discuss with students about the following growth indices.
  - Crop Growth Rate (CGR)
  - Leaf Area Index (LAI)
- Define the Crop Growth Rate (CGR)
  - Crop Growth Rate is the increase of the dry weight of a plant in a unit within a given time period.
- Point out that following equation can be used to calculate the rate of growth.

$$CGR = \frac{w_2 - w_1}{t_2 - t_1} \quad m^2/g$$

$t_2 - t_1$ - Deference between two given times

$w_2 - w_1$ - Deference of dry weight during that period.

- Define the Leaf Area Index.
  - Leaf area per unit ground area
- Point out that leaf area can be calculated by following equation.

$$\text{Leaf Area Index (LAI)} = \frac{\text{Total leaf area of crops in a particular land area}}{\text{Total land area cultivated with those crops}}$$

- Point out the students that the photosynthesis capacity of a tree decreases when LAI exceeds a certain limit, it is important to maintain the LAI value So as to gain amaximim photosynthesis capacity.
- Point out that following methods are used to measure leaf area.
  - Plants leaf length and width relationship method
  - Using standards
  - Using leaf area measurement meters
    - Planimeter method
    - Disk method
    - Leaf length and width relationship method
    - Grid method
- Guide students to measure the leaf area by grid method.

Key Words :

- Crop Growth Rate (CGR)
- Leaf Area Index (LAI)
- Growth indices
- Growth parameters

Qualitative Inputs :

- Planimeter
- Two seedlings of small long bean/bean planted in two pots
- Graph papers
- A measuring tape
- few leaves

Instruction for Evaluation and Assessment:

Pay attention on following points.

- To define the plant growth
- To state the growth parameters.
- To define and determine the crop growth rate.

Competency Level 8 : Engages in plant propogation using suitable technologies.

Competency Level 8.1 : Investigates methods of plant propogation.

Duration : 02 periods

Learning outcomes :
- Defines the plant propagation.
- Classifies and states various plant propagation methods with examples.

Instructions for preparing the lesson:
- Present easily available seedlings such as *gotukola* plant ginger plant green pea plant .
- Go to the lesson by asking how by those plants Propogates their breeds
- Define the plant propagation
  - Breeding new plants for the survival of their species is plant propagation.
- Guide students to name the two major plant propagation methods
  - Sexual propagation
  - Asexual propagation (growth propagation)
- Inquire the students about the difference between the sexual propagation and asexual propagation (growth propagation).
  - Sexual propagation - propagation by seeds
  - Asexual propagation - propagation by growth parts
- By using diagrams or video scenes, make students aware that asexual propagation methods can be classified as follows:-
  - Cutting
  - Layering
  - Budding
  - Grafting
  - Tissue culture
- Ask students the examples for each growth propagation.
  Eg: - Cutting - underground stems, bulbil
  layering – leaf parts, parts of stems, parts of roots

Key Words :
- Plant propagation
- Sexual propagation
- Asexual propagation

Qualitative Inputs :
- Easily available seedlings such as *gotukola* plant, ginger plant, green peaplant
- Relevant diagrams and videos

Instruction for Evaluation and Assessment :

Pay attention on following points.
- To introduce the Plant propagation.
- To state the differences between the sexual propagation and asexual propagation.
- To state the examples for asexual propagation.

Competency Level 8.2 : Inquires into seed development and germination.

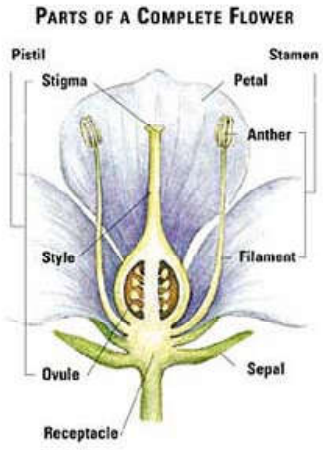
Duration : 04 periods

Learning outcomes :

- Names components of a typical seed.
- Describes seed generating process.
- Explains seed germination methods by observing seedlings.
- Determines the factors necessary for seed germination.
- Compares the characteristics of monocotyledonous and dicotyledonous.
- Describes seed germination process.

Instructions for preparing the lesson:

- Go to the lesson presenting to the class various flowers and giving the opportunity to identify their parts
- Give students an opportunity to identify the parts of a typical flower using a diagram.

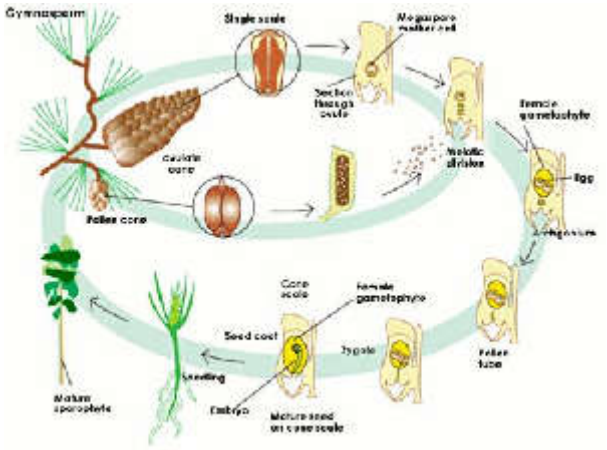


- Point out students that there are two forms of flowers according to the location of androecium and gynoecium.
  - Unisexual flowers
  - Bisexual flowers
- Give students instructions to separate the flowers presented to the class as unisexual flowers and bisexual flowers.
- Ask students how to bear fruits of a plant. Using that, highlight the term pollination.
  - Pollination is the transferring of pollen grain on the stigma.
- Point out that there are two pollination methods in flowers.
  - Self-pollination
  - Cross pollination
- Discuss the differences between the sexual propagation and asexual propagation.
- Self pollination

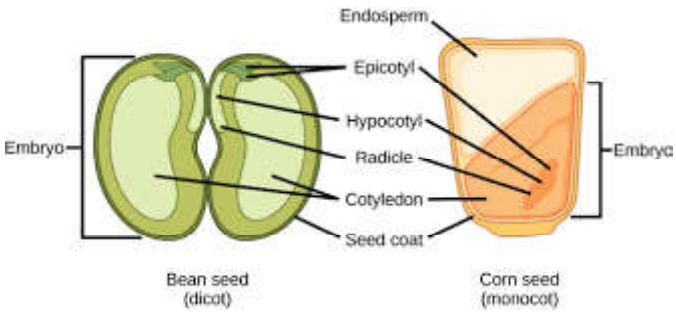
  Eg: - • Bearing bisexual flowers
- Cross pollination

  Eg: - • Dichogamy
  - Having self- sterility and self- incompatibility
  - Springing up Bisexual flowers

- Give students instructions to present examples for plants showing self-pollination and cross pollination.
  - Plant showing self-pollination - Ex: - paddy, green pea, tomato
  - Plant showing cross pollination - Ex: - sorghum, radish, avocado
- Point out that both self-pollination and cross pollination occur in some plants.
- Ask students the examples for those plants.
  Eg: - • Brinjal, amaranth (Thampala), green chilly
- Explain student how the seeds are formed by gamete- fertilization.



