General Certificate of Education (A/L)

(Grade 12)

Agricultural Science

Teacher's Instructional Manual

Department of Technical Education
Faculty of Science & Technology
National Institute of Education
Maharagama.

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(To be Implemented from 2009)

Department of Technical Education
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Foreward

Curriculum developers of the NIE were able to introduce Competency Based Learning and Teaching curricula for grades 6 and 10 in 2007 and were also able to extend it to 7, 8 and 11 progressively every year and even to G.C.E. (A/L) classes in 2009. In the same manner syllabi and Teacher's Instructional Manuals for grades 12 and 13 for different subjects with competencies and competency levels that should be developed in students are presented descriptively. Information given on each subject will immensely help the teachers to prepare for the Learning – Teaching situations.

I would like to mention that curriculum developers have followed a different approach when preparing Teacher's Instructional Manuals for Advanced Level subjects when compared to the approaches they followed in preparing Junior Secondary and Senior Secondary curricula. (Grades 10, 11)

In grades 6, 7, 8, 9, 10 and 11 teachers were oriented to a given format as to how they should handle the subject matter in the Learning – Teaching process, but in designing AL syllabi and Teacher's Instructional Manuals freedom is given to the teachers to work as they wish.

At this level we expect teachers to use a suitable learning method from the suggested learning methods given in the Teacher's Instructional Manuals to develop competencies and competency levels relevant to each lesson or lesson unit.

Whatever the learning approach the teacher uses it should be done effectively and satisfactorily to realize the expected competencies and competency levels.

I would like to note that the decision to give this freedom is taken, considering the importance of G.C.E. (A/L) examinations and the sensitivity of other stakeholders who are in the education system to the Advanced Level examination. I hope that this Teacher's Instructional Manual would be of great help to teachers.

I hope the information, methods and instructions given in this Teacher's Instructional Manual will provide proper guidance to teachers to awaken the minds of our students.

Professor Lal Perera
Director General
National Institute of Education

Preface

Action taken over long years of the past to retain the known and learn the predetermined has made us little able today to construct even what is. The first curriculum reform of the new millennium on secondary education that comes to being with a drastic change in the learning-teaching process at school level attempts to overcome this inability while bringing about a set of worthy citizens for the country who are capable of revising the known, exploring the undetermined and constructing what might be.

If you are a teacher teaching this subject or any other subject in grades 6 to 11, it will not be difficult for you to align yourself with the new learning-teaching approaches that are recommended in a considerable way for the G.C.E. (A/L) as well. This reform calls the teacher to identify competency levels under each competency and plan activities to achieve them. The teachers entering the new role of transformation should understand that the procedures which emphasize the teacher in the learning-teaching process are of limited use for the present and that it is more meaningful for the children to learn co-operatively sharing their experiences. This situation, however, requires the teachers to provide a new direction for their teaching by selecting new learning–teaching methods that emphasize the student over the teacher.

If you study the Teachers' Instructional Manuals (TIMs) prepared by the National Institute of Education for Mathematics, Science, Health & Physical Education, Technology and Commerce subject of grades 6 to 11, you certainly will be able to acquire a good understanding on the student-centred, competency based and activity- oriented approaches we have recommended for learning and teaching. The activities presented in these Manuals attempt to bring learning, teaching assessment and evaluation on to the same platform and to help you to adopt co-operative learning techniques on the basis of the 5E Model.

Considering the need to establish an innovative teaching force we have selected just a few activities from the relevant activity continuum incorporated in the TIMs. Yet we have given you a vast freedom to plan your own activities to suit the subject and the class requirements by studying the exemplar activities in the Manuals and improving your understanding on the principles underlying the reform. The activities incorporated in the TIM, provide you with four types of information. At the beginning of each activity you come across the final outcome that the children are expected to achieve through each activity. This learning outcome named as 'Competency' is broad and long-term. The competency level stated next highlight one out of the number of abilities that the children have to develop to realize the competency.

The above explanation shows us that the competency levels are more specific and of a shorter duration when compared to the competency. The next section of the Mannual presents a list of behaviours that the teacher has to observe at the end of each activity. To facilitate the task of both the teacher and the students, an attempt has been made to limit the number of such behaviours to five. These behaviours referred to as learning outcomes are more specific than the competency level. They include three abilities derived from the subject and two others derived from the learning teaching process. Out of the three subject abilities listed in an order of difficulty, the teacher has to direct the children to realize at least the first two through the exploration. The next section of the activity presents what the teacher should do to engage the children for the exploration. Although the implementation of each and every activity starts with this step of

engagement, the teachers should not forget that activity planning should begin with the exploration which is the second 'E' of the 5E Model.

Instructions for the group exploration from the next section of the exemplar activities the teacher plans these instructions in such a way to allow different groups studying different facets of the same problem to reach the expected ends through a variety of learning-teaching methods. For this, further the teacher can select either Inquiry-based Learning carried out through a series of questions or Experiential Learning where children learn by doing. It is the responsibility of the G.C.E (A/L) teacher to use the knowledge that the children acquire by any of the above methods to solve problems that are specific to the subject or that runs across a number of subjects of the curriculum is meaningful to plan such problem-based learning-teaching methods on the basis of real-life situations. For this you can select dilemmas, hypothetical situations, analogies or primary sources. Some techniques that can be used for the explorations are reading, information management, reflection, observation, discussion, formulation and testing of hypotheses, testing predictions, preparing questions and answers, simulation, problem solving and aesthetic activities such as drawing or composing. There is room here even for memorization although it is considered as a form of mechanical learning.

The students explore in small groups. Instead of depending on the knowledge available to the teacher, they attempt to construct their own knowledge and meaning with the support of the teacher. Moreover, they interact with others in the group to learn from others and also to improve the quality of their exploration findings. All this works successfully only if the teacher is capable of providing the students with the reading material and the other inputs they are in need of. The teacher also has to support student learning throughout the learning process by moving from one group to another. Although it is the discovery that is prominent in this type of learning you have to recognize this as a guided discovery rather than a free discovery. There is no doubt that students learning likewise with instructional scaffolding both by the teacher and the peers acquire a whole lot of worthwhile experiences that they find useful later in life.

Explanation follows the second stage of exploration. The small groups get ready to make innovative, team presentations on their findings. The special feature here is that the children have selected novel methods for their presentations. The responsibility for the presentation is also shared by all members of the group. In the next step of elaboration the children get the opportunity to clarify the unclear, correct the incorrect and fill any gaps that are left. They also can go beyond the known to present new ideas. All activities end with a brief lecture made by the teacher. This stage allows the teacher to go back to the transmission role. The teacher also has to deliver this lecture covering all the important points that the syllabus has prescribed for the relevant competency level. Step 3 of each Activity Plan guides the teachers in this compulsory final elaboration.

To overcome many problems that are associated with the general system of education today, the National Institute of Education has taken steps to move the teachers to the new transformation role recommended for them. This role that starts with a transaction gets extended to a lengthy exploration, a series of student explorations and elaborations and a summative transmission by the teacher. The students involve themselves in the exploration using reading material and other quality inputs provided to them by the teacher.

The students attend school daily to learn joyfully. They achieve a number of competencies that they need to be successful in life and the world of work. They prepare themselves for nation building by developing thinking skills, social skills and personal skills. For the success of all this, an examination system that inquires into the ability of students to face real challenges of life is very much needed in place of an examination system that focuses on the knowledge acquired by children through memorizing answers to model questions.

A number of activities have already begun at the national level to protect the real nature of school-based assessments. The written tests have been minimised to gain recognition for school-based assessments. Compulsory question has been incorporated in the term tests along with a scheme of authentic evaluation to ensure real outcomes of learning. It is the co-ordinated responsibility of all citizens of the country to open up doors for a new Sri Lanka by thriving for the success of this new programme on the basis of sound instructional leadership and quality assurance by the management.

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Introduction

The present Teacher Instruction Manual has been prepared in relation tot he Agriculture Science syllabus to be implemented in Grade 12 from 2009 and in Grade 13 from 2010 onwards. It is necessary to face technological changes that take place day to day, especially in the students of an applied and technical subject like Agriculture Science. Along with the advancement of science other new specimens will come to be used very soon in place of the present breeds of animals, seed varieties, weedicides and insecticides etc. As such the teacher will have to make use of things used currently in place of examples provided in this Teacher Instruction Manual.

Since, the home garden, crops suited for the home garden and paddy cultivation, have been included, newly, in this syllabus, student should be encouraged to plan a home garden and gain experience of crop cultivation practically.

In the implementation of the instructions provided through this Teacher Instruction Manual, the teacher has to implement an assessment of to ensure that the learning outcome with respect to each competency level is actualized. While the teacher should be prepared in advance to present the material mentioned in the approach to this the material necessary for the student to make his/her presentation should be supplied in the form of quality inputs.

It is your responsibility to improve the practical skills of students by properly organizing the practical exercises provided herein. For the purpose of teaching the subject Agriculture Science a teacher with the qualifications mentioned in the syllabus should be deployed. In instances where a teacher with such qualifications is not available a recommended teacher with a Diploma in Agriculture can be involved for that purpose.

Even where this Teacher Instruction Manual does not carry details of how any particular competency mentioned here is to be actualized, the teacher has the complete liberty to employ a suitable methodology to the learning-teaching process. Similarly, it is my pleasure to inform you that your critical views regarding this publication will prove extremely helpful in the further development of the subject.

Table of Content

Competency 1 : **Plans to contribute effectively to the development of Agriculture in Sri Lanka.**

Competency 1.1 : **Analyze qualitatively and quantitatively, the contribution of agriculture to the Sri Lankan economy.**

Duration : **05 periods.**

Learning outcomes :

- **Explains the contribution of agriculture, animal husbandry and fishery industry to the Gross Domestic Product (GDP) of Sri Lanka.**
- **Describes the importance of developing the above mentioned sectors.**
- **Shows the progress or drawbacks of the above sectors using statistical data.**
- **Expresses ideas about entreprenaurship in the agricultural sector**
- **Predicts the potentials of jobs in the agricultural sector .**

Teaching-learning process:

Engagement:

- **Assign two students to read the following dialogue to the entire class.**

Villager1 :	**There are a lot of paddy fields in this country, but the price is so high. Why is this?**
Villager2 :	**We have rice, but a lot of people to eat it. Therefore, production might not fulfill the demand.**
Villager1 :	**We have to increase the price or import rice, if we do not develop paddy cultivation.**
Villager2 :	**There is a labor shortage in agriculture sector, too. Most of the people wish to work in factories or they might go for foreign jobs.**
Villager1 :	**Oh, That's also important. But we should know how to protect them while preserving agriculture. Shouldn't we?**

- **Ask students to express their views on the above dialogue.**
- **Lead a discussion to highlight the following points. .**

That,

- **different sectors contribute to the Gross Domestic Product.**
- **agriculture is the main sector among them.**

- both agriculture and agro-based industries contribute to employment opportunities in Sri Lanka.

Proposed suggestions for learning :

- Each group should explore one of the following topics.
  - Crop production
  - Animal husbandry, fishery industry and forestry
  - Industries and services
- Explore the given topic, in relation to the following fields.
  - Quantity of production/ value of products
  - Contribution to the gross domestic product
  - Contribution to employment.
  - Contribution to industries and infrastructure.
  - Progress of these sectors
- When necessary get help from your teacher.
- Be prepared to present your findings creatively, to the entire class.
- Use tables and graphs to present your findings, if necessary.

Instructions for the explanation of subject matter :

- Let each group present its findings to the class.
- Lead a discussion to highlight the following.

  That,
  - Agriculture is an important sectors for the Gross Domestic Product, employment and infra-structural facilities of Sri Lanka.
  - Contribution of Agriculture has been declining over the years.
  - Recently, the contribution of industries and services has increased.
  - Animal husbandry and fishery industries also have not achieved considerable progress during the past period.
  - But, these sectors are very important and cannot be neglected.
  - Agriculture, animal husbandry and fishery are important fields to be developed, to minimize expenses necessary to import goods such as infant formula, other items of foods.
  - Agriculture is an important sector to expand local employment opportunities.
  - However, the percentage of employees in the agriculture sector has been declining with time.