- Ask students what a seed is.
  - A seed is matured fertilized embbyo enclosed by a protective cover.
- Present seeds of various plant species to the class room. Give students an opportunity to observe the interior by splitting those seeds longitudinally.
- With that, point out that there are two types of seeds according to the seeds texture.
  - Monocotyledonous seeds
  - Dicotyledonous seeds
- Present pictures of monocotyledonous seeds and dicotyledonous seeds to the class.



dicotyledonous seeds Monocotyledonous seeds

- Assist students to identify the parts of monocotyledonous seeds and dicotyledonous seeds.
  - Seed coat
  - Endosperm
  - Foetus

- Give students the opportunity to compare the differences between the monocotyledonous seeds and dicotyledonous seeds.

Ex: -

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- Discuss the functions of each part of a seed.
- Define seed germination.
  - Seed germination is emergence of seed plant by sprouting seed coat due to the active growth of embryo
- Discuss about the seed germination process.
  1. entering water to seeds by imbibition
  2. Encyme activation
  3. starting growth
  4. splitting the seed coat
  5. Sprouting the seedling
- Lead a discussion with students about the factors required for seed germination. Guide students to determine whether those factors are necessary.
- Germinate monocotyledonous seeds and dicotyledonous seeds and present those seedlings to the class.
- By observing that, give students an opportunity to identify the differences of those two methods of germination.
- With that, point out that there are two types of seed germination.
  - Hypogeal germination
  - Epigeal germination
- Give students an opportunity to present examples for showing hypogeal germination and epigeal germination.
- Give students instructions to list the differences between the hypogeal germination and epigeal germination.

Hypogeal germination	Epigeal germination

- Lead a discussion with students to highlight the information about the importance of plant propagation by seeds.

Eg: -
- Propagation of plants that cannot be propagated by vegetative growth. Generating new verities.
- Ability to take scions for budding.
- Ability to take large amount of offsprings from one parent plant.

Key Words :

- Seed
- Self pollination
- Cross pollination
- Seed germination

Qualitative Inputs :

- Relevant diagrams
- Monocotyledonous seeds and dicotyledonous seeds
- Relevant videos

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To name the two methods of flower pollination.
- To explain the gamete fertilization and formation of seeds
- To name the parts of a typical seed
- To explain the functions of those seeds components.
- To define the seed germination.
- To explain the factors affecting seed germination.
- To name the methods of seed germination.
- To identify the forms of seed germination in germinated seeds.

Competency Level 8.3 : Inquires into the methodologies to safeguard the viability of seeds.

Duration : 02 periods

Learning outcomes :
- Defines the Seed viability.
- Describes the factors affecting to seed viability.
- Describes the methods of determining seed viability.

Instructions for preparing the lesson:

- Go to the lesson by asking reasons for not germinating some vegetable seeds after a long period of seeds production
- Define the Seed viability.
  - Seed viability is the potentiality or ability of a seed to germinate under suitable condition such as moisture content, temperature, air.
- Ask students about the factors affecting seed viability.
- Using students answers, point out that factors affecting to seed viability can be classified as follows:
  - External factors
    Eg: - Temperature, CO_2 concentration, atmospheric relative humidity
  - Internal factors
    Eg: - Genetic factors, percentage of moisture in the seed factors that occur during seed maturity.
- Lead a discussion with students about how does each factor effect for seed viability.
  Eg: -
  - Degeneration of seed viability, when seeds have been stored in an environment with high temperature condition.
  - When atmosphere relative humidity increase, viability may be damaged.
- Point out that following methods can be used to measure the seed viability.
  - Measuring the germination percentage of seeds
  - Tetrasolium test
  - CO_2 emission test
- Discuss the how to measure seed viability by using each method.
- Conduce that when seed viability is measured by using the germination percentage measure, dormant seeds viability cannot be checked.
- Emphasize that dormant seeds viability can be determined by tetrasolium test and CO_2 emission test.
- Lead a discussion with students about the methods of protecting seed viability.
  Eg: - Controlling temperature, air, moisture content
  Controlling fungus, bacteria, insects

Key Words :
- Seed viability

Qualitative Inputs :
- Relevant diagrams
- Relevant video scenes

Evaluation and Assessment:

Pay attention on following points.

- To define the seed viability
- To explain the factors affecting to seed viability
- To describe the tests used for measuring the seed viability
- To explain the methods of protecting seed viability

Competency Level 8.4 : Inquires into the qualities persistent in the seeds enabling successful cultivation.

Duration : 06 periods

Learning outcomes :
- Explains the necessity of seed testing.
- Determines the percentage of seed germination by using various methods.
- Determines the moisture percentage of seeds.
- Selects suitable seeds for cultivation.

Instructions for preparing the lesson:
- Present a pure seed sample (A) and a seed sample with weed seeds, empty seeds colluvial seed to the class.
- Go to the lesson by asking about the differences between these two samples.
- With that, lead a discussion to highlight the importance of seed testing.
- Guide students to find out germination percentages of a few seed samples by using various methods.
  - Petri dish method
  - Wet tissue paper method
  - Nursery box method
- Lead a discussion with students how to examine the physical purity of a seed sample.
- Guide students to determine the physical purity of a seed sample.
- Discuss the methods that are used to find the moisture percentage.
- Guide students to find out the moisture percentage of a seed sample.

Key Words :
- Seed testing
- Seed germination tests

Quality Inputs :
- Material required for examining seed germination percentage.
- Material required to find out the physical purity of seeds.
- Material required to find out moisture percentage of seeds.
- Relevant video scenes.

Instruction for Evaluation and Assessment :

Pay attention on following points.
- To need seed testing.
- To find out the seed germination percentage.
- To find put moisture percentage.
- To find out physical purity of seeds.

Competency Level 8.5 : Inquires into the methods of removing seed dormancy.

Duration : 04 periods

Learning outcomes :
- Explain the importance of seed dormancy.
- States the factors that affect seed dormancy.
- Explain the various types of seed dormancy.
- Prepares seeds for germination by removing dormancy.