- **Employment in other industries and services have increased gradually.**
- **Occupations in the garment industry, foreign employment and military services do not exist for a long time.**
- **Therefore, employment opportunities related to agriculture should be expanded to overcome the above problems.**
- **Agriculture related jobs should be developed up to a profitable and stable level.**
- **Agriculture related industries and services, also contribute to employment opportunities.**

Competency level 1.2 : **Makes suggestions for the future of agriculture while recalling the successes of the past.**

Duration : **05 periods.**

Learning outcomes :

- **Gives evidence of ancient agricultural prosperity of Sri Lanka.**
- **Explains about the developed irrigation technology and government support as reasons for the agricultural prosperity of the past.**
- **Suggests methods of developing the present agriculture using experiences of ancient agricultural prosperity.**
- **Presents facts creatively.**
- **Gives suggestions for future improvements in agriculture.**

Teaching-learning process

Engagement :

- **Display a poster with a picture of king Parakramabahu.**
- **Lead a discussion to highlight the following points.**
  That,
  - **Picture shows the great king Parakramabahu the 1st.**
  - **"***Parakrama samudraya***" is the main contribution of king Parakramabahu to the irrigation technology.**
  - **Statement made by king Parakramabahu on the use of water is**
    "Let not a drop of water be allowed to flow into the sea without being used"
  - **The king made the above statement based on his knowledge of irrigation technology and conservation of rain water for the future.**
  - **Sri Lanka was known as "The granary of the east" during that era.**

Proposed instructions for learning :

- **Each group should explore fields relevant to the topics given below.**
  - **Prosperity of ancient agriculture**
  - **Recent changes in agriculture.**
- **Explore the given topic, in relation to the following fields.**
  - **Effect of developed irrigation on agriculture**
  - **Contribution of the government in the development of agriculture during the past.**

- **Effect of the cultural and religious background on agricultural development.**
- **Reasons for the sustainability of agriculture during the past.**

- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,
  - **Economy in the past was mainly based on agriculture**
  - **Sinhala-** *"Wewa"* **(Tamil-** *"Kulam"***) and Sinhala-"***Amuna"*, **Tamil-** *"Kulakkaddu"* **(Tanks and anicuts) were built to develop agriculture.**
  - **There was a prosperous agriculture during the Anuradhapura and Polonnaruwa era**
  - **Land use policy of the country affected the recent agricultural economy immensely.**
  - **Establishment of agricultural colonies was a method used to develop agriculture during the recent past.**
  - **Ancient people collected water in reservoirs by constructing Sinhala-"***Amuna"*, **(***"Kulakkaddu"* **) (anicuts) across rivers and was then cannelled to the lower lands through canals.**
  - **People in the past showed special skills in designing canals.**
  - **Special and complex irrigation systems with** *"wewa"* **(***"Kulam"***) (tanks), rivers, canals and Sinhala - "***Amuna"* **(***"Kulakkaddu"* **) (anicuts) were constructed in the Anuradhapura era.**
  - **Modern irrigation schemes were established in the recent past.**
  - **Different crops, other than paddy, are cultivated using irrigated water by constructing large reservoirs.**
  - **Government support was a major factor in agricultural development in the past.**
  - **The great kings** *Wasaba, Dhathusena, Mahasen* **and** *Parakramabahu* **the great mainly contributed to the development of ancient agriculture.**
  - **Different governments in the resent past helped introduce multipurpose development projects.**
  - **Large extents of land could be developed using these projects.**
  - **Cultural and religious backgrounds also have an affect on agricultural development**
  - **Constructions in the past contributed to the sustainability of agriculture**
  - **The green revolution in the recent past contributed to agricultural development.**

Competency level 1.3 : Plans to overcome the challenges to modern agriculture.

Duration : 05 periods.

Learning outcomes :

- Names trends, threats and challenges affecting agricultural development.
- Explains the possibilities of applying various strategies to overcome challenges.
- List challenges and trends in the agricultural sector .
- Describes effective ways of using these trends to develop agriculture.
- Explains threats to the Sri Lankan agricultural sector .

Teaching-learning process:

Engagement :

- Assign a student to read the following newspaper article to the class.

> **Newspaper article**
>
> **"Price of rubber drops. Farmers in danger"**
>
> The unusual reduction in the price of rubber is a problem to the sale of rubber products. Increase in fertilizer prices, as well as the rise in wages has brought about a situation where the small scale rubber manufacturers face losses.
>
> Therefore, some small holders have stopped tapping rubber latex. Farmers said that they need more government intervention to overcome this matter such as introduction of a fertilizer subsidy scheme and fixed and stable prices for rubber .

- Lead a discussion to highlight the following.
  That,
  - There are various threats and challenges which affect Sri Lankan agriculture
  - Profit in agriculture has declined due to the problems above.
  - Government intervention and proper planning will help overcome most of the above mentioned problems.

Proposed instructions for learning :

- Each group should explore a topic given to your group, from the following.
  - Means of overcoming threats and challenges to agriculture.
  - Trends in agriculture and ways of using these trends to develop agriculture.
- List the existing conditions in relation to your topic.
- Describe different ways of using these conditions to develop agriculture.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.
  - There are a lot of threats and challenges which affect Sri Lankan agriculture Viz;
    - There are lots of problems in marketing.
    - Agricultural lands are diminishing gradually.
    - Improper land use.
    - low capital investment
    - Human attitudes that affect in different ways.
    - Existence of small farms
    - Low Agricultural crop yield
    - High Import of goods.
    - International policies and acts.
    - Laws related to land ownership
    - Problems of irrigation
    - Weaknesses in agriculture extension service
    - International agreements and treaties
  - Steps to overcome challenges.

    They are,
    - Use various strategies in agricultural marketing.
    - Use appropriate technology
    - Efficient use of lands
    - Take necessary actions to minimize dropouts in the agricultural labor force.
    - Introduce cooperate farming systems
    - Partitioning of agricultural lands
    - Reduce food imports
    - Planning in the production of commodities
    - Expansion of agricultural extension service

- **Various trends in agriculture.**
  Viz;
  - **Government intervention is high in paddy cultivation**
  - **Necessary actions being taken to develop irrigation systems**
  - **Necessary researches being implemented in agriculture**
  - **Availability of a wide range of support services in agricultural.**
  - **Availability of a well trained extension service.**
- **These trends can be used to develop agriculture.**

Competency level 1.4 : **Plan agricultural development of Sri Lanka according to the agricultural policies and regulations.**

Duration : **04 periods.**

Learning outcomes :

- **Names main fields in relation to agricultural policies and acts.**
- **Shows the relevance of agricultural policies and acts in agricultural development.**
- **Explores agricultural policies and acts.**
- **Takes necessary action to avoid problems in agriculture by following policies and acts.**
- **Describes ways of using policies and acts to develop agriculture.**

Teaching and learning process :

Engagement :

- **Display the following newspaper article to the class.**

> **Newspaper article**
>
> **New Policies to asvaddumize (break in) bare lands.**
>
> **The Minister of Agriculture say that, he would take necessary action to enact policies to make use all cultivable lands in Sri Lanka. He also mentioned that this will help to minimize the use of wet zone paddy lands for other purposes and keep them as bare lands. Land owners who had not cultivated for three consecutive seasons will be called for explanations. Thereafter, the government will take over ownership or the authority of cultivation.**
>
> **Accordingly, laws and regulations will be formulated to take ownership of lands to the government or to offer to another farmer, if the owner is not capable of cultivating it successfully for a long period of time. He says the aim of these policies is to use land in an effective and sustainable manner.**

- **Allow students to read the article.**
- **Ask the following questions.**
  - **What do you mean by agricultural policies?**
  - **What is the necessity of agricultural policies?**
  - **What do you mean by agricultural acts?**

  - What is the necessity of agricultural acts?
- Lead a discussion to highlight the following:
  - Agricultural policies are standards, which have been formulated to develop agriculture.
  - Policies have been formulated for necessary government intervention to develop living standards of farmers by solving their problems.
  - Agricultural acts are laws and regulations, which have been formulated by the government to develop agriculture.
  - Agricultural acts help in solving problems of farmers and to formulate strategies for agricultural development

Proposed instructions for learning :

- Each group should explore one of the topics given below.
  - Agricultural Policies
  - Agricultural Acts.
- Explore your topic on the following fields.
  - Name the main fields/sectors related to your topic.
  - List ways of using policies for agricultural development.
  - Describe benefits of agricultural policies/acts to society as well as to farmers.
- Be prepared to present your findings creatively, to the entire class

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following:-

  That,
  - Current agricultural policies are formulated to fulfill the following objectives.
    - To ensure the sustainability of agriculture and to improve productivity
    - To ensure national food security.
    - To improve the living standards of the farming community
    - To increase agricultural productivity by minimizing costs of production
    - To maximize benefits and minimize adverse effects of the globalization of agriculture
    - To promote export agriculture.
    - To promote agro-based industries to increase employment opportunities
    - To minimize adverse environmental effects related to agriculture.
    - To promote utilization of local food crops
    - To promote private sector investments and entrepreneurship.
    - To initiate institutional facilities to prepare laws and regulations necessary for environmental management

- To promote environmental friendly and scientific land usage.

➢ Agricultural acts are formulated to achieve the following objectives

- To solve problems related to irrigation
- To secure rights of farmers
- To offer authority for agriculture related institutes to take necessary action
- To provide compensation for farmer losses
- To distribute fertilizer methodically among farmers
- To prepare plans to cultivate bare lands
- To use large areas of land for agricultural activities
- To control plant pest attacks

Competency level 1.5 : **Investigate about possible institutions to obtain services for agricultural activities.**

Duration : **04 periods.**

Learning outcomes:

- Names various institutions that contribute to agricultural development.
- Prepares plans to obtain services and inputs for agricultural development.
- Describes services related to agricultural development.
- Gets help of services of various institutes to complete tasks successfully.
- Explains ways of using various services to maximize profit.

Teaching-learning process

Engagement :

- Ask students to focus attention on the problems given below.
  - What is the institute, you have to get instructions to control brown plant hopper attack in your field?
  - Name an institute that produces new varieties for farmers.
- Lead a discussion to highlight the following points based on the answers above.

  That,
  - Farmers need various services that provide instructions to carryout their activities successfully.
  - Government and non-governmental organizations provide the necessary services and support.
  - These services could be used to solve problems and maximize profits in agriculture

Proposed instructions for learning :

- Each group should select a topic from the following.
  - Government organizations that contribute towards agricultural development
  - Private, educational and non-governmental organizations, that contribute towards agricultural development.
- List the institutions and services of each institute related to your topic.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **There are large numbers of government institutes that contribute to agricultural development.**
    - **Research institutes for each crop is located in various places**
  - **The Department of Agriculture is engaged in various activities**
    - **Main functions of Department of Agriculture are conducting research, zonalization of crops, planning crop cultivation, production of certified seeds and seed certification, implementation of pest control act.**
  - **Department of Export Agriculture also contributes to agricultural development**
  - **Department of Agrarian Services contributes to agricultural development as,**
    - **Implementation of the agrarian development act**
    - **provide agricultural inputs and services**
    - **rehabilitation of minor irrigation schemes**
    - **maintain registries of agricultural lands**
    - **conduct meetings during agricultural seasons.**
  - **Identification of research potentials, research planning, find necessary funds, publishing research findings are some of the functions of Central Agricultural Research Policy (CARP)**
  - *Hector Kobbekaduwa* **Agrarian Training and Research Institute (HARTI) provides various services to agrarian sector**
  - **Agrarian Insurance Board provides an insurance scheme for selected crops, a pension scheme for farmers and a social security scheme for farmers**
  - **Co-ordination of fertilizer importation and distribution, ensures quality of fertilizers, are some of the functions of the National Fertilizer Secretariat.**
  - **Institute of Post Harvest Technology helps in functions such as introduction of recommendations to minimize post harvest losses and establishing agricultural marketing net works.**
  - **Private sector institutes also help agriculture by providing various inputs for agricultural development**
  - **Non Governmental Organizations (NGO's) implement various programs for agricultural development**
  - **Government and non governmental educational institutes provide knowledge and skills for agricultural development**

Competency 2 : Decides crop management practices in terms of climatic conditions.

Competency level 2.1 : Determines the climatic condition of the region by measuring climatic factors affecting agriculture.

Duration : 04 periods

Learning outcomes :

- Names equipment used to measure weather parameters.
- Describes the importance of measuring weather data in agriculture
- Selects appropriate equipment to measure weather parameters.
- Records meteorological data and draws correct conclusions through proper observation.
- Records data after measuring weather parameters.

Teaching-learning process

Engagement :

- Present the following weather forecast to the class.

> **Weather Forecast**
>
> - Maximum rainfall reported within last 24 hours in Colombo was 20 mm.
> - The maximum temperature recorded from Anuradhapura was 31°C, and the minimum temperature recorded at Nuwara Eliya was 18°C
> - Wind blowing from south-west is 25 km/h and sea can be choppy.
> - According to the satellite imagery of today, clouds were scattered, and there is a tendency for rain or thunder storms in the west, south and south-west areas today in the afternoon or evening.

- Lead a discussion to highlight the following.

  That,

  - Department of Meteorology releases weather data.
  - weather is the condition of the atmosphere over a short period of time
  - climate is the long-term pattern of weather in a particular area
  - following are the major climatic factors
    - Rainfall
    - Temperature
    - Light

- Humidity
- Wind

➢ evaporation is a derived factor of weather parameters

Proposed instructions for learning :

- Focus your attention to the topic assigned to your group from the following.
  - Rainfall and wind
  - Light and evaporation
  - Temperature and humidity
- Describe your topic.
- Name instruments used to measure weather parameter .
- Identify and label the parts of the instrument.
- Explain the correct use of the relevant instruments.
- Measure rainfall, temperature and relative humidity and prepare a table
- Prepare graphs on annual rainfall, relative humidity and temperature using the above data
- Accordingly, determine the climatic condition of the area.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following:-

  That,
  - ➢ rainfall is the droplets water (with diameter of 1-5mm) reaching the earth from clouds.
  - ➢ automatic rain gauges (pluviograph) and non recording type rain gauges are used to measure rainfall.
  - ➢ Rainfall data can be presented as tables and graphs.
  - ➢ Bi-modal rainfall patterns could be observed in most of the dry zone areas in Sri Lanka.
  - ➢ Dry period of the wet zone is from mid January to mid March.
  - ➢ Amount of water received on a particular area from rainfall can be expressed as a volume
  - ➢ Rainfall intensity can be measured using a recording type rain gauge
  - ➢ A Pyranometer is used to measure the intensity of light.
  - ➢ Sun shine recorder is used to measure the sun shine hours.
  - ➢ The light spectrum contains the visible range of light, infra red and ultra violet rays.
  - ➢ The visible range of light consists of purple, indigo, blue, green, yellow, orange and red colours.

- Movement of air from an area of high pressure to an area of low pressure is called 'wind'.
- Wind speed and direction of the wind can be measured using an anemometer and wind vane, respectively.
- The wetness of the atmosphere or the amount of water vapor in the air is called its humidity.
- Relative humidity is the measure of the amount of water vapor in the air (at a specific temperature and pressure) compared to the maximum amount of water vapor air could hold at that temperature and pressure, and is given as a percentage value.
- The wet and dry bulb thermometer and hygrometer can be used to measure humidity
- weather data can be presented in graphs
- evaporation is a derived factor of weather parameters
- Evaporation pans are used to measure evaporation
- Evaporation data is used to determine the irrigation water requirement and irrigation interval.

Competency level 2.2 : **Inquires into the effect of climatic factors on agriculture**

Duration : **05 periods**

Learning outcomes :

- **Describes the effect of climatic factors on crops.**
- **Explains ways of improving crop yield considerating climatic factors.**
- **Explains crop cultivation patterns according to climatic factors.**
- **Describes different patterns of crop management, suitable for climatic factors.**
- **Names factors that affect climatic changes.**

Teaching-learning process:

Engagement :

- **Use a suitable Folk song about climatic factors as an engagement procedure.**
- **Lead a short discussion to highlight the following points.**

  That,
  - **Climate is the weather pattern identified over a long period of time.**
  - **Weather is short term, while climate is long term, stable and occurs annually.**
  - **The following climatic factors are important for crop cultivation.**
    - **Rainfall**
    - **Temperature**
    - **Light**
    - **Humidity**
    - **Wind**
  - **Evaporation is an important process affect on agriculture**

Proposed instructions for learning :

- **Each group should explore the fields relevant to the topics given below.**
  - **Rainfall and wind**
  - **Light and evaporation**
  - **Temperature and relative humidity**
- **Explore the following using the resources given to your group.**
  - **forms of the climatic factor that you have studied**
  - **Effect of the above climatic factor on crop production**
  - **Suitable crop management practices according to the climatic factor**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **there is a relationship between rainfall and water cycle**
  - **the major mechanisms of rainfall in Sri Lanka are,**
    - **Convection**
    - **Monsoon**
    - **Weather systems**
  - **the effects of the above rainfall types are different**
  - **accordingly, there are 4 rainfall periods/rainfall seasons in Sri Lanka**
  - **rainfall patterns affect crop cultivation patterns**
  - **different cropping seasons are determined according to the rainfall pattern**
  - **rainfall affects crop cultivation with respect to,**
    - **land preparation**
    - **seed germination**
    - **plant growth**
    - **flowering of some plants**
    - **drying of crop yield**
  - **The adverse effects of high rainfall on crop cultivation are,**
    - **Falling of trees**
    - **falling of immature fruits and flowers**
    - **reduction of cultivatable land in fertile state due to soil erosion**
    - **Damage to cultivations due to floods**
    - **Damage from land slides**
    - **Disturbances in harvesting of crops.**
    - **destruction of paddy cultivations due to poor drainage conditions**
  - **Factors affecting temperature fluctuations are**
    - **distance from the equator**
    - **elevation**
    - **topography**
    - **vegetation**
    - **human activities**
    - **location of inland water resources**
    - **usage of land**
  - **Effect of temperature on crop cultivation are,**
    - **photosynthesis**
    - **transpiration**

- flowering
- soil microbial activities
- drying of yield
- growth of tubers

- Relative humidity affects the following,
  - Transpiration
  - Pollination
  - Rooting of stems
  - Quality of flowers
  - Opening of stomata
  - Proliferation of pests
- Light affects crop cultivation in different ways.
- Light intensity affects following,
  - Photosynthesis
  - Transpiration
  - Flowering
  - Tropic movements
  - Leaf area
- Quality of light affects the following processes,
  - Red light – on formation of branches and seed germination
  - Blue light – on photosynthesis
- Duration of light affects the following,
  - Tuber growth
  - Flowering
- Plants are classified into three groups according to the effect of light duration such as,
  - Long day plants
  - Short day plants
  - Day neutral plants
- Wind affects crop cultivation as follows,
  - air movement around crops
  - cooling
  - evapo-transpiration
  - pollination
  - dispersal of fruits and seeds
- Following climatic factors affect on evaporation
  - Rainfall

- **Temperature**
- **Wind**
- **Humidity**
- **Radiation of light**

- **Apart from climatic factors , evaporation also affects crop cultivation as follows,**
  - **To determine crop-water requirement**
  - **To determine the irrigation interval**
  - **For the crop transpiration**
- **Potential Evapo-transpiration /maximum water requirement is determined by measuring evaporation.**
- **Evapo-transpiration is an important measurement considered in irrigation.**

Competency level 2.3 : **Designs an agro climatic unit in the school**

Duration : **03 periods**

Learning outcomes :

- **Describes the necessity of a meteorological unit to obtain the necessary data for agricultural activities.**
- **Explains important factors to be considered in the establishment of an agro-meteorological unit.**
- **Explains factors which should be considered in the selection of a suitable site for a meteorological unit.**
- **Explains the maintenance procedure of a meteorological unit.**
- **Prepares plans to cultivate crops with knowledge of weather data.**

Teaching-learning process

Engagement :

- **Display a poster of an agro-meteorological unit or pictures of equipment used to measure climatic factors.**
- **Lead a discussion to highlight the following:**
  That,
  - **Agro-climatic data is necessary to determine the agricultural potential of a particular area**
  - **It is important to install equipment properly in an agro-meteorological unit, measure data accurately and maintain the site properly**
  - **Agro-meteorological station/unit is important for the above purpose**

Proposed instructions for learning :

- **Describe an "Agro-meteorological unit".**
- **Explain the importance/necessity of an agro-meteorological unit in an agricultural field.**
- **Explore your topic about an agro-meteorological unit using the materials provided.**
  Topics,
  - **Selection of a site and maintenance**
  - **Name and install meteorological equipment**
- **Plan the activities necessary to establish a meteorological unit in your school relevant to your topic.**
- **List reasons for your planning.**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following:**

  That,

  - **An agro meteorological station is the site where meteorological equipment are installed to measure the necessary weather information on agriculture.**
  - **There is a difference between an Agro meteorological station and an Meteorological observation station.**
  - **Information related to climate is important to determine,**
    - **agricultural activities,**
    - **crops and cropping systems,**
    - **agricultural potentials,**
    - **irrigation requirement in a particular area.**
  - **The following factors are important in the selection of a site to establish an agro meteorological unit**
    - **a representative site**
    - **represents common physical and topographical characteristics in the area**
    - **open space**
    - **area of the site should be 50×50 m**
    - **equipment should be installed in the centre of the site (equipment installation area should be 10×10 m)**
    - **selected site should not be close to open water sources such as ponds, reservoirs etc.**
    - **flat land with proper drainage conditions**
    - **free of disturbances and if there are any (trees, buildings); site should be 4 times away from the height of disturbances**
  - **Factors considered in maintaining a meteorological unit are as follows,**
    - **Should maintain a properly moved lawn**
    - **To enclose the site/area using wire mesh to protect it from animals**
    - **it is not suitable to build a wall instead of a protected fence**
    - **soil thermometers should be protected by a separate fence**
    - **Maintain cleanliness of the location**
  - **The following equipment should be installed in an agro meteorological unit**
    - **Rain gauges**
    - **maximum thermometer, minimum thermometer**
    - **soil thermometer**
    - **sun shine recorder and pyranometer**
    - **wet and dry bulb thermometer**

- wind vane and anemometer
- evaporation pan

➢ The following factors should be considered in the installation of this meteorological equipment

- factors to be considered in the installation of rain gauges
  - place on a concrete or cement base/stage
  - top level of the rain gauge should be 30 cm above ground level
  - inner container of the rain gauge should be free of leakage, dust or other residues
- factors to be considered in the installation of an anemometer and wind vane
  - should be installed 2m above land because wind speed is measured 2m above land for agricultural activities
- important factors about minimum thermometer
  - made of an alcohol column
  - indicator in the middle of the alcohol column moves with the expansion of alcohol and it helps read the temperature
  - thermometer should be erect while holding by the bulb and the other end should be first fixed to the stand thermometer
  - should fixed at an angle of 5^0 to the stand
  - *"Six's maximum and minimum"* thermometer is also used to measure maximum and minimum temperature
  - alcohol and mercury columns are used in this thermometer and 2 indicators can be seen on the mercury column
  - expansion and contraction of alcohol is used to measure minimum and maximum temperature
- Important characteristics of wet and dry thermometers are,
  - used to measure relative humidity of atmosphere
  - consists of 2 thermometers; a normal thermometer as the dry bulb thermometer and a thermometer covered with a piece of cloth (cotton) placed in a bottle of water as the wet bulb thermometer
  - difference of the thermometer values and standard charts are used to calculate relative humidity
- normal thermometer, maximum and minimum thermometers and wet-dry thermometer are fixed to a panel and placed in the Stephenson screen
- important characteristics of the normal thermometer
  - the normal thermometer is used to measure atmospheric temperature

- maximum thermometer is used to measure maximum temperature
- minimum thermometer is used to measure minimum temperature

- maximum temperature can be measured accurately using the effect of the curvature in the mercury column
- mercury column should be readjusted and fixed to the stand at an angle of 5 degrees after measuring the temperature
- important factors about Stephenson screen
  - used to place thermometers and wet-dry bulb thermometers
  - white colour of the wooden structure helps to minimize the effect of radiation
  - also helps to protect instruments and avoid direct exposure from rain and solar radiation
  - height of the instrument is 1.5m
  - opening of the instrument should be aligned to the North-South direction to avoid the effect of sun light
  - this direction changes twice a year viz,

    towards the South during 10th April to 31st August

    towards the North during 01st September to 09th April
- important characteristics of soil thermometers
  - used to measure soil temperature at different depths
  - measure temperature at different depths like 5, 10, 20, 30, and 100 cm from ground level
- important characteristics of sun shine recorder
  - used to measure sun shine hours
  - the Campbell sun shine recorder is used mostly
  - a special paper strip is placed on the glass sphere of the instrument and the focused light rays causes the paper to burn.
  - sun shine hours can be determined by observing the burn pattern of the strip of paper .
  - installed 1.5m above ground level and placed to pointing East to West
- important characteristics of the pyranometer
  - used to measure the intensity of light
  - changes of length occur in the bi-metallic strip due to solar radiation use to plot the graph
  - it helps determine solar radiation that reaches the place during a day
- important characteristics of evaporation pan
  - Made of galvanized metal, painted white
  - diameter of the pan is 120 cm and its depth is 25 cm

- should maintain its water level up to 20 cm and the level should not be less than 7.5 cm from the top of the pan
- should be placed on a wooden frame of 15 cm height and it should allow for air circulation and unnecessary heating from the ground
- should be covered using a wire mesh to protect from animals
- a still well is used to take measurements
- it helps minimize the effects of waves in the pan to the reading
- hook gauge is used to take measurements accurately using the vernier caliper
- should be installed 5m away from the rain gauge and 1.5 m from the fence

- the following are the times for the measurement of data in an agro meteorological station in a day
  - standard times of recording data are 8.30hrs and 15.30 hrs
  - weather data such as rain fall, maximum and minimum thermometer values, sun shine hours, wind speed and direction, daily evaporation are measured only at 8.00hrs
  - weather data such as wet & dry bulb thermometer values and soil temperature are measured in 8.30hrs and 15.30 hrs
- special factors considered in recording data
  - data which is taken once is recorded opposite the data of the previous day
  - data which is taken twice is recorded morning and evening of the particular day

Competency level 2.4 : Plans agricultural activities to minimize the effect of climatic changes

Duration : 05 periods

Learning outcomes :

- **Plans agricultural activities to overcome adverse effects of climatic changes.**
- **Prepares plans to minimize situations resulting from adverse climatic changes.**
- **Describes eco-friendly practices in agriculture.**
- **Explains methods of solving environmental issues.**
- **Plans effective strategies to face risky situations.**

Teaching-learning process:

Engagement :

- **Chant the following stanza to the class.**

"Dewo wassathu kalena
sassa sampaththi hothucha
peetho bhawathu lokocha
raja bhawathu dhammiko"

May there be timely rain
may the crops yield well
may the whole world be happy
and may the king be benign

- **Lead a short discussion to highlight the following.**
  That,
  - **Lack of suitable climatic factors lead to the failures in the agriculture sector .**
  - **climatic changes create problems in the agriculture sector and we have to find solutions to overcome these challenges.**

Proposed instructions for learning :

- **Each group should explore one of the topics given below.**
  - **changes in rainfall**
  - **changes in temperature**
  - **rise of the sea water level**

- Describe the term "climatic changes"
- Collect information about the formation of climatic conditions on the earth, solar radiation for existence of life, green house effect and its contribution on the climate.
- Present your findings about the climatic changes, in relation to your topic.
- Collect information about present status of the climatic change you studied.
- Explain how it affects on agriculture.
- Explain means to overcome these climatic changes to do agricultural practices effectively.
- Present your findings to the entire class

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following points.