Instructions for preparing the lesson:

- Go to the lesson by asking the reasons for not germinating the lima beans, teak, and mango seeds.
- Emphasize students that though it gives necessary factors for germination, some seeds do not germinate based on various reasons.
- With that, introduce the seed dormancy.
  - Though the factors such as moisture, temperature, oxygen are provided for germination of a matured live seed, Viable seeds do not germinate
- Lead a discussion with students to reveal importance of seed dormancy.
  Eg: -
  - Prevention of seed germination in matured fruits during heavy rains.
  - Not Able to get a uniform cultivation
- Ask from students about the reasons for seed dormancy.
- With students answers, point out that the types of seed dormancy are as follows.
  - External dormancy
  - Internal dormancy
- Emphasize that external dormancy arises due to both physical dormancy and chemical dormancy.
- Define the physical dormancy.
  - Dormancy caused due to not receiving the water and oxygen required for the growth of embryo because of a physical barrier (thick coat)
- Guide students to mention examples for seed with physical dormancy.
  Eg: -
  - Seed with thick seed coat/ impermeable seed coat – mango, teak, melia koenigii (Lunumidella)
- Define the chemical dormancy.
  - Seeds become dormant due to chemicals such as growth inhibitors and hormones.
- Guide students to mention examples for seed with chemical dormancy.
  Eg: - Seed with inhibitory coats – passion fruits, papaya, tomato
- Explain students that internal dormancy arises due to phonotypic and physiological dormancy.
- Guide students to state the examples for internal dormancy.
  Eg: -
  - Coconut, palm
- Discuss the methods of removing dormancy.
  Eg: -
  - Splitting seed coats – bitter gourd
  - Removing seed coats - mango
  - Scraping seed coats – tamarind seeds, lima bean seeds
  - Burning seed coats – teak, melia koenigii (Lunumidella)
  - Keeping in a high temperature or changing the temperature
  - Hot water treatment – Acasia, Ipil ipil, Ehala
  - Applying chemicals
- Provide students the seed of various species.
- Guide students to practically test the suitable methods to remove seed dormancy of those seeds.

Key Words :

- Seed dormancy

Quality Inputs :

- Seeds
- Necessary equipment and materials to measure seed dormancy.

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To introduce seed dormancy
- To explain the importance of seed dormancy.
- To describe the methods of seed dormancy.
- To test the methods of removing dormancy.

Competency Level 8.6 : Inquires into the methods of selecting healthy seeds for planting.

Duration : 06 periods

Learning outcomes :
- Defines the term seed health.
- Describes the importance of obtaining healthy seeds for planting.
- Names the factors affecting to seed health.
- Explains the importance of testing seed health.
- Performs tests whether there are diseases agents in seeds.

Instructions for preparing the lesson:

- Present a few seeds samples in various conditions.
  Eg: - seeds with fungus infections, healthy seeds, broken seeds
- Go to the lesson by asking about the nature of those seeds.
- With that, introduce the seeds healthy
  - Seed health is the seeds quality of the seed stock. Seeds without fungus, bacteria, virus and nematodes are considered as healthy seeds.
- Guide students to gather information about the importance of seed health.
  Eg: -
  - Prevention the decreases of crop products due to infection of diseases for plants by microorganisms present in seeds.
  - Importance when exchanging seeds among the countries as a seed propagation unit and exchanging of genetic plasmas.
- Lead a discussion with students about the necessity of obtaining healthy seed for planting.
  - Seed requirement is low
  - High Germination percentage (> 70%)
  - Need for replanting is low
  - Resulting a uniform plant population
  - Controlling the weeds and resistance against pets and diseases due to growth enhancement at early growth stages.
- Lead a discussion about the factors affecting for seed health.
  - Biological factors
    - Disease causing agents – fungus, bacteria, nematodes, virus
    - Non disease infections– weed seeds, other seeds, hook parts
    - Insects
    - Broken seeds
  - Non-biological factors
    - Dead parts
    - Soil particles
- Guide students to find information about the importance of seed testing.
  - Increase the customer satisfaction
  - Important for international seeds circulation.
  - Useful for international seed industry by improving the quality of product.
  - Assisting for risk management of seeds Companies.
  - Compliance to national and international constitutions

- Guide students to find information about the characters of quality seeds.
  - Compliance to the variety
  - Perfect and uniform seeds
  - Vitality (germination percentage should be more than 80% - then strong seedlings can be obtained)
  - Free from other organisms.
  - Having labeled accurately
- Guide students to do a suitable activity to test fungus of seeds

Key Words :
- Seed health

Quality Inputs :
- Infected and non –infected seeds samples
- Necessary equipment and materials to measure infections of seeds

Instruction for Evaluation and Assessment :

Pay attention on following points.
- To define seed health.
- To explain the importance of obtaining healthy seeds for planting.
- To test whether the disease agents present in seeds.

Competency Level 8.7 : Inquires into the methodology of producing certified seeds.

Duration : 02 periods

Learning outcomes :
- Explains the process of certified seed production.
- Mentions the importance of planting certified seeds.
- States the quality standards of seed paddy.

Instructions for preparing the lesson:

- Go to the lesson by presenting a label of a certified seed stock to the class or using any other approach.
- Define the certify seed production programme.
- Discuss the necessity of seed production programme.
  Eg: -
  - The yield can be increased being able to get most suitable varieties for crop cultivation method.
  - The yield increases by using seeds with uniform maturity and genetic purity.
  - Ability to gain maximum results from nutrients, water and agro chemicals due to the uniformity of the crop at seeds germination and growth.
  - Ability to decrease seeds requirement by obtaining certified seeds with high quality of which the germination percentage has been tested.
- Discuss the steps of seed production programme which is implemented by the Department of Agriculture.
  I step - Production of breeder seeds
  II step - Production of foundation seeds
  III step - Production of registered seeds
  IV step - Production of certified seeds
- Lead a discussion with students about the quality standards for seeds which are used as planting materials.
  Eg: - Research Laboratory Standards of seeds certification service for seed- paddy

Germination percentage	-	> 85 %
Other seeds	-	< 100/500 g
Weed seeds	-	wed seed 5/500 g
Moisture	-	< 13% (maximum)
Colour/ odour / appearance	-	good
Broken and mechanically damaged seed	-	100/500 g
Tetrazoliun test	-	95%
Other colluvials	-	2 %

- Point out that various colour labels are used to easily identify the seed grade of seeds stocks with properties related to due quality standards.
  Eg: - Breeder seeds - White with two pink and white lines
  Foundation seed - white
  Registered seeds - light green
  Certify seeds - light blue

Key Words :

- Seed certification

Quality Inputs :

- Seeds labels use for seeds stocks of seeds certification service (according to seeds grade)

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define the seed production programme.
- To explain the necessity of certified seed production process.
- To explain the steps of seeds certification process.
- To name the places in which various steps of seeds certification process is carried out
- To state the standard values to be present in seeds that are used as planting materials.

Competency Level 8.8 : Engages in asexual plant propagation by separating plant propagative structures.

Duration : 04 periods

Learning outcomes :
- Selects plant propagation structures for asexual propagation.
- Prepares plant propagation structures for planting.

Instructions for preparing the lesson :
- Display students few plants such as ginger, alocasia, gotukola etc.
- Go to the lesson by asking how to propagate those plants.
- Discuss with examples that asexual propagation can be done by separating following structural.
  - Underground stems
    - Rhizome - Eg: - turmeric, ginger
    - Corm - Eg: - alocasia, colocasia
    - tubers - Eg: - potato, coleus
    - Bulb - Eg: -onion, tulip
  - Runners - Eg: - gotukola Strawberry
  - Suckers - Eg: - pineapple, plantain
  - Bulbil - Eg: - agaves
- Emphasize the students that new plants can be obtained through asexual propagation using these structures.
- Give the students an opportunity to observe and identify the differences in the structures of rhizome□ runners□ corm ☙bulb□ suckers, Tubers and bulbil and give students an opportunity to identify the differences between them.
- Lead a discussion about how to prepare each propagation structure for planting.
- Give students an opportunity to plant propagation structures that are propagated by cuttings adopting suitable strategies.

Key Words :
- Vegetative structures

Quality Inputs :
- Examples for propagative structures used for propagation by cuttings
- Necessary planting containers, germination medium, sharp blades

Instruction for Evaluation and Assessment :

Pay attention on following points.
- To name propagation structures that are used to propagate by cuttings
- To prepare the plant propagation structures for propagation.

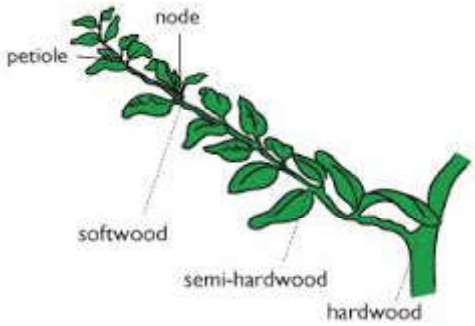
Competency Level 8.9 : Engages in asexual plant propagation using cuttings.

Duration : 02 periods

Learning outcomes :
- Selects suitable cuttings for planting.
- Prepares plant cuttings for planting.

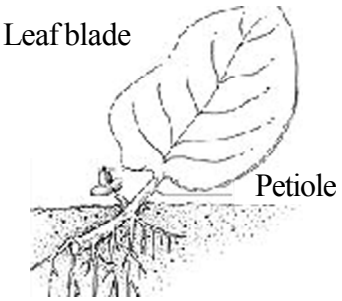
Instructions for preparing the lesson:

- Go to the lesson by presenting an example displaying how a new plant has formed by a plant cutting.
- With that, give students an opportunity to name plant cuttings that can be used to obtain new plants.
  - Plant cuttings
  - Root cuttings
  - Plant leaves
- Emphasize students that in selecting cuttings for plantings, they are selected according to its nature of maturity.

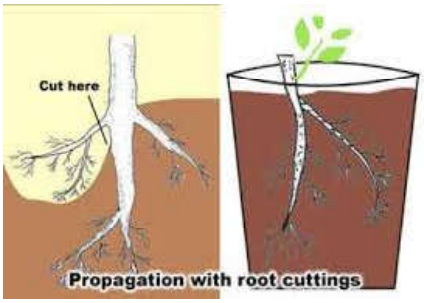


Eg: - Immature plant cuttings for sweet potato planting
Hemi hard stem cuttings for rose planting

- Give students plant cuttings of various species and give an opportunity to select plant cuttings which are in suitable mature condition.
- Explain how to prepare those cuttings for planting.
  Eg: - Cutting basal to 45^0 angel and application of hormones
- Guide students to prepare the media for selected cuttings for planting.
- Guide students to plant cuttings in the planting media.
- Lead a discussion about how to prepare leaf cuttings and root cuttings for planting.



Leaf cuttings



Root cuttings

- Guide students to duly prepare the necessary planting media for planting them.
- Guide students to plant root cuttings and leaf cuttings in planting media.

Key Words :

- Plant cuttings

Quality Inputs :

- Plant cuttings of various species
- Materials, sharp blade, secateurs

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To select suitable plant cuttings for planting
- To prepare suitable planting media for each plant cutting.
- To prepare cuttings for planting
- To plant the cuttings duly

Competency Level 8.10 : Engages in plant propagation using layering.

Duration : 06

Learning outcomes :
- Selects suitable plants for layering.
- Performs experiments on various layering methods.

Instructions for preparing the lesson:

- Display students a layered pot plant.
- Go to the lesson by asking about that method of plant propagation.
- Define the layering.
  A method of propagating a new plant by stimulating the roots while still attached to the parent plant.
- Lead a discussion with students about the scientific principle that causes rooting by removing a layer from the bark.
  - In layering method, the feature of adopting an unspecialized plant cell is utilized.. Here, when a cut is made up to cambium of the branch, its cells adopt as a shape of a root to perform the absorption function by absorbing by colliding with soil and water. Also, the rooting stimulates by accumulating the food foods produced in leaves a near the incision and also due to the increase of C: N rate as a result.
- Display students the diagrams showing various layering methods. Guide students to compare this each method.
- With that, point out that there are two methods of layering.
  - Ground layering
  - Air layering
- Point out that ground layering can be used to propagate plants with a flexible stem growing closely to the earth.
- Guide students to name the ground layering methods.
  - Simple layering
  - Tip layering
  - Serpentine/Compound layering
  - Trench/Continuous layering
  - Mound layering
- Demonstrate students how to practice simple layering.
- Guide students to practice a simple layering by using a suitable plant.
- Demonstrate students how to practice compound layering.
- Guide students to practice a compound layering by using a suitable plant.
- Explain students how to practice tip layering and guide students to experiment it practically.
- Discuss how to practice mound layering.
- Point out that air layering is practiced to root the branches that located above the earth level and cannot be bent up to the earth.
- Demonstrate students how to practice the air layering.
- Give students the opportunity to practice an air layering by using a suitable plant.
- Give students instructions to list suitable plants for each layering method.
- Discuss about the advantages of layering.
  Eg: -
  - Easy to control the shorter than seed plants.
  - special equipments are not required
  - Ability to get new plants from the removed branches.
  - Ability to get planting materials over the year.

Key Words :

- Layering
- Ground layering
- Air layering

Quality Inputs :

- Necessary plants for layering
- Planting materials
- Polythene
- Twin threads
- Sharp blade

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define the layering.
- To explain the scientific principle of layering.
- To name layering methods.
- To experiment the various methods of ground layering practically.
- To define the air layering.
- To experiment air layering practically.

Competency Level 8.11 : Engages in plant propagation using budding.