  That,
  - solar radiation and infrared rays which emit from the earth maintain the equilibrium of energy
  - solar radiation produce energy for air circulation and it leads to form climatic conditions on the earth
  - climatic changes are the long term changes of weather parameters such as rainfall, temperature, etc
  - both natural and human activities contribute to the climatic changes
  - main reason for the climatic changes is the global warming due to green house effect
  - green house effect is a natural phenomena needed for existence of life on the earth
  - but, the enhanced green house effect, which is accelerated by the human activities is badly affect on climate to create changes
  - human activities such as combustion of fossil fuel, destruction of forests, industrialization, accumulation of urban waste materials and agriculture leads to increase in the percentage of green house gases.
  - examples for green house gasses are water vapor , Carbon dioxide, Methane, Nitrous oxide, Chloro-fluoro carbon, Purpluorocarbon
  - these gasses contribute to global warming
  - it leads to changes in the water cycle
  - fluctuations in rainfall, high temperature and increasing sea water level are the adverse effects of climatic changes
  - non availability of rainfall on time, unexpected rainfall, erosive rains, soil erosion, earth slips, loss of fertile soil, droughts and floods are the adverse effects of the rainfall fluctuations
  - these conditions lead to reduced crop yields qualitatively and quantitatively

- rainfall fluctuations affect the production of grass and other animal feed, pest and diseases in animals
- high ambient temperature leads to increase in the temperature of sea water and increases of sea water level up due to melting of glaciers
- it leads to the flow of brine water to sea side lands resulting in soil pollution and destruction of bio diversity
- the following are the strategies which could be adopted to minimize effects of climatic change,
  - effective water management in farms
  - use of micro irrigation systems
  - reuse of drainage water
  - use of soil and water conservation methods
  - rehabilitation of ponds, lakes and anicuts
  - use of crop varieties suitable to agro ecological zones
  - breed new varieties which could resist drought, resist pest and diseases, resist salinity and short term crops
  - launch programs such as re-forestation, agro forestry, home gardening, conservation of beaches
  - introduce farming systems which use minimum levels of chemicals
  - eco friendly use of fertilizer
  - introduce awareness programs and apply environment acts
- the following can be used to minimize effects of climatic change in agriculture
  - use of regenerative energy sources
  - improved use of nitrogenous fertilizer
  - improve food conversion efficiency of ruminants
  - planting crops in marshy lands to minimize release of methane
- However, we are not legally bound to reduce the release of green house gases
- It is a essential to practice eco friendly agriculture for sustainability.

Competency level 2.5 : Studies map of Agro Ecological Zones .

Duration : 04 periods

Learning outcomes :

- Describes the criteria for the classification of agro ecological zones
- Explains the importance of agro ecological zones in agriculture
- Selects crops suitable for the soil and climate in agriculture.
- Names factors determining climate of Sri Lanka.
- Explains the importance of map of agro ecological zones.

Teaching-learning process

Engagement :

- Present the following news to the class.

> **News**
>
> The Department of Agriculture shows that the planing of crop cultivation taking soil and other environmental factors into consideration is important to get better results from agriculture

- Explain the following:
  - importance of identifying environmental conditions in planing agricultural activities
  - recommendation of crops suitable for different environmental conditions
- Lead a discussion to highlight the following.

  That,
  - optimum environmental factors are important for effective crop cultivation
  - It is easy to practice agricultural activities according to the knowledge of environment.
  - There are three climatic zones in Sri Lanka on the basis of rain fall
  - These can be further divided on the basis of rain fall and other physical and biological factors

Proposed instructions for learning :

- Use the resource book and map of agro ecological zones (2003) published by the Department of Agriculture to answer the following questions.
  - Describe factors determining the climate of Sri Lanka
  - Try to identify the major climatic zones of Sri Lanka

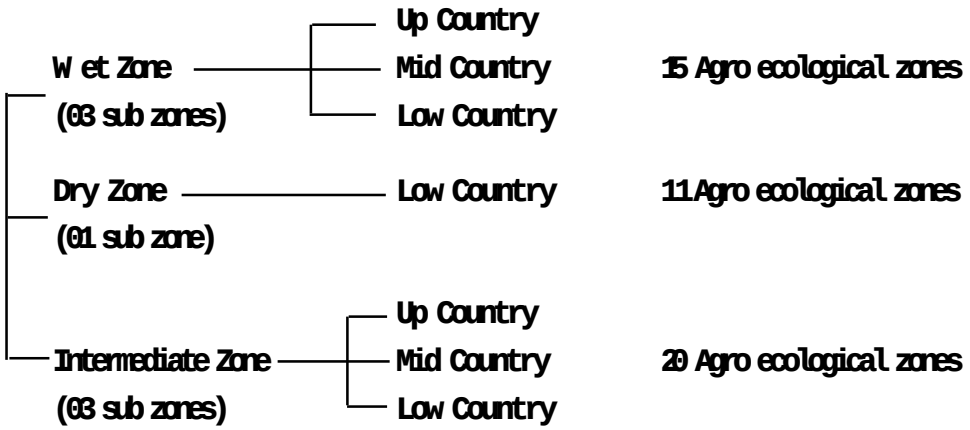
  - Mark climatic zones in a map
  - Name the factor used to determine the above mentioned climatic zones.
- Select one topic from the following
  - Wet zone
  - Dry zone
  - Intermediate zone
- Describe the term agro climatic zone
- Explain the basis of the classification, above
- Name characteristics used for further division of these climatic zones.
- Write the number of agro ecological zones in the climatic zone which you have studied.
- Explain the nomenclature of agro ecological zones.
- Collect information about the following in relation to your topic
  - 75% expected rainfall
  - Major soil types
  - Land use
  - Other specific characteristics
- Describe the importance of the map of agro ecological zones
- Present your findings creatively to the entire class

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.

  That,
  - Factors which determine the climate of Sri Lanka are as follows,
    - Sri Lanka is a tropical country
    - It is located close to the sub continent of India
    - It is an island
    - Close to the bay of Bengal which faces frequent climatic changes
    - Location of the central highlands perpendicular to two different types of monsoon winds
  - Rainfall is the major factor affecting the climate of Sri Lanka
  - Sri Lanka is divided into three basic climatic zones on the basis of rainfall
  - It can be further divide into agro ecological zones according to environmental conditions
  - 46 agro ecological zones have been identified
  - It was published by the Department of Agriculture in 2003.
  - Following are the characteristics and descriptions of agro ecological zones

- Major climatic zones are classified on the basis of rainfall
  - wet zone (rainfall above 2500 mm)
  - Intermediate zone (rainfall 1750-2500 mm)
  - Dry zone below (rainfall 1750 mm)
- Apart from rainfall factors such as soil, topography, land use, active contribution of south-west monsoon rain are also considered in the classification of climatic zones.
- The Wet zone is distributed in the south-west to the central highlands.
- The Dry zone is distributed to the North, North-Central, East and South-East areas and large extents of land belong to the dry zone
- Intermediate zone is the area in between the dry and wet zones
- Climatic zones are further divided, on the basis of the elevation from the mean sea level.
- Accordingly, major climatic zones can be divided into 7 sub zones



- The Dry zone covers only the low country
- The following factors have being used to classify Agro climatic zones in the Agro ecological zones
  - Average annual rainfall
  - 75% probability of monthly rainfall
  - Topography
  - Major land use
  - Major soil types
- Monthly rainfall is plotted on a graph, therefore it is easy to obtain information regarding the rainfall pattern
- Agro ecological limits are not considered as permanent limits, and various factors cause on long term changes

  e.g. ecological changes, collection of excessive data, changes of factors use determine these zones

- A symbol with letters and 4 digits, is used to denote each zone.
- First the Wet zone, the Intermediate zone and the Dry zone are labeled W, I and D respectively
- Secondly, the Low country, Mid country and Up country are labeled L, M and U respectively.
- Thirdly, the given digit shows the wetness of the zone. Reduction of the wetness indicated by numerals 1 to 5.
- Fourthly, the simple letter (from "a" to "f") show changes in rainfall seasons and the effect of other factors on wetness.
- An example of a description of an Agro ecological zone is shown below,

Agro ecological zone	75% expected rainfall (mm)	Major soil types	Land use
WU_{1}	>3100	-Red yellow podzolic - Mountain regosols	Tea, agro- forests, Natural forests
WU_{2a}	>2400	Red yellow podzolic	Tea, forests, plantations

- Uses of the map of agro ecological zones are,
  - to identify a place with unique climatic conditions.
  - to recommend suitable crops for each zone
  - to facilitate planning and implementation of projects
  - to help in the zonalization of agricultural lands
  - to facilitate development and conservation of land
  - to maximize profits from agriculture and minimize risk
  - to obtain a seasonal cropping calendar and prepare plans accordingly.

Competency 3 : **Decides the soil environment suitable for crop cultivations.**

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

Duration : **06 periods.**

Learning outcomes :

- **Describes the soil formation process.**
- **Names the factors affecting soil formation.**
- **Explains the rock weathering process according to environmental factors.**
- **Draws a soil profile.**
- **Describes the importance of studying a soil profile for crop cultivation.**

Teaching-learning process:

Engagement :

- **Assign two students to read the following dialogue to the entire class.**

Dialogue		
Amal	:	**Do you know how soil is formed?**
Janaka	:	**I read an article about soil genesis. It's a long process and takes thousands of years according to that article.**
Amal	:	**What else?**
Janaka	:	**It says that soil formation starts from rock weathering.**
Amal	:	**Oh! the next lesson is soil formation. Isn't it? We will get more details there.**

- **Lead a discussion to highlight the following:**

  That,

  - **soil is a consistent media which is useful for plant growth and is composed of minerals, organic matter, various organisms, air and water.**
  - **2 stages of the soil formation process**
    - **Weathering of rocks**
    - **Soil genesis**
  - **Soil profile is formed by developing different soil zones**

Proposed suggestions for learning :

- Each group should explore one of the following topics on soil formation.
  - Weathering of rocks
  - Soil genesis
- Describe the topic given to your group.
- Explain the process.
- Explain the factors affecting the process given and its effects.
- What is a soil profile?
- Explain the development of a soil profile and different zones in a profile.
- Explain the importance of studying a soil profile for crop cultivation.
- Observe a soil profile in the field and present your ideas.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.

  That,
  - rock weathering is the process of the formation of parental materials as a result of different reactions on rocks by physical, chemical and biological processes.
  - Factors that affect rock weathering can be classified as
    - physical factors
    - Chemical factors
    - Biological factors
  - Physical factors are
    - running water
    - sea waves
    - formation of ice crystals in cracks of rocks
    - gales
    - Differences between day and night temperatures
  - Chemical factors are
    - solution
    - hydration
    - hydrolysis
    - oxidation
    - chelating
  - biological weathering is enhanced with the,
    - growth of plant roots through soil cracks
    - secretion of chemicals by mosses and lichens on rocks

- organic acids formed in decomposing organic materials
- constant turning of soil by ungulates.

- Effects of rock weathering are,
  - formation of rock particles
  - removal of silica
- Soil genesis is the process of soil formation. Soil forms through the effect of climatic conditions on rocks for a long period of time and combination with organic matter.
- An equation derived by soil scientist, V.V. Dokushev in 1895,
  S = f(Cl,O,P)t
- There are 5 factors affecting soil genesis,
  - parental material
  - topography
  - time
  - climate
  - biotic factors
- biotic factors and climate are active factors
- others are non active factors
- various soil types are formed by different types of parental material
- the effect of topography can be explained by 3 factors:-
  - elevation
  - slope
  - direction to the sun
- soil genesis rate varies with the factors mentioned above,
- Mature soils are formed by a long term process and immature soils are formed by a short term process.
- The different climatic factors affecting soil genesis are,
  - rainfall
  - temperature
  - wind
  - humidity
  - light
- These climatic factors can be caused directly or indirectly.
- Reinfall and temperature are the most important factors among them.
- Plants and animals in the biosphere also influence soil genesis
- Soil profile is formed as a result of soil genesis.
- Soil profile is a longitudinal section from the soil surface to the parental rock
- A Soil profile consists with 5 horizons

- horizon O
- horizon A
- horizon B
- horizon C
- horizon R

- horizon O contains organic matter
- Minerals are leached from horizon A and it is called the elluvial zone.
- Minerals leached from horizon A is accumulated in horizon B; therefore, it is called the alluvial zone.
- horizon C is called the regolith and it consists of parental materials formed by rock weathering
- horizon R contains unconsolidated parent rock beneath the soil
- The soil profile is developed with time.
- It takes nearly 100, 000 years for a soil profile with 5 main horizon to form.
- The agricultural importance of studying a soil profile is as follows,
  - To identify the depth of soil useful for root growth.
  - To determine the tilling depth with the knowledge of the depth of soil zones.
  - To understand various minerals in the soil and nutrients released to the soil from these minerals.
  - To determine the crops suitable for soil depth.
  - To determine drainage condition.
  - To select suitable land preparation equipment

Competency 3.2 : **Decides on the soil constituents suitable for crop cultivation.**

Duration : **05 periods.**

Learning outcomes :

- **Explains the effect of soil constituents for cultivating crops.**
- **Finds the soil moisture percentage.**
- **Explains the methods of improving soil productivity by changing the effects of soil constituents.**
- **Finds the field capacity of soil.**
- **Describes the arrangement of constituents in the soil.**

Teaching-learning process

Engagement :

- **Let students observe a soil sample.**
- **Lead a discussion to highlight the following.**

  That,
  - **soil consist of different constituents.**
  - **soil solids, soil air , soil water and soil organisms are the constituents mentioned above.**
  - **management of soil constituents is important for effective crop cultivation.**

Proposed suggestions for learning :

- **Each group should pay attention to one of the following topics given to your group,**
  - **Soil solids**
  - **Soil water**
  - **Soil air and soil organisms**
- **Collect information about your topic on the following themes.**
  - **Arrangement of soil constituents in the soil**
  - **Importance of soil constituents for crop cultivation**
  - **Management practices of soil constituents to improve crop cultivation**
- **Test the soil sample given in your work station.**
- **Test one of the following, using your soil sample.**
  - **soil moisture content using gravimetric method**
  - **field capacity of soil**
  - **permanent wilting point**

- Be prepared to present your findings creatively, to the entire class

Instruction for the preparation of work stations

- Prepare 3 work stations with the equipment and materials given on the following themes.
  - To determine the soil moisture content (gravimetric method)
  - To determine the field capacity of soil
  - To determine the permanent wilting point

Common inputs for all work stations

- Soil samples
- Oven
- Weighing balances (accuracy up to two decimal points)

Special inputs for work station 1

- Soil augers
- Evaporation dishes

Special input for work station 2

- Soil auger
- Metal can without the base
- Beaker
- Polythene paper
- A rubber band