Duration : 06

Learning outcomes :
- Selects suitable plant for budding and grafting
- Experiments the different methods of budding and grafting

Instructions for preparing the lesson:

- Present students a real example of a picture of a grafted plant.
- Go to the lesson by asking about the propagation method of that plant.
- Define the budding and grafting.
  - The budding is joining apart of one plant to an another plant with a root stock And growing it to a new plant.
- Discuss the characteristics to be considered in selecting a stock and a scion.

  Eg: -
  - Parent plant of the scion
    - With an expansive vegetation
    - Rapid and continual growth style
    - Resistance for diseases and pest
    - No any incompatibility with the stock
  - Parent plant of the stock
    - No any incompatibility with scion
    - Consisting of spreading and deep expanding root system
    - Resistance to diseases and pest
- Display students the diagrams showing various budding methods. Guide students to compare each method.
- With that, point out that there are two budding methods.
  - Budding
  - Grafting
- Define the budding.
  - The budding is taking an active bud from a slightly grown plant and joining it as it contacts with the cambium of the stock plant of the same species and allowing it to grow into a single plant.
- Guide students to name budding methods
  - T budding
  - H budding
  - Patch budding
- Demonstrate students about how to carry out each budding method.
- Give students the opportunity to name suitable crops for each budding method.

  N.B. – Here, it is most suitable to give a practical training about the budding methods to the students by organizing a field visit to a nursery.
- Guide students to experiment this budding methods practically.
- Define Grafting.
  - The grafting is taking a branch with several active buds and joining it with a stock plant of the same species and allowing it to grow as a single plant.
- Guide students to name grafting methods.
  - Wedge grafting
  - Inarch grafting
  - Stone grafting
  - Crown grafting
  - Side grafting

- Demonstrate students about how each grafting is carried out
- Give students the opportunity to name suitable crops for each grafting method.
- Guide students to experiment this grafting methods practically.
- Define the term budding incompatibility.
  - Budding failure caused due to not properly joining the stock with the scion used for budding
- Lead a discussion about the measures that can be taken to prevent that.

  Eg: -
  - Joining scion and stock by other plant parts that are coincidential with scion and stock both.
  - Proper control of crop cultivation
  - Keep few leaves of the stock remain
  - Prevention the plants from infecting with disease and pest
- Discuss the advantages and disadvantages of budding.

  Advantages:

  Eg: -
  - Forming a plant with high genetic characteristics.
  - Ability to produce an ornamental plant grafting few branches with various colors (crown budding)
  - Ability to increase yield by grafting plant parts with high yield into a plant with self-sterility, difficult pollination and low yield.
  - When there is a weakroot system or diseased root system, minimizing the effect of the damaged part by grafting a healthy plant root stock. (Inarch grafting)

  Disadvantages:

  Eg: -
  - Requirement of skilled labour and knowledge for budding
  - Inability to use for Monocotyledonous plants
  - Unsuitable for every dicotyledonous plant

Key Words :

- Budding
- Grafting

Quality Inputs :

- plants required for budding
- Budding strips
- Budding knives

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define budding
- To explain the characteristics to be considered in selecting a stock and a scion.
- To name the budding methods.
- To deifne the budding and grafting
- To practice the T budding, H budding and patch budding practically
- To practice the wedge grafting, crown grafting, inarch grafting, side grafting, and stone grafting practically.
- To explain budding incompatibility.
- To state the advantages and disadvantages of budding.

Competency Level 8.12 : Inquires into the methods of micro propagation.

Duration : 04

Learning outcomes
- Describes the conditions that should be prevailed in each section of tissue culture laboratory and the functions of those sections.
- Define the micro propagation.
- Describes the micro propagation process.

Instructions for preparing the lesson:

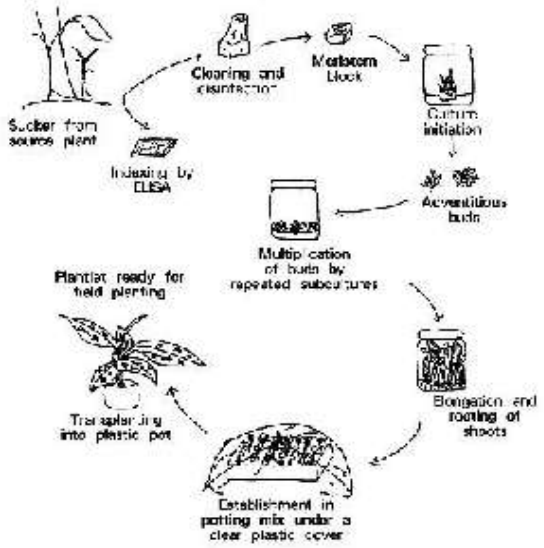
- Go to the lesson by displaying a tissue culture clone, and asking about that.
- With students' views, raise a definition for tissue culture.
  - Tissue culture is the process of producing plants by planting any live part of a plant (Ex: -pollen, parts of leaves (with veins), buds, seeds, anthers) under controlled environmental conditions in an artificial culture media under sterilized conditions.
- Explain the principle that is used for tissue culture process.
  - The ability of each cell to regenerate a whole plant by dividing and differentiating or the cellular totipotency.
- Emphasize students that the tissue culture process is carried out in a laboratory.
- Present a plan of a tissue culture laboratory to the students and guide students to name the sections that should be in a tissue culture laboratory.
  - Cleaning room
  - Media preparation room
  - Transfer room
  - Incubation room
- With the use of diagrams, video scenes, lead a discussion about the materials and equipment that should be available in each section, and about the functions carried out in each section.
- With that, give students instructions to complete the following table.

Sections of tissue culture lab	materials and equipment	functions

- Lead a discussion with students about the conditions that should be available in the incubation room. Ex: - temperature, light, fresh air, relative humidity
- Discuss about the materials that are necessary in tissue culture process and should contain in the tissue culture process and the importance of them.

  Eg: -
  - Inorganic nutrients (Essential elements) – supplying macronutrients and micronutrients that are essential for plant growth.
  - Carbon and energy source – supplying essential energy for the growth of tissue.
  - Carbon materials – to grow tissue
  - Growth regulators – cell division and differentiation
  - Gelling agents – to solidify the media
  - Other additive materials – to speed up the cell growth

- Ask students the examples for nutrient medias used commonly in tissue culture.
  Eg: - MS (Murashige and Skoog) and LS (Lismaier)
- Explain students the importance of sterilization the equipments and nutrient media that are used in tissue culture process.
  - Ability to gain more economical advantages by obtaining maximum number of seedlings from a tissue without microorganism's infections.
- Ask students the methods which can be used to sterilize the equipments and nutrient media in tissue culture process.
- With that, point out that the equipments and nutrient media used in tissue culture process can be sterilized by chemical sterilization and physical sterilization.
  Eg: -
  - Chemical sterilization – bleaching powder – used for laboratory sterilization.
  - Physical sterilization - wet air sterilization – used to sterilize growth media. For that a pressure cooker or autoclave is used.
- Point out students that out of tissue culture methods, micro propagation is commonly used in Sri Lanka.
- Raise a definition for micro propagation through the students.
  - Micro propagation is the practice of rapidly multiplying stock (parent) plant material to produce a large number of projeny plants, simultaneously, using plant tissue culture methods.
- With the diagrams, discuss micro propagation process.



  - Selection and maintenance the mother plant
  - Pre establishment
  - Multiplication stage
  - Rooting
  - Acclimatization
- Discuss the advantages and disadvantages of micro propagation.
  - Advantages:
    Eg: -
    - Ability to obtain more seedlings at a short period.
    - Ability to obtain virus free seedlings without virus
    - Ability to obtain more seedlings similar to the mother plant
    - to conserve genetic resource
  - Disadvantages:
    Eg: -
    - High cost for technological methods, and specialized equipments.
    - Necessity of a technique skill
    - Mutation due to continuous sub-culturing

Key Words :

- Tissue culture
- Micro propagation

Quality Inputs :

- A picture showing a tissue culture clone.
- A diagram or video scenes indicating tissue culture laboratory plan.
- A diagram showing micro propagation process.

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To name the sections of a tissue culture laboratory.
- To explain the functions carried out by each sections.
- To name the materials and equipments that should be available in those sections.
- To state materials and the necessity of those materials that are used to prepare essential nutrients for tissue culture.
- To describe the materials and equipments sterilization methods used in tissue culture process.
- To define the micro propagation.
- To describe the stages of micro propagation.
- To state the advantages and disadvantages of micro propagation.

Competency 9 : **Investigates the methodologies of plant breeding for crop improvement and conservation of genetic resources.**

Competency Level 9.1 : **Explores into scientific information on transmission on characteristics.**

Duration : **04**

Learning outcomes :

- Explains the basic concepts of genetics.
- Explains how to transmit the inherited characteristics from one generation to another.
- Describes the factors which control the characteristics of living organisms
- Explain the Mendal's laws.
- Resolves simple problems by using the Mendal's laws.

Instructions for preparing the lesson:

- Go to the lesson by presenting few plants which belongs to same crop specie and show various characteristics as relevant to the Mendel's laws or any other other suitably approach.
- Ask students about the differences between those plants and the reasons for displaying various characteristics among the same species.
- Point out that the following major two factors affect to control the characteristics of any organisms.
  - Heredity
  - Environment
- Point out that heredity is the inheritance of the characteristics from one generation to another and those characteristics may be controlled up to a certain extent by external environmental factors.
- Point out that the characteristics of parent generations transmit to the child generations.
- Convince students that in some occasions, children receive some other characteristics in addition to the parents' characteristics, and this knowledge can be used to generate high quality plants.
- Point out that the study about the transmission of the characteristics of organisms from one generation to another is called genetics.
- Point out that when the subject of genetics is studied, parent of living family (mother plants) is called as parent and children (progeny) is called as offspring while the characteristics transmitted from parents to the offspring is called as hereditary characteristics.
- Accordingly, point out that transmission of hereditary characteristics from parent to offspring is called as heredity.
- Discuss with students about the key technical terms related with genetics.
  - Alleles – when a gene controlling a certain characteristic locates in a homogenous chromosome, a gene locates in other correspondent homogenous chromosome also. It is called as allelic gene.
  - Dominant gene and recessive gene – The allele which highlight the characteristics in F1 generation (in heterozygous situation) is named as dominant genes and allele which suppress the characteristics is named as recessive gene.
  - Phenotype - An observable characteristics of any organism by a set of gene arrangement is called as phenotype.
  - Genotype – The constitution of allelic genes in order to give a certain characteristics is called as genotype.
- Ask students about the person who first discovered the hypothesis of genetics.

- Point out students that since the authenticity of those laws has been confirmed, currently, those laws are called as the Mendel's law.
- Discuss about the Mendel's law.
  - Mendel's first law – In the formation of gametes in living beings , two alleles sgergare and move to separate gametes.
  - Mendel's second law - In the formation of gametes, any of the two factors associated with a certain characteristic of the beings can enter to a gamete and in the fusion of two gametes , it independently joins with any of the factor in another combination
- Guide students to solve simple problems using the Mendel's laws.

Key Words :

- Mendel's Law
- Heredity
- Genotype

Quality Inputs :

- Few plants belong to same crop specie and showing various characteristics
- Diagrams related to the Mendel's laws

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define the heredity and inheritance .
- To state the key words of genetics.
- To name the factors effecting the characteristics of living beings.
- To state the Mendel's laws
- To solve simple problems using the Mendel's laws.

Competency Level 9..2 : Investigates the scientific knowledge of inheritance for crop improvement.

Duration : 04

Learning outcomes :
- Defines the plant breeding.
- Explains the objectives of plant breeding.
- Describes how to use the genetics knowledge in plant breeding.
- Describes the methods of plant improvement through plant breeding.
- Explains the applications of bio technology for improving crops.

Instructions for preparing the lesson:

- Go to the lesson by displaying pictures of plants such as fish berry□ blue rose which ware produced by geno- technology to the class or any other suitable method.
- Point out that the knowledge of genetics is used to improve the qualitative and the quantitative crop yield.
- Define the plant breeding.
  - Creating a new genetic composition (genetic variability) or forming verities in any plant population for achieving crops production targets, and selecting plants with favourable genotype is called as plant breeding.
- Discuss about the purposes of plant breeding and give students instructions to list those purposes.
  Eg: -
  - To increase crop yield potential
  - To change the protein percentage and fat percentage of crops.
- Discuss with students about the basic methods used for plant breeding.
  - Selection
  - Hybridization
  - Mutation breeding.
  - Gene- technology
- Point out that choosing the plants with favorable characteristics from a large population is carried out in selection.
- Point out that selection is done by two methods.
  - Pure line selection
  - Mass selection
- Point out that plants improvement can be done up to a certain level by the selection, and hybridization is required for further improvement.
- Explain the Hybridization.
  - Pollination of two plants with deference gene constitution to produce offspring is known as hybridization.
- Introduce the hybrid vigor and discuss its importance.
- Discuss how to create hybrid vigor.
- Give students instructions to gather information about hybrid plants.
- Point out students that a mutation is a permanent change of a gene that located in chromosome structure, number or a chromosome.
- Point out students that natural factors and artificial factors affect to form mutations.

- Define the mutation breeding.
  - Creating artificial mutations, and selecting most suitable plants from said varieties is called as mutational breeding.
- Discuss with students how to make mutation breeding.