Special input for work station 3

- Beaker
- Bell jar
- Black coloured paper
- Sunflower seeds
- Materials and equipment necessary to plant seeds

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.
  That,
  - Soil consists of different constituents.
    - Soil solids
    - Soil organisms

- Soil water
- Soil air

- Soil minerals are formed by rock weathering
- Different soil minerals are,
  - Sand
  - Clay
  - Silt
- Clay minerals can be classified into two as,
  - Silicate minerals
  - Non-silicate minerals
- Characteristic features of soil minerals are,
  - Adsorption of anions and cations
  - Adsorption of pesticides
  - Act as a source of plant nutrients
- Soil organic matter which is formed as a result of microbial activities, is a mixture of different materials
- Types of organic matter
  - Un-decomposed organic matter
  - Decomposing organic matter
  - Decomposed organic matter
- Soil organic matter is important for plant growth,
  viz,
  - to improve physical, chemical and biological characteristics of soil
  - act as a plant nutrient pool
- Crop growth can be improved by adding organic matter to the soil
- Soil air is available inside soil pores
- Following are the factors that affect the composition of soil air ,
  - Nature of soil
  - Crops in the field
- Proper soil preparation improves soil air and soil water
- Soil water is available inside soil pores
- There is an inverse relationship between soil water and soil air
- Soil water is important as a,
  - solvent for plant nutrient
  - medium for the translocation of plant nutrients
- pF value is an important parameter that shows the power of adhesion between soil particles and water molecules.
- Soil water can be classified as,

- Physical classification
- Biological classification

- Different methods that can be used to determine soil water content are:
  - Gravimetric method
  - Gypsum block method
  - Tensiometer method
- Methods of transporting water to the soil are,
  - Infiltration
  - Percolation

- Methods of removal water from soil are,
  - deep percolation
  - evapo-transpiration
  - drainage
- various types of soil organisms are,
  - photosynthetic microbes
  - saprophytes
  - pathogens
  - parasites
  - root eaters
- beneficial microbes for crop cultivation are,
  - photosynthetic microbes
  - saprophytes
- harmful microorganisms to crop cultivation are,
  - parasites
  - root eaters
- necessary conditions should be provided to increase the population of beneficial microbes

Competency 3.3 : **Decides on the soil texture and consistency suitable for crop cultivation.**

Duration : **04 periods.**

Learning outcomes :

- **Describes soil texture.**
- **Explains the importance of soil texture.**
- **Prepares plans for agricultural activities according to suitability of soil.**
- **Finds soil texture using various methods.**
- **Explains soil consistency.**

Teaching-learning process

Engagement :

- **Provide different types of soil samples to students.**
- **Let them observe the soil samples.**
- **Allow students to tabulate the characteristics observed**
- **Test the soil sample using "Texture by Feel method"**
- **Explain your observations.**
- **Ask students to write soil characteristics at wet and dry conditions.**
- **Lead a discussion to highlight the following points.**

  That,

  - **Some soil characteristics can be identified by visual observation.**
  - **Characteristics which can identified by the observation are physical characteristics**
  - **"Texture by Feel method" of soil testing is suitable to get a rough estimation of soil texture**
  - **Characteristics of soil are vary with the dry and wet conditions of soil.**

Proposed suggestions for learning :

- **Each group should test one of the following soil samples.**
  - **A soil sample obtained from the school field**
  - **A soil sample obtained from a paddy field**
- **Observe the soil sample.**
- **Find the texture of soil using "Texture by Feel method" and write your findings.**
- **Write the characteristic features of soils at wet and dry conditions.**

- Analyze your soil sample.
  - Find the soil texture using the pipette method or hydrometer method.
  - Determine the textural class of the soil using "Textural Triangle" according to the percentages of soil minerals.
  - Determine the soil texture using "Rolling method".
  - Compare the values obtained through these two methods.
- Explain the importance of soil texture in agriculture.
- Test hardness, stickiness and elasticity of the soil sample.
- Write the effect of the above characteristics on crop cultivation.
- Be prepared to present your findings creatively, to the entire class

Instruction for the preparation of work stations

- Prepare 2 work stations to find the soil texture using the following methods.
  - Pipette method or hydrometer method
  - Rolling method

Quality inputs necessary for work stations

- Hydrogen peroxide
- Sodium hydroxide or 10% ammonium hydroxide
- Sodium hexa-meta phosphate (5% Calgon solution)
- Electric stirrer, beaker and a glass rod
- Distilled water
- Wash bottle
- Stop watch
- 25 ml pipette
- Piece of polythene and a rubber band
- Crucible
- Balance
- Oven
- Hydrometer
- Measuring cylinder (100 ml)
- Water bath
- Three air dried soil samples (sandy soil, clay soil and loam soil)
- Water
- Set of sieves

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **Soil texture is the relative percentage of soil minerals; clay, silt and sand.**
  - **Soils can be categorized as sandy soil, clay soil and loam soil on the basis of relative percentages of soil minerals.**
  - **Soil minerals can be classified as sand, silt and clay particles according to the diameter of particles.**
  - **Different methods to determine soil texture are,**
    - **Pipette method**
    - **Hydrometer method**
    - **Rolling method**
  - **Soil textural class can be determined using the textural triangle according to the percentages of soil minerals (sand, silt and clay).**
  - **Soil textural classes obtained from different methods can be compared.**
  - **Soil texture is important for agricultural activities.**
  - **Soil consistency is a character which can be explained in different aspects.**
  - **Soil consistency can be explained by observing the following characteristics of soils, in dry and wet conditions**
    - **Hardness of soil**
    - **Compactness**
    - **Elasticity**
    - **Stickiness**
  - **Soil consistency is important in agriculture**

Competency 3.4 : **Decides on soil structure and colour suitable for crop cultivation.**

Duration : **04 periods.**

Learning outcome :

- **Explains the importance of soil structure for crop cultivation.**
- **Explains the importance of soil colour for crop cultivation.**
- **Describes the importance of proper soil colour and structure for successful crop growth.**
- **Decides on soil structural patterns by soil testing.**
- **Determines soil colour .**

Teaching-learning process

Engagement :

- **Display pictures of different soil profiles with different soil colours and soil manse l colour charts to students.**
- **Discuss about locations with different soil colours.**
- **Provide several soil samples and ask students to check their hardness.**
- **Lead a discussion to highlight the following.**

  That,
  - **soil structure and colour are physical characteristics of soil.**
  - **soil colour indicates it's properties.**

    eg.
    - **drainage**
    - **aeration**
    - **organic matter**
  - **soil structure is the arrangement of primary soil particles into aggregates or secondary soil particles.**
  - **soil structure could be described by,**
    - **Type (shape)**
    - **Class (size)**
    - **Grade**

Proposed suggestions for learning :

- **Each group should explore one of the following topics given to your group.**
  - **soil colour**
  - **soil structure**

- Observe and find out the physical characteristics of the soil sample given to your group.
- Explain the effect of the above soil characteristics, for crop cultivation.
- Explain strategies to improve crop productivity by developing the particular character .
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - soil colour is the colour which can be observed to the naked eye
  - soil colour is determined by the,
    - parental material used to form the soil
    - factors that contributed to the development of the soil profile
  - chemical constituents can influence the formation of different soil colours,
    - lime and soil minerals give a white colour to the soil
    - anhydrous Iron oxide gives a red colour to the soil
    - hydrated Iron oxide gives an yellow colour to the soil
  - two factors can influence the formation of black coloured soils,
    - soil organic matter
    - poor drainage conditions
  - Munsell colour chart is used to find out the soil colour
    - soil colour is arranged based on factors such as:-
      - hue
      - value
      - chroma
  - There are 4 main colours in the spectrum of light
    - red
    - yellow
    - blue
    - green
  - Combinations of these colours also make different colours
  - This is known as Hue
  - The above mentioned main colours are arranged according to relative darkness and relative whiteness
  - This is known as chroma
  - This is further arranged according to the purity of the colour
  - This is known as value

- secondary soil particles are formed by the aggregation of primary soil particles with binding materials.
  - There are different types of binding materials such as,
    - organic matter
    - Iron oxide
    - carbonate
    - clay
    - silica
- soils on the surface layers of the soil profile comprise the granular structures while deeper layers contain conical structures.
- Soil may have a structure or not.
- particles are dispersed in soils without a structure
- Soil particles bind together to form soil structures
- soils can be divided into sub orders according to the power of bondage, such as:
  - poor structured soils
  - medium structured soils
  - hard structured soils
- soil aggregates are formed as a result of the combination of adhesive materials and swelling & shrinking property of soils
- soil aggregates are made by the formation of cracks due to the shrinking and swelling of soils in drying and hydration.
- soil structural types are,
  - Granular
  - Sub-angular
  - Blocky
  - Columnar
  - Prismatic
  - Platy
- soil structure is mainly destroyed by Na^+.
- soil structure can be determined through soil testing.
- the importance of soil structure in crop cultivation are,
  - to adopt precautionary measures to minimize soil erosion
  - to provide awareness regarding soil fertility
  - to understand soil moisture levels and soil aeration
  - to understand activity of plant roots

Competency level 3.5 : Decides on the soil density and porosity suitable for crop cultivation.

Duration : 04 periods.

Learning outcomes :

- Defines soil density and soil porosity.
- Describes factors affecting soil density.
- Describes factors affecting soil porosity.
- Explains the importance of soil density and porosity on crop growth.
- Conduct laboratory tests to determine true density and bulk density accurately.

Teaching-learning process

Engagement :

- Take a piece of stone and a dry soil aggregate of similar size. Drop them into 2 beakers with equal amounts of water. Let students observe the bubbling of water in the beaker containing dry soil.
- Lead a discussion to highlight the following points.
  That,
  - air bubbles are released due to the replacement of air in soil pores with water.
  - soil porosity is important in crop cultivation.
  - soil porosity can be calculated using soil bulk density and true density.

Proposed instructions for learning :

- Each group will be given one of the following topics.
  - soil bulk density
  - soil true density
- Briefly explain the topic given to your group.
- Discuss about the effect of the particular soil characteristic on crop cultivation.
- Go to the work station & test the physical characteristic given to your group.
- Write your observations and findings.
- What do you understand by the term soil porosity? Explain soil porosity using soil bulk density and true density.
- Explain the factors affecting soil porosity and their effects on crop growth.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of work stations:

- Prepare 2 work stations using equipment and materials given below.

Special inputs for work station 1

- 10 cm Galvanized tube (Sharpen end which is inserted to the soil, using a pile)
- Knife
- Evaporating dish
- Balance
- Oven
- Piece of wood

Special inputs for work station 1

- Specific gravity bottle
- Motor and pestle
- 0.25 mm sieve
- Chemical balance

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.
  That,
  - soil density is the mass of unit soil volume.
  - types of soil density are true density and bulk density .
  - bulk density is the proportion between mass of soil solid and volume of soil solid.
  - Usually soil true density is higher than the soil bulk density .
  - soil true density is a definite value.
  - true density is determined by the quantity and type of particles
  - soil bulk density varies with the place
  - units of soil density is g/cm^3.
  - soil bulk density could be determined using the core sampler method.
  - soil true density could be determined using the specific gravity bottle method.
  - soil bulk density is determined by the soil structure, moisture content and amount of soil pores.
  - soil porosity is the quantity of pores in a soil.
  - there are 2 types of soil pores as macro and micro pores.
  - soil porosity is determined by soil composition, amount of organic matter and depth of soil.
  - soil porosity affects crop growth.
  - soil porosity affects on existence of soil organisms.
  - soil density changes with the soil porosity .

Competency level 3.6 : **Decides on the chemical properties of the soil suitable for crop cultivation**

Duration : **04 periods**

Learning outcomes :

- **Names the effects of chemical properties on crop cultivation.**
- **Describes the effects of chemical characteristics on crop cultivation.**
- **Explains that the above factors vary with the place and that cultivable crops vary accordingly.**
- **Tests pH values of given soil samples.**
- **Describes the characteristic features of soil colloids.**

Teaching-learning process

Engagement :

- **Prepare 2 soil solutions using highly acidic and highly basic soils separately.**
- **Show colour changes of the soil solutions using red and blue litmus papers.**
- **Lead a discussion on the relationship between colour change and pH value**
- **Highlight the following points,**

  That,
  - **pH value can vary with the soil**
  - **soil acidity and alkalinity can be determined by the pH value**
  - **acidity and alkalinity are chemical properties**
  - **iron exchange, base saturation and electrical conductivity are also chemical properties of soils**

Proposed instructions for learning :

- **Review the resource book.**
- **Pay attention to one of the following methods to find the pH value.**
  - **Use of the pH papers**
  - **Colorimetric method (BDH method)**
  - **Use of pH meter**
- **Go to the work station and determine the pH value**
- **Describe the soil reaction of the soil sample according to the pH value.**
- **Discuss the effect of the pH value on crop cultivation.**
- **Collect information about other chemical properties using the resource book.**
- **Write this information on the following themes.**
  - **definition**
  - **importance**
  - **method of testing (measurement)**

- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of work stations:

- Prepare 3 work stations to test the soil pH value using equipment and materials.
  - Determine the pH value using pH papers
  - Determine the pH value using colorimetric method (BDH method)
  - Determine the pH value using pH meters

Special inputs for work station 1

- A soil sample
- pH papers
- Test tubes
- Distilled water
- Chemical balance
- Glass rod

Special inputs for work station 2

- A soil sample
- BDH indicator
- BDH colour chart
- BDH tube
- Distilled water

Special inputs for work station 3

- A soil sample
- pH meter
- Distilled water
- A beaker
- A glass rod
- A chemical balance

Instructions for the explanation of subject matter:

- Lead a discussion to highlight the following.

  That,
  - soil chemical properties form due to charged ions
  - charged ions are retained on the surface of the colloidal complex
  - clay particles and humus particles act as soil colloidal particles
  - colloidal particles are charged negatively
  - isomorphic substitution of clay particles and ionization of humus particles cause to negative charges to form

- soil reaction is a chemical property
- soil reaction can be explained by the pH value
- pH is defined as the inverse of the logarithm of concentration of active hydrogen ions in the soil solution
- acidic, alkaline and neutral conditions of soils can be determined by the pH value
- the following methods can be used to determine soil pH,
  - Determination of the pH value using pH papers
  - Determination of the pH value using colorimetric method (BDH method)
  - Determination of the pH value using pH meters
- soil pH is important for crop cultivation
- soil acidity is formed due to adsorption of hydrogen ions (H^+) on soil colloidal particles
- various reactions affect the above reaction
- soil alkalinity is formed due to the accumulation of soil basic ions
- alkalinity of soils form when the exchangeable sodium ion (Na^+) in the colloidal complex is higher than 15%
- pH value in alkaline soils is greater than 8.5 and electrical conductivity is greater than 4 desi seman per meter .
- soil salinity is formed due to high concentrations of soil minerals.
- the properties of saline soils are,
  - sodium ions are not adsorbed to the soil colloidal complex
  - pH value is between 8.5 and 7
  - electrical conductivity is greater than 4 desi seman per meter
  - exchangeable Na+ percentage is less than 15%.
- saline and alkaline soils are formed due to various reasons.
- Ion Exchange is the exchange of ions in the soil solution with ions adsorbed to the colloidal complex
- exchange of cations in this process is named "Cation Exchange" and exchange of anions is named "Anion Exchange".
- cation exchange is important in crop cultivation.
- the amount of exchangeable cations in a unit weight of dry soil is referred as the "Cation Exchange Capacity".
- the percentage of basic cations compared of total cations in the cation complex is referred as "Base Saturation".
- base saturation is a high value in soils which have a pH value of 7 or over .
- ions in the soils form electrical conductivity .
- electrical conductivity is used to determine the salinity and alkalinity of soils.
- electrical conductivity meter is used to measure electrical conductivity .

Competency level 3.7 : **Selects suitable crops for different soil groups**

Duration : **04 periods.**

Learning outcomes :

- Names soil groups in Sri Lanka.
- Describes the major soil groups.
- Explains the agricultural potentials of various soil groups.
- Selects suitable crops according to physical, chemical and biological properties of soil groups.
- Identifies soil groups of the area.

Teaching-learning process

Engagement :

- Provide a map of Sri Lanka which shows the distribution of soil groups.
- Let students study about the distribution of the soil groups in Sri Lanka using the map.
- Allow students to identify the soil group of the area.
- Lead a discussion to highlight the following.

  That,
  - there is a diversity of soils of Sri Lanka.
  - soils have been classified to make it easy for identification.
  - Sri Lankan soils have been categorized into 14 different groups.

Proposed instructions for learning :

- Your group should explore one of the topics given below.
  - Reddish brown earth, red yellow latesol
  - Non Calcified Brown earth, reddish brown latesol
  - Red yellow podsolic, alluvial soil
- Collect information about your topic on following themes.
  - name of the soil group
  - distribution of soil group
  - physical and chemical characteristics of the soil
  - agricultural potential of the soil
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following points.**

  That,

  - **the following are the major soil groups in Sri Lanka**
    - **reddish brown earths**
    - **red yellow podzolic soils**
    - **non-calcic brown soils**
    - **latesols**
    - **alluvial soils**
  - **reddish brown earth is distributed in a large extent of the country and it is the main soil group in the dry zone**
  - **the main soil group in the low country wet zone is red yellow podzolic soil.**
  - **the shape and physical, chemical properties are used in classifying soil groups.**
  - **alluvial soils can be used to cultivate paddy and other aquatic plants.**
  - **physical and chemical properties are different in top soils and sub soils**

Competency level 3.8 : Inquires into the reasons for soil degradation and decides on crops suitable for cultivation.

Duration : 05 periods.

Learning outcomes :

- Describes soil degradation.
- Explains the effects of human activities in accelerating soil degradation.
- Calculates the quantity of soil erosion.
- Prepares plans to use land effectively taking future generations into consideration.
- Explains the factors affecting soil degradation.

Teaching-learning process

Engagement :

- Present the following newspaper headlines to the class.

> **Newspaper headlines**
>
> - Food and Agriculture Organization says 5-7 million cultivable land of the world lost due to soil erosion, annually.
> - Iron pyrite layer of the Nilwala river base was exposed by the widening of river and resulted in the formation of acidic soils in that area. It results in making paddy land uncultivable due to Iron toxicity.
> - It is necessary to spend hundred million rupees for fertilizer to supply soil nutrients which was eroded to the sea from South African rivers.
> - Poverty and low food security are the long-term adverse effects of soil degradation.

- Lead a discussion to highlight the following:

  That,

  - Soil degradation is the loss of soil productivity due to improper agricultural practices or soil erosion due to various human activities and loss of soil physical, chemical, biological properties suitable for crop production.
  - soil erosion or loss of soil properties leads to soil degradation.
  - soil degradation causes reduction of crop productivity.

Proposed instructions for learning :

- Pay attention on one of the following topics given to your group related to soil degradation.
  - soil erosion
  - loss of soil properties
- Collect information on your topic based on following themes.
  - Reasons for loss of soil productivity
  - ways of reducing soil productivity
  - soil degradation process
  - factors that affect the above process
- Go to the work station and calculate the quantity of soil erosion
- Be prepared to present your findings creatively, to the entire class.

Instructions for preparation of work stations:

- Prepare 2 work stations as follows, in a location where soil erosion takes place.
  - location 1
  - location 11
- Provide following inputs for each work station.

Common inputs for all work stations

- 1 m length - straight wooden sticks
- Meter ruler
- Marker pens
- Craw bars

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following:

  That,
  - Reasons for soil degradation are,
    - soil erosion
    - loss of soil properties
  - soil erosion is the removal of soil particles from the earth and deposition in another place
  - there are different agents cousing soil erosion as,
    - water
    - wind
  - the first step in soil erosion is the detachment of soil particles from the earth
  - there are different factors that affect the above process. They are
    - rainfall
    - runoff

- the second step in soil erosion is transportation of soil aggregates.
- factors affecting the above process are,
  - speed of water flow
  - climatic factors
- the third step in soil erosion is the deposition of soil particles.
- types of soil erosion are,
  - splash erosion
  - sheet erosion
  - gully erosion
  - rill erosion
- the following are the adverse effects of soil erosion,
  - loss of soil fertility
  - loss of soil physical, chemical and biological properties
  - reduction of the depth of the top soil layer
- different methods are used to determine soil erosion.
- Quantity of soil erosion can be calculated practically.
- Loss of soil characteristics also leads to soil degradation.
- Reasons for soil degradation are,
  - improper land use
  - use of improper cropping systems and cropping patterns
  - improper water management
  - improper usage of agro chemicals and organic fertilizers
- cultivation of crops against the standard land use causes soil degradation
- improper cropping patterns like mono cropping and improper farming systems like chena cultivation causes soil degradation.
- Poor drainage conditions results from improper water management, incidence of salinity are also reasons for soil degradation.
- Over use of agro chemicals leads to the reduction of soil biological properties due to adverse effects of chemicals on soil organisms
- Accumulation of toxic compounds in agro chemicals is also a reason for soil degradation.
- Decomposing organic matter is also a reason for soil degradation

Competency level 3.9 : Inquires into the adverse effects of soil degradation and makes suggestions to improve the soil.

Duration : 05 periods.

Learning outcomes :

- Explains methods for soil development.
- Describes the adverse effects of soil degradation on crop cultivation.
- Describes about soil erosion as the main factor in soil degradation.
- Suggests appropriate soil conservation methods.
- Explains adverse effects of soil degradation.

Teaching-learning process

Engagement :

- Display a picture of a patch of land, which shows soil degradation.
- Lead a discussion to highlight the following.

  That,
  - Adverse effects of soil degradation
  - The following are the results of soil degradation,
    - compaction of soil
    - flooding of soil
    - loss of plant nutrients
    - formation of salinity
    - formation of alkalinity
    - nutrient toxicity
  - soil development is adopted to minimize adverse effects of soil degradation on crop cultivation.

Proposed instructions for learning :

- Pay attention to the topic given to your group about soil development.
  - Effects of soil degradation and soil rehabilitation methods
  - Soil conservation methods
- What do you understand by soil development?
- Review the materials given and explain your topic.
- Describe the importance of the theme given to your group, for crop cultivation.
- Explain the use of methods mentioned in your topic, for soil development.
- Prepare a poster on "Let's develop soil to improve the yield", in relation to your topic.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following:**

  That,

  - **soil compaction is a result of soil degradation**
  - **there are various reasons for soil compaction**
  - **it causes adverse effects**
  - **reasons for loss of soil properties are,**
    - **flooding**
    - **reduction of soil nutrients due to loss of organic matter**
    - **formation of salinity**
    - **increase of soil acidity**
    - **increase of soil alkalinity**
    - **nutrient toxicity**
  - **Soil conservation methods could be adapted to develop soil**
  - **soil conservation methods are,**
    - **mechanical methods**
    - **agricultural methods**
    - **biological methods**
    - **these methods can be adapted to minimize soil erosion**
    - **the main purpose of mechanical soil conservation is to reduce the speed of run off water**
    - **there are various mechanical soil conservation methods as,**
      - **Digging drains along contours**
      - **preparation of soil furrows**
      - **contour cultivation in uplands**
      - **construction of stone terraces**
    - **Two types of drains are,**
      - **contour drains**
      - **Lock and spill drains**
    - **Speed of run off water can be reduced by preparation of furrows using soil**
    - **Various methods of cultivation in terraces**
      - **Plain terraces**
      - **Slopy terraces**
      - **Lengthy terraces**
      - **Simple terraces**
    - **Advantages of contour cultivation are,**
      - **Increase of infiltration rate by stagnation of water in contours**

- Low cost
- advantages of stone terraces
  - retention of soil particles in the run off water
  - suitable for stony land
- factors which should be considered in the construction of stone terraces
  - leveling surface of the stone terrace
  - base of the stone terrace should be constructed using stones with similar sizes
- agricultural methods of soil conservation are,
  - cultivation of crops scientifically
  - selection of appropriate plantations for lands
  - minimize damage in soil preparation
  - use of proper spacing to cover land in crop establishment
  - use of suitable irrigation methods to minimize soil erosion
  - addition of organic matter to the soil
  - improvement of tolerance of plants against erosion by enhancing crop growth by applying fertilizer properly
  - avoiding eradication of weeds
  - use of mixed cropping to avoid over exposure of land

- the following methods can be adopted to develop soils through soil rehabilitation,
  - adjustment of pH
  - use of proper treatment to adjust salinity
  - adoption of appropriate agricultural practices
- taking necessary action to correct levels of acidity and alkalinity in the adjustment of pH.
- the following are the treatment procedures suitable for acidic soils to ensure pH levels,
  - addition of materials containing Calcium
  - avoid frequent application of fertilizers which lead to increase of acidity of soil
- the following procedures can be adopted to adjust the salinity in saline soils,
  - improve soil drainage conditions
  - wash off soils using water
- proper agricultural practices should be followed for the rehabilitation of soil such as,
  - application of correct amounts of recommended fertilizer at correct stages
  - mixed cropping

Competency 4 : Plans to utilize environment friendly usage of fertilizer to obtain potential yield of crops.

Competency level 4.1 : Identify and classify nutrient elements required for plant growth. .

Duration : 03 periods

Learning outcomes :

- Explains the necessity of nutritional elements for plant growth.
- Classifies plant nutrients with examples.
- Explains the importance of various plant nutrients.
- Describes beneficial elements.
- Describes mobile and immobile elements.

Teaching-learning process

Engagement :

- Assign two students to read the following dialogue to the entire class.

Dialogue

Sameera : The flower bed in front of the Buddhist shrine has grown up well. Plants are healthy and green. But the plants in front of our class look weak. Plants are small and the leaves have turned yellow, too.

Upul : It's a gravel soil. Lacks fertilizer, also. Let's mix some compost, then the plants will grow well.

Sameera : Please tell me truly, what are the things in the compost fertilizer?

Upul : It has lots of elements needed for plants. These elements are essential for the plant growth. Hence, we call them "Essential elements"

Sameera : Why do we call them essential elements?

Upul : We call them essential, because plants are unable to grow without these elements. If even one of these essential elements is missing then, plants will not grow. Some of these elements are needed in larger quantities than the others. They are the macronutrients. Others are needed in very small quantities. They are the micronutrients. However, these essential elements are essential for plant growth.

- Lead a discussion considering the dialogue above to highlight the following:

  That,

  - Elements are needed for plant growth
  - Elements that are needed for plant growth are called essential elements
  - Essential elements can be categorized into two groups as,
    - macro-nutrients
    - micro-nutrients

Proposed suggestions for learning :

- Each group should study one of the following topics given to your group.
  - Group 1 : essential elements in plant nutrition
  - Group 11 : important beneficial elements in plant nutrition
  - Group 111 : mobile and immobile elements in plant nutrition
- Collect information using the materials given.
  - classify plant nutrients in relation to your topic
  - identify the basics of the above classification
  - find examples of each groups
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following facts.