  Eg: -
  - By Somatoclonal variation
  - By polyploidy
- Discuss with students how to create polyploidy artificially.
- Define students the biological technology.
  - Formation of plants, animals or microorganisms using living beings or a part of their tissues, and to change the existing living beings to use for different purposesis called as bio- technology
- Discuss how to breed plants by using bio-technology.
  - By recombination bio-technology.
  - By introduction mutated crops
- Give students the instructions to gather information about the plants in the world which have been produced using bio- technology.
- Give students the opportunity to engage in a review by comparing various plants breeding methods.

Key Words :

- Plant breeding
- Hybrid vigor

Quality Inputs :

- Pictures of theplants which have been produced by using bio- technology.

Instruction for Evaluation and Assessment :

Pay attention on following points

- To define the plants breeding and state its objectives
- To explain the plants breeding methods.

Competency Level 9.3 : Explores information on conservation of genetic resources.

Duration : 04

Learning outcomes
- Defines genetic resources.
- Explains the importance of conservation ofgenetic resources.
- Explain the reason for degradation of genetic resources..
- Explain the various methods of genetic resources conservation with examples.

Instructions for preparing the lesson:

- Present following extractionabout bio diversity to the class.
  It has been estimated that plant species on earth is about 5-10 million and out of this, plant species of 1.4 million have been identified and reported. There are 15 million animal species and out of which 8 million is insect species. Since this genetic reserveofall species is an universal inheritance, all human beings are responsible for the conservation of bio diversity.
- Ask students' views about above extraction.
- Convince students that some of the genetic resources in Sri Lanka are under threat of degradation
- Discuss the reasons for the depletion of genetic resources.
  - Natural
  - Human activities
- Discuss the importance of conservation ofgenetic resources.
  Eg: -
  - Prevention some beings from extinction.
  - Prevention the breakdown of ecological equilibrium.
  - Protection of genetic variability of living beings.
- Discuss with students about the methods ofconservation ofgenetic resources.
  - In - situ conservation
  - Ex - situ conservation

Key Words :

- Genetic resources depletion
- Conservation of genetic resources

Quality Inputs :

- An article or a poster consisting information about the genetic resources depletion.

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To define genetic resources and state the importance.
- To mention the reasons for the depletion of genetic resources.
- To state the importance of conservation ofgenetic resources.
- To explain the conservation methods ofgenetic resources.

Competency 10 : Plans controlled environmental conditions to obtain successful crop cultivation.

Competency Level 10.1 : Investigates the importance of controlling the aerial and soil conditions on crop cultivation.

Duration : 02 periods

Learning outcomes :
- Indicates the importance of controlling the environmental conditions in crop cultivation.
- Explains the soil and environmental conditions that should be controlled for a successful crop cultivation.
- States examples for suitable crops to cultivate under controlled environmental conditions.

Instructions for preparing the lesson :
- Display students a picture showing a protected shed
- Enter in to the lesson by asking about that.
- Raise a definition for a protected shed through the students.
  - The structures that are used to control one of more of aerial environmental conditions such as temperature, light, humidity, air etc. in crop cultivation as required by the crop under controlled environmental conditions.
- Emphasize students that environmental conditions can be controlled through the cultivation in a protected shed.
- Highlight the importance of controlling environmental conditions in crop cultivation.
  Eg: -
  - Protection crops from diseases and pest damages.
  - Ability to gain a high yield
  - Receiving a high quality yield
- Guide students to name the environmental conditions that should be controlled in crop cultivation under controlled environmental conditions.
  - Soil environmental conditions - Ex: - air, pH value, nutrient content
  - Aerial environmental conditions - Ex: - atmospheric temperature, humidity
- Guide students to find the information about crop varieties used to cultivateunder controlled environmental conditions.
  Eg: - crop varieties with high economical value

Key Words :
- Protected Agriculture

Quality Inputs :
- A diagram of a protected structure

Instruction for Evaluation and Assessment :

Pay attention on following points
- To define environmental conditions control in crop cultivation.
- To explain the importance of environmental conditions control in crop cultivation.
- To name the soil an aerial conditions that should be controlled in crop cultivation.
- To name the crop varieties that should be cultivatedunder controlled environmental conditions.

Competency Level 10.2 : Inquires into the suitable protective structures to control environmental conditions.

Duration : 06

Learning outcomes
- Classifies protected structures that are used to control environmental conditions.
- Describes procedures for preparingvarious protected sheds.
- Selects suitable protected structures according to the area and crops variety.
- Prepares solar propagative structure
- Presents proposals to minimize theproblems that are arisen in crop cultivation within protected structures.

Instructions for preparing the lesson :

- Display pictures of various protected structures to the class.
- Go to the lesson by asking about those protected structures.
- Ask students the examples for various protected structures.
- Point out that protected structures can be categorized as follows.
  - Temporary protected structures
  - Semi- permanent protected structures
  - Permanentprotected structures
- Give students the instructions to include protected structures presented by students to these categories logically.
  - Temporary protected structures – single plant cover, raw cover, bed cover, simple propagation structures, water conservative structures, hot beds, cool frame.
  - Semi- permanent protected structures - polythene tunnels, lath houses
  - Permanentprotected structures - greenhouses
- Discuss how to prepare each protected structure.
- Lead a discussion with students how to control aerial environmental conditions in each protected structure.

  Eg: -
  - Installing exhaust fans at places of the wall in poly tunnels to prevent the increasing of temperature, using insects protected nets instead of polythene for walls.
  - Installing thermo regulators structures in greenhouses.
  - Installing the equipment named misters to the water pumps that are applied internally to spray water as a mist.
- Give students the opportunity to present examples for suitable crops to cultivate in each protected structure.
- Guide students to prepare solar propagators.
- Lead a discussion with students about the changes that should be done in polythene house according to the area used.

  Eg: - Preparing the roof as to remove hot air from above of the semicircular roof in poly tunnels prepared in low country areas.
- Give students the opportunity to disclose the problems that are arisen in the crop cultivation in protected houses.

  Eg: -
  - Selection protected structures and issues that exists in construction technology.
  - Not using crop cultivation technology duly.
  - Excessively rely on chemical pesticides
  - Wastage disposal

- Guide students to suggest solutions to minimize those issues.
  Eg: -
  - Development of institutional facilities
  - Regularizing extension services, marketing, supplying raw materials and services etc.

Key Words :

- Protected structures

Quality Inputs :

- Diagrams/ videos showing protected structures

Instruction for Evaluation and Assessment :

Pay attention on following points

- To classify protected structures
- To explain how to control environmental conditions by temporary structures.
- To create a simple solar propagator.
- To select suitable protected structure for each crop variety.
- To select protected structure that is suitable to the area.
- To list out the problems facing in the crop cultivation within protected sheds and suggest solutions to minimize those issues.

Competency 11 : Plans soilless cultures for quantitative and qualitative yield.

Competency Level 11.2 : Classifies the methods of soilless culture.