  That,

  - there are 3 reasons to call an element an essential element,
    - Element is essential for plant growth and to complete the life cycle
    - Essential elements cannot be replaced by another element
    - Essential elements directly contribute to the metabolic activities of plants
  - There are 16 essential elements
  - Essential elements are categorized into 2 groups
    - macro-elements
    - micro-elements (Trace elements)
  - Elements that are required for plant growth in large quantities are called as macro elements and elements required for plant growth in small quantities are named micro elements
  - There are 9 macro elements (C, O, H, N, K, Ca, Mg, P, S) and 7 micro elements (Cl, Fe, Mn, B, Zn, Cu, Mo)

- Elements that are not essential for plant growth but, sometimes necessary for the healthy growth of plants are called non-essential elements (Na, V, Ga, Si, Al, F, Ni, Co)
- Elements that are needed for special activities of some plants are called as beneficial elements

  eg.
  - Co - for nitrogen fixation in leguminous plants
  - Si - to improve degree of rigidness in poacea plants (graminae plants)
  - Na - for osmosis and balance of anions-cations in plants
- These nutrients are further divided into 2 main groups as follows, according to the incidence of deficiency symptoms in plants,
  - mobile nutrients
  - immobile nutrients
- elements that transport from older tissues to new tissues through the phloem are mobile elements (C, O, H, N, K, Cl, Mg, P, S) and elements that are not transported as mentioned are immobile elements (Ca, Fe, Mn, B, Zn, Cu, Mo)

Competency level 4.2 : **Selects essential elements required to increase crop yield.**

Duration : **04 periods.**

Learning outcomes :

- **Designs necessary methods to overcome nutritional deficiencies of plants.**
- **Takes necessary actions to prevent nutritional deficiencies in plants.**
- **Describes efficient methods of fertilizer application.**
- **Describes the functions of elements in plants.**
- **Explains methods of absorption of elements in plants.**

Teaching-learning process

Engagement :

- **Display pictures of plants with deficiency symptom, healthy plant parts and plants/ parts with deficiency symptoms to the class.**
- **Lead a discussion to highlight the following points.**
  That,
  - **Deficiency symptoms of plants are indicated by the changes in plant growth and colour changes**
  - **Reasons for various deficiency symptoms are due to the lack of various nutrients**
  - **nutritional deficiencies can be prevented by the application of necessary nutrients**
  - **This is important to increase yield**
  - **Hence, knowledge of deficiency symptoms of each nutrient is important**

Proposed suggestions for learning :

- **Each group should study one of the following topics given to your group**
  - **macro-elements**
  - **micro-elements (Trace elements)**
- **Collect information about methods of absorption of each element in plants in relation to your group.**
- **Describe the functions of each element in plants.**
- **Write deficiency symptoms, toxicity symptoms and preventive measures for these nutrients.**
- **What characteristic deficiency symptoms are evident in mobile and immobile elements?**

- Describe the relationship between plant growth and nutrients applied to the soil.
- Identify the deficiency symptoms of the samples given.
- Describe the importance of "Liebig's law of the minimum" in plant fertilizer application.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - various nutrients are essential to complete the life cycle of a plant and these nutrients contributed to yield
  - method of absorption is different in each nutrient
  - each nutrient is necessary for specific activity
  - these activities are affected, if any nutrient is not sufficiently provided
  - changes of plants can be observed by the naked eye

    eg.

    - Changes in leaf colour , shape and size
    - Reduced growth rate, stunting
  - The above changes are referred to as deficiency symptoms
  - Knowledge of deficiency symptoms of each nutrient is essential to identify the nutrient deficiency in the plant
  - Places of deficiency symptoms vary with the nutrient

    eg. Deficiency symptoms of mobile elements can be observed in mature leaves
  - Low levels of nutrients result in low yields.
  - Abnormal characteristics such as toxicity in plants occurs due to improper application of nutrients
  - Yield is reduced due to these toxicities.
  - Deficiencies can be prevented by the application of appropriate nutrients
  - Improvements in crop yield is determined by the nutrient available in minimum quantities and it can explained by "Liebig's law of the minimum"

Competency level 4.3 : Decides on availability of soil nutrients in terms of soil characteristics.

Duration : 04 periods.

Learning outcomes :

- Names conditions of soil required for nutrient availability.
- Designs strategies necessary to improve nutrient availability.
- Describes methods to correct soil conditions which affect nutrient absorption.
- Explains means of maintaining soil conditions for proper nutrient absorption.
- Names factors that affect nutrient availability.

Teaching-learning process

Engagement :

- Use a suitable/creative method of engagement related to absorption of nutrients.
- Lead a discussion to highlight the following.

  That,
  - nutrient absorption of plants can be varied according to soil properties
  - the following soil properties are important for nutrient absorption,
    - soil pH value
    - soil texture
    - soil colloids
    - soil moisture
    - soil aeration

Proposed suggestions for learning :

- Each group should study one of the following topics given to your group.
  - soil pH value
  - soil colloids and texture
  - soil moisture and aeration
- Collect information about the effect of a particular soil property on nutrient availability.
- Explain how a particular soil property is maintained for effective nutrient absorption.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - Though, essential elements are available freely in soil, plants cannot always absorb it as it is.
  - Nutrients should be available in a form that can be absorbed by the plant
  - presence of nutrients in an available forms for plant is called nutrient availability
  - various soil properties affects plant nutrient availability
  - Soil pH value is important for nutrient absorption
  - The following factors are important for this,
    - availability of macro-nutrients is higher and micro-nutrients are available of a satisfactory levels in neutral pH conditions
    - nutrients may be toxic when pH is less than 5.5
    - some elements are abundant (Aluminum, Iron, Manganese) in high acidic conditions (<4 pH) and this leads to toxicity
    - Availability of nutrients high in pH 6.5 to 7.5
    - Some nutrients can be limited with high pH or high basic conditions.
      e.g. Nitrogen, Iron
    - It is possible to overcome nutrient deficiencies by adjusting pH.
  - factors other than pH also affect nutrient availability
  - soil colloids play an important role in nutrient retention
  - organic colloids as well as clay particles are important for water retention and adsorption of nutrients in the soil.
  - Nutrient availability varies with soil moisture
  - Nutrient availability is affected by physical properties of soil such as soil texture and structure
  - Nutrient availability is affected by soil aeration

Competency level 4.4 : Inquires into direct inorganic fertilizers and their usage and determines the quantity of their nutrients.

Duration : 05 periods.

Learning outcome :

- Describes the necessity of direct fertilizer application to provide essential nutrients in crop cultivation.
- Explains the need of applying direct fertilizers for nutrient deficiencies in plants.
- Names fertilizers that provide various nutrients.
- Identifies fertilizer by physical characteristics.

Teaching-learning process

Engagement :

- Provide samples of direct fertilizers and mixed fertilizers to the students.
- Allow students to select direct fertilizers using their knowledge.
- Lead a discussion to highlight the following.

  That,
  - it is necessary to supply nutrients which are removed from the soil
  - application of (chemical) fertilizers is the most popular method of supplying nutrients
  - (Chemical) fertilizers can be divided into 2 groups as,
    - direct fertilizers
    - mixed fertilizers
  - direct fertilizers contain only one plant nutrient and mixed fertilizers contain more than one plant nutrients

Proposed suggestions for learning :

- Each group should pay attention to one of the following topics given to your group.
  - Nitrogen containing (chemical) fertilizers
  - Phosphorus containing (chemical) fertilizers
  - Potassium containing (chemical) fertilizers
- Review the resource book.
- Name fertilizers that provide the nutrient given to your group.
- Write the percentages of nutrients in each fertilizer .
- Explain the changes of soil conditions that can happen when fertilizers are applied to the soil.

- Explain the storage ability of fertilizers.
- Go to the work station and engage in the activities given.
- Test the following physical properties using given fertilizer samples,
  - Colour
  - Physical nature (particles/granules)
  - Hygroscopic nature
  - Solubility in water
- Explain the reasons for applying direct fertilizers and their advantages/disadvantages.
- Calculate the percentages of nutrients in a few direct fertilizers
- Discuss effects of improper fertilizer usage.
- Be prepared to present your findings creatively, to the entire class.

Instructions for preparation of work stations:

- Prepare 3 work stations as follows using given equipment and materials.
  - Nitrogen containing (chemical) fertilizers
  - Phosphorus containing (chemical) fertilizers
  - Potassium containing (chemical) fertilizers

Common inputs for all work stations

- Containers with water
- Beakers
- A glass rod

Special inputs for work station 1

- Urea
- sample of Ammonium sulphate
- sample of Sodium nitrate

Special inputs for work station 11

- sample of Super phosphate
- sample of concentrated Super phosphate
- sample of Ammonium phosphate
- sample of Rock phosphate

Special inputs for work station 111

- sample of Muriate of potash
- sample of Sulphate of potash

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **it is necessary to supply nutrients that are removed from the soil**
  - **application of (chemical) fertilizers is the most popular method of supplying nutrients**
  - **(Chemical) fertilizers can be divided into 2 groups as,**
    - **direct fertilizers**
    - **mixed fertilizers**
  - **direct fertilizers contain only one plant nutrient and mixed fertilizers contain more than one plant nutrients**
  - **The Department of Agriculture recommends direct fertilizers/unmixed fertilizers for each crop as a solution to problems in mixed fertilizer usage.**
  - **Nutrients identified as deficient nutrients in the soil testing can be given direct**
  - **The advantages of direct fertilizer applications are,**
    - **Low wastage due to application of fertilizers only for the requirements of the plant**
    - **Little risk of adulteration of fertilizers**
  - **There are problems in the application of direct fertilizers, but there are solutions for them,**

    eg. problem : Difficult to purchase small quantities of direct fertilizers

    solution : Able to purchase from Agrarian Service Centers
  - **There are several nitrogen containing fertilizers**
  - **Urea is a nitrogen containing fertilizer and the following are the properties of urea**
    - **contains 46% of nitrogen**
    - **shiny granular material**
    - **high solubility in water**
    - **biurate is a byproduct of urea production**
  - **percentage of biurate contained in urea fertilizer should be less than 1%**
  - **nitrogen in urea can be released as ammonia in high temperature conditions in tropical climates.**
  - **Therefore, urea should be mixed with soil to minimize loss.**
  - **urea is suitable to prepare fertilizer mixtures because of it's non hygroscopic nature and it is easy to store.**
  - **urea produces Ammonium carbonate with the combination of soil water after the application**

    CO(NH$_2$)$_2$ $+2H_2O \longrightarrow (NH_4)_2CO_3$

Ammonium carbonate

- **urea produces an alkaline condition instantly, after the application**
- **urea converts into NH_4^+** and is fixed in the soil, therefore it prevents leaching of NH_4^+
- **The following reaction is occurrs when applying urea under oxidized conditions,**

  $(NH_4)_2CO_3 + 3O_2 \longrightarrow 2HNO_3 + CO_2 + H_2O$

  Ammonium carbonate Nitric acid
- **soil can be acidic due to the formation of nitric acids under such conditions**
- **produced nitrates can be absorbed by plants**
- **Excess NO_3^-** is combine with Ca^{++} and washed off with water

  $Ca^{++} + 2NO_3^- \longrightarrow Ca(NO_3)_2$
- **Ammonium sulphate is also a direct fertilizer and following are the properties of Ammonium sulphate**
  - **It contains 20.6% nitrogen**
  - **Ammonium Sulphate is a crystalline salt**
  - **It is easily dissolved in water and is less hygroscopic**
  - **Hence it can be used to prepare fertilizer mixtures**
  - **It also supplies S to the soil**
  - **Toxicity can be developed due to the formation of H_2S** after S reduction

    $CO_4^{-2} \longrightarrow S^{-2} \longrightarrow H_2S$
  - Especially this reaction can especially be seen in soils with low Fe content.
- **Sodium Nitrate (Nitrate of Soda - $NaNO_3$)** is another Nitrogen containing fertilizer and the following are the properties of Sodium nitrate
  - contains 16% nitrogen
  - a white coloured salt.
  - a hygroscopic fertilizer
  - Hence, it is not suitable to prepare fertilizer mixtures
  - Basic conditions of the soil can be developed due to frequent application
  - Application of tractors is difficult after applying these fertilizer to clay soils
  - Soil structure can be destroyed due to the continuous application of Na^+ to these fertilizers
- **Calcium cyanamide is used as another fertilizer that provides nitrogen and the following are its properties**
  - **contains 35% nitrogen**
  - **suitable to prepare fertilizer mixtures as it is a non hygroscopic fertilizer**

- **It should be applied 8-10 days before establishing seeds in the soil because of the development of toxicity just after applying fertilizer and it needs 3 weeks to oxidize nitrate ions**
- **Basic conditions can be developed by the frequent application of this fertilizer because it contains Ca^{+2}**
- It acts as a weedicide with a high level of applications

- **Super phosphate is a phospherous containing chemical fertilizer and the following are the properties of Super phosphate**
  - **contains 16-22% P_2O_5**
  - a brownish ash coloured granules
- **Concentrated Super phosphate is also a phosphorus containing fertilizer and it contains 40-45% P_2O_5**
- **There are 2 types of Concentrated Super phosphates**
  - **Double Super Phosphate**
  - **Triple Super Phosphate**
- **These are ash coloured granules**
- **These fertilizers are suitable for short term crops**
- **Rock phosphate is another kind of phosphorus containing fertilizer and it contains 27-30% P_2O_5**
- **The composition of rock phosphate which is obtained from mines is varies according to location**
- **Ammonium Phosphate is a chemical fertilizer which provides both phosphorus and nitrogen**
- **Ammonium Phosphate that is available in the market contains 48% P_2O_5** and 20% Nitrogen
- **Soil reactions can be converted into acidic with the continuous application of this fertilizer**
- **Eppawala Apatite is a Phosphorus containing fertilizer that is mined from Sri Lanka**
- **Muriate of Potash is a chemical fertilizer that provides Potassium (K) and the following are the properties**
  - **contains 60% K_2O**
  - orange or white colour small crystals
  - hygroscopic fertilizer, therefore it should be stored in a dry place
- **Most farmers use this fertilizer to supply Potassium, but this is not recommended for crops such as tobacco, tomato as it contains Cl^-.**

- **Sulphate of Potash (K_2SO_4)** is a fertilizer that is used to supply Potassium and it contains 50% K_2O
- **It is recommended for crops as tobacco and tomato which show toxic conditions with the application of KCl.**
- **Potassium nitrate is also used as a fertilizer to provide Potassium and it contains 28% K_2O**
- **The usage of Potassium nitrate is low due to high prices**
- **Dolomite and Kieserite are used as fertilizers to provide Magnesium (Mg)**
- **Improper application of fertilizers create problems**

Competency level 4.5 : Exhibits readiness to prepare fertilizer mixtures using direct fertilizers

Duration : 04 periods.