Duration : 04

Learning outcomes :
- Explains the importance of soilless culture.
- Name the soilless culture methods.
- Explain the nutrient media and cultivation media used in soilless culture.

Instructions for preparing the lesson:

- Go to the lesson by presenting a diagram or picture of a soilless culture to the class.
- Define the soilless culture.
  - Cultivation without soil
- Lead a discussion with students about the importance of soilless culture.
  Eg: -
  - More suitable for gardening and urban cultivation
  - Ability to use in situations that cannot be taken labour.
  - Minimize the soil generating diseases
- Guide students to name soilless culture methods.
- Point out that soilless culture methods can be categorized as follows.
  - Hydroponics
  - Cultivation in solid media
  - Air cultivation
- Point out that solid, liquid or air can be used as the cultivation media in soilless culture.
- Discuss about factors to be focused in the selection of a suitable cultivation media.
  Eg: -
  - Space available from environment
  - Employable resource and capital
  - Natural and artificial media available easily/ profitably
  - Harvest available from unitary area
  - Quality of production
    - Color, view, shape
    - Devoid of agro-chemicals
    - Devoid of microorganisms harmful to human
- Discuss about properties to be considered in the selection of solid media for soilless culture.
  Eg: -
  - Flexibility
  - Friability
  - Water holding capacity
  - Aeration
  - Drainage
  - Buffering capacity
- Devoid of poison constituents.
- Guide students to list solid media that can be used for soilless culture.
  Eg: -
  - Inorganic natural solid media

    Ex: - gravel, granite chips

- Organic natural solid media
  Eg: - organic rice husk, saw dust, coir dust, fit moss, coir fiber
- Inorganic artificial media
  Ex: - rockhole, perlite, vermiculite
- Organic artificial media
  Eg: - Polyurethane
  Polyphenol
  Polyether
  Polyvinyl

- Discuss the importance of sterilization the solid media.
- Ask students about nutrient media used for soilless culture methods.
  Eg: - Albert, hydro crystalon, hydro calcium, nitrate, total grow, loncin
- Lead a discussion with students how to prepare the nutrient media.
- Guide students to prepare the nutrient media.
  N.B. – here, students should be aware about the preparation of mother solution and dilution.
- Lead a discussion with students how to maintain and control nutrient media.
  Eg: - pH value of nutrient solution and electrical conductivity

Key Words :

- Soilless culture

Quality Inputs :

- The diagram / picture of a soilless culture method
- Solid media used for soilless culture
- Nutrient media of soilless culture
- Necessary materials to prepare nutrient media solution

Instruction for Evaluation and Assessment :

Pay attention on following points

- To define soilless culture
- To explain the importance of soilless culture
- To name soilless culture methods
- To name the media of soilless culture
- To state the properties that should be in soilless culture media.
- To prepare soilless nutrients media

Competency Level 11.2 : Inquires into hydroponicmethods.

Duration : 04

Learning outcomes :
- States the methods of various soilless culture in nutrient media.
- States the advantageous of Hydroponics methods.
- Experiments Hydroponics methods.

Instructions for preparing the lesson:

- Go to the lesson by presenting a diagram or video scene of a hydroponics method to the class or any other method.
- Emphasize that hydroponics method is the crop cultivation of aqueous media.
- Convince students that hydroponics method can be classified according to the circulating or immovable Hydroponics method.
  - Circulating - Nutrient Film Technique - NFT
    Deep Flow Technique - DFT
  - Not circulating - Root dipping technique
    Floating technique
    Capillary action technique
- Use exemplary diagrams /video scenes or pictures for displaying crop cultivation methods in circulating solutions to students.
- Guide students to identify the parts of diagram necessary to implement Nutrient Film Technique.
- Lead a discussion with students how to implement Nutrient Film Technique.
- Guide students to experiment Nutrient Film Technique.
- Assist students to identify the parts of diagram necessary to implement Deep Flow Technique.
- Lead a discussion with students how to implement Deep Flow Technique.
- Guide students to experiment Deep Flow Technique.
- Use diagrams /video scenes/ pictures for displaying how to implement hydroponics methods in immovable solutions.
- Lead a discussion with students about how to implement root dipping technique.
- Guide students to experiment root dipping technique.
- Lead a discussion with students about how to implement floating technique.
- Guide students to experiment floating technique.
- Explain students about the capillary action technique.
- Guide students to experiment capillary action technique.
- Discuss the advantageous of hydroponics.

Key Words :
- Hydroponics

Quality Inputs :
- Diagrams /video scenes/ pictures of soilless culture
- Planting media
- Seeds
- Albert solution
- Plants

Instruction for Evaluation and Assessment :

Pay attention on following points

- To name circulating and immovable soilless culture methods.
- To explain how to implement circulating and immovable soilless culture methods.
- To experiment circulating and immovable soilless culture methods.
- To explain the advantageous of Hydroponics.

Competency Level 11.3 : Inquires into soilless culture in solid media.

Duration : 04

Learning outcomes
- Describes soilless culture methods in solid media.
- Cultivates suitable crops by preparing vertical crops bags.
- States the problems of soilless culture.
- Suggests strategies to minimize the problems of soilless culture.

Instructions for preparing the lesson:

- Go to the lesson by presenting true examples/ video scenes/ pictures that shows soilless solid media methods.
- Convince students that solid media culture is carried out in bags, pots and ditches or basins.
- Prepare cultivation structures for each method and discuss how to establish crops.
- Prepare vertical and horizontal cultivation bags and guide students to establish crops on them.
- Guide students to experiment soilless culture in pots.
- Discuss how to maintain a solid media culture.
  Ex: - supplying nutrients
- Lead a discussion with students as to disclose the issues of soilless culture.
  Eg: -
  - Since basic production cost is excess, limiting to the small scale cultivations for crops with high value.
- When protected structures are used, its environmental conditions should be maintained as favorable for the crop.
  - Decrease institutional facilities
  - Increase unfavorable results due to a minor fault.
- Guide students to suggest measures used to minimize those issues.
  Eg: -
  - Creating good expansion service.
  - Creating facilities for obtaining raw materials and marketing.
  - Giving good training for labours by creating service facilities.

Key Words :

- Solid media culture

Quality Inputs :

- Diagrams /video scenes/ pictures of soilless solid media culture.
- Refuse of coir / sand
- Coir fibers
- Ultra violet ray resistant polythene
- PVC pumps parts
- Nutrients liquid micro supply pumps
- Nutrients liquid tanks
- Plastic/ clay pots
- pH meter
- EC meter

Instruction for Evaluation and Assessment :

Pay attention on following points.

- To explain soilless culture methods that can be done in solid media culture.
- To cultivate suitable crops by preparing vertical crops bags.
- To state soilless culture issues
- To suggest strategies to minimize the issues of