Learning outcomes :

- Classifies fertilizer mixtures as complete fertilizer mixtures and incomplete fertilizer mixtures.
- Calculates the requirement of fertilizers in the preparation of mixtures.
- Finds suitable filling materials for fertilizer mixtures.
- Describes about the "Fertilizer Grade" of a fertilizer mixture.
- Explains the 'Nutrient Ratio" of a fertilizer mixture.

Teaching-learning process

Engagement :

- Provide samples of fertilizer mixtures, empty sacks and labels for students and lead a discussion for highlight the following.

  That,
  - Mix direct fertilizers to prepare fertilizer mixtures.
  - fertilizers should be mixed taking the supply of nutritional requirements to the crop into consideration

Proposed instructions for learning :

- Review the relevant section of the resource book.
  - Explain complete and incomplete fertilizers, comparatively .
  - Calculate the necessary amounts of fertilizers to prepare the fertilizer mixtures given to your group.

Group 1

- Explain the "Fertilizer Grade" of a fertilizer mixture.
- It is recommended that 250g of a fertilizer mixture with 11-10-25 fertilizer grade, is applied per plant in a papaya plantation, as a basal mixture. Calculate the amounts of Urea, TSP and MOP in kg to prepare a fertilizer mixture for 400 papaya plants? Calculate the weight of the filling material?
- What are the factors to be considered in the preparation of the above fertilizer mixture?

Group 2

- **Explains 'Nutrient Ratio' of a fertilizer mixture.**
- **A farmer needs to prepare 1000kg of fertilizer of a nutrient ratio of 2:4:13. Calculate the amounts of Urea (N-46%), Rock Phosphate (P_2O_5-27%)** and Muriate of Potash (K_2O-60%) needed to prepare the fertilizer mixture.
- **What are the factors to be considered in the preparation of the above fertilizer mixture?**

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following.**
  That,
  - **There are 2 types of fertilizer mixtures viz,**
    - Complete fertilizer mixtures
    - Incomplete fertilizer mixtures
  - **A complete fertilizer mixture contains all the three major elements; Nitrogen, Phosphorus and Potassium**
  - **An Incomplete fertilizer mixture contains only two major elements**
  - **A ratio of N, P_2O_5,** K_2O and the Fertilizer grade are required in the preparation of fertilizer mixtures
  - **"Fertilizer Grade" is the percentage of N, P_2O_5,** K_2O in the mixture according to the weight.
  - **A fertilizer mixture can be prepared according to nutritional requirement of the crop**
  - **Filling materials are added to maintain the constant weight of the fertilizer mixture**
  - **Inactive materials such as sand, powdered stones can be used as filling materials**
  - **There are advantages and disadvantages in the application of fertilizer mixtures**
  - **Suitable fertilizer types should be selected to prepare fertilizer mixtures**

Competency level 4.6 : **Prepares different types of organic manure**

Duration : **05 periods.**

Learning outcomes:

- Describes characteristics of various types of organic manures.
- Prepares compost fertilizer using waste material.
- Explains the importance of eco friendly usage of fertilizers in agriculture.
- Prepares liquid organic manures.
- Lists the raw materials used in the preparation of organic manures.

Teaching-learning process

Engagement :

- Produce samples of organic manures, animal and plant waste material for students.
- Ask students about the methods of applying these materials for successful crop cultivation.
- Lead a discussion to highlight the following.

  That,
  - Environment friendly organic manures can be prepared using plant and animal origin waste materials
  - Organic manure can be used to increase the productivity of crop cultivation

Proposed instructions for learning :

- Each group should study one of the topics given below.
  - Production of compost fertilizers
  - Production of liquid organic manures using animal or plant waste material
- List the ingredients necessary to prepare manure in relation to your topic
- Refer to the resources given to you and show the steps in the preparation of manure using a flow chart.
- Prepare the relevant organic manure using suitable raw material.
- List the other types of organic manure.
- Explain the trends in the use of these types of organic manure in agriculture.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **Organic manures are animal and plant waste materials that is used in planting crops to provide necessary nutrients, to be absorbed after digestion or decomposition.**
  - **There are some organic manures that to be used frequently.**
  - **Nutrient content can vary among various raw materials used to prepare organic manures**

    eg.

    - **nutrient value is low in paddy straw**
    - **N and K content is higher in animal faeces**
    - **Nutrient content is higher in legume plant parts**
    - **K is high in wood ash. It controls pH value**
  - **The nature of the raw materials and effects of environmental factors should be considered in the preparation of organic manure.**

    eg.

    - **C/N ratio of raw materials**
    - **Rainfall, temperature and intense sun light**
  - **the following factors should be considered in the preparation of compost pit/heap successfully**
    - **C/N ratio of raw materials**
    - **Effect of environmental factors**
    - **Selection of a preparation method suitable to the climatic zone**
  - **The main stages in compost preparation are as follows,**
    - **Selection, collection and chopping of raw materials**
    - **Preparation of inoculums**
    - **Packing of materials in pits/heaps**
    - **Covering**
    - **Examination and turning of compost pit/heap**
  - **the following are the advantages of the use of compost in agriculture,**
    - **Improves soil structure**
    - **Improves cation exchange capacity**
    - **A complete fertilizer which provides most of the essential nutrients needed for plants**
    - **prevents soil erosion**
    - **Improves moisture retention/absorption**

- Increases population of soil microbes
- Acts as a buffer to maintain the pH value

➢ Limitations in the use of organic manures are,

- Difficult to transport / supply raw materials
- Releases various toxic materials from plant parts
- Provides energy sources for pathogenic microbes
- Difficulty in crop establishment
- Need of large quantities
- Difficulties in preparation
- Need for large spaces for storage

Competency level 4.7 : Designes different methodologies of effective fertilizer usage

Duration : 05 periods.

Learning outcomes :

- Prepares plans necessary to maximize profits in the use of fertilizers efficiently.
- Suggests steps needed for efficient fertilizer use.
- Applies fertilizers minimizing losses.
- Describes methods of fertilizer application.
- Explains factors and reasons for fertilizer wastage.

Teaching-learning process

Engagement :

- Use a suitable engagement procedure on efficient use of fertilizer.
- Lead a discussion to highlight the following.

  That,
  - High yield and high profit can be obtained by using fertilizers efficiently
  - The following factors should be considered in order to increase the efficiency of fertilizers,
    - Soil and environmental factors
    - Factors related to crops
    - Fertilizers and methods of application of fertilizers

Proposed instructions for learning :

- Pay attention on one of the following topics given to your group, related to factors that affect efficiency of fertilizer usage.
  - Soil and environmental factors
  - Crop factors
  - Fertilizers and methods of application of fertilizers
- Explain the efficiency of fertilizer usage.
- Describe methods of maximizing profits by improving efficiency of fertilizer usage.
- State the ways of fertilizer wastage in relation to your topic.
- Collect information on the contribution of the factors given in your topic to improve efficiency of fertilizer usage.
- List steps that can be followed to increase efficiency of fertilizer usage, in relation to your topic.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - Fertilizer use efficiency is the percentage of truly used amount of fertilizer by the plant from the applied amount of fertilizer .
  - Profits can be maximized in the maximum level of fertilizer use efficiency .
  - There are various ways of fertilizer wastage that applied to the soil
    eg. Fixation, leaching
  - Crop factors are important in efficiency of fertilizers.
    eg.
    - Root system of the crop
    - Growth phase of the crop
    - Response to fertilizers
  - The following soil factors are important in the absorption of fertilizers by plants,
    - Soil moisture
    - Soil structure
    - Soil texture
    - pH
    - Drainage conditions
  - Fertilizer can be wasted due to environmental factors such as,
    - Rainfall
    - Warm weather conditions
    - Drought conditions
  - The following factors affect the efficiency of fertilizers,
    - Type of fertilizer
    - Quantity of fertilizer applied
    - Time of fertilizer application
    - Method of fertilizer application
  - The following are the methods of improving fertilizer efficiency,
    - Application of fertilizer under suitable soil and environmental conditions
    - Avoiding application of fertilizers under conditions as heavy rainfall, warm weather and drought conditions
    - Preparation of soil environment to minimize wastage of fertilizers
      eg.
      preparation of pH value, moisture and drainage
      use soil conservation methods
      weed control

- Application of recommended fertilizer after soil testing
- Crop factors should be considered in fertilizer applications
- Suitable types of fertilizers and recommended amounts of fertilizers should be applied several times
- Application of organic manure and chemical fertilizers together according to the concept 'Integrated Plant Nutrient System (IPNS)'
- Fertilizer application methods also affect efficiency of fertilizer usage eg. sowing, deposition
- Fertilizer efficiency can be increased through the application of fertilizer as liquids on leaves and applying same as small particles to the soil

Competency 5 : **Exhibits readiness to establish crops in a suitable soil environment.**

Competency 5.1 : **Inquires into necessity of land preparation to improve properties of soil.**

Duration : **04 periods.**

Learning outcomes :

- **Explains objectives of land preparation.**
- **List the changes in the physical properties of soil due to land preparation.**
- **Describes the changes in the chemical properties of soil due to land preparation.**
- **Describes the changes in the biological properties of soil due to land preparation.**
- **Describes the effect of land preparation on agriculture.**

Teaching-learning process

Engagement :

- **Display a poster which shows land preparation.**
- **Ask a few questions about land preparation practices in the poster .**
- **Produce the following table for students.**

Soil Property	Sandy soil		Clay soil	
	Before land preparation	After land preparation	Before land preparation	After land preparation
Hydraulic conductivity(cm/h)	17.64	22.23	1.91	6.08
Random roughness (cm)	1.15	1.75	1.72	2.77
Soil water at saturation (%)	32.00	38.00	40.00	61.00
Bulk density (g/cm^3)	1.42	1.11	1.24	0.80

- **Allow students to study the table and select soil properties which might change with land preparation.**
- **Lead a discussion to highlight the following:**
  That,
  - **land preparation is the process of preparing soil, to make it suitable for crop growth.**
  - **the main purpose of land preparation is for planting crops.**

- the following are the changes in soil after land preparation
  - occurrence of random roughness
  - reduction of bulk density
  - improvement of porosity
  - improvement of hydraulic conductivity
  - formation of soil aggregates

Proposed suggestions for learning :

- Draw attention to the following topics.
  - Aims of land preparation
  - Changes of soils due to land preparation.

- Explore the topic given to your group on the following themes.
  - Define the topic
  - Aims/changes
  - Effect on agriculture.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following:

  That,
  - land preparation is the process of preparing soil to make it suitable for crop growth.
  - the following are the aims of land preparation
    - loosen soil
    - controlling weeds by the burial of weeds
    - controlling pests
    - improving soil aeration
    - improving water absorption
    - mixing organic matter
    - removal of unnecessary materials
  - physical, chemical and biological properties of soil change due to land preparation
  - These changes are mainly the physical properties and the following are examples,
    - random roughness
    - bulk density
    - porosity
    - hydraulic conductivity

Competency 5.2 : **Selects suitable methods of land preparation.**

Duration : **05 periods.**

Learning outcomes :

- **Defines the term basic land preparation.**
- **Names steps in basic land preparation**
- **Explains intercultivation.**
- **Explains that special land preparation techniques should be selected according to the need.**
- **Selects appropriate methods of land preparation by comparing their advantages and disadvantages.**

Teaching-learning process

Engagement :

- **Display a poster which shows land preparation.**
- **Lead a discussion to highlight the following.**

That,

- **land should be prepared before planting seeds or seedlings**
- **There are different types of land preparation techniques**
- **these should be selected according to the type of crops and planting method**

Proposed suggestions for learning :

- **Each group should study one of the topics given below.**
  - **Maximum tillage**
  - **Minimum tillage**
  - **Zero tillage**
- **Explore the given materials and answer the following.**
- **Explain basic land preparation and intercultivation**
- **Describe your topic briefly**
- **Discuss the advantages and disadvantages of land preparation in relation to your topic**
- **Suggest suitable land preparation techniques for various locations in the school garden**
- **Explain the importance of puddling in paddy cultivation**
- **Be prepared to present your findings creatively, to the entire class**

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following:**

That,

- **basic land preparation is done before the crop establishment**
- **Land preparation practices after crop establishment are referred to as intercultivation**
- **There are three steps in basic land preparation such as,**
  - **primary tillage**
  - **secondary tillage**
  - **seed bed preparation**
- **primary tillage is the loosening of compacted soil using different equipment**
- **different land preparation practices are being used according to the need and situation e.g. deep tillage, loosening sub soil, continuous land preparation throughout the year**
- **secondary tillage is the preparation of the smooth surface of the soil after primary tillage**
- **removal of unnecessary particles such as stones, remaining weeds, stubble and partitioning of large soil aggregates into smaller particles is done at the secondary tillage.**
- **preparation of the field suitable for seed/seedling planting and for irrigation is referred to as seed bed preparation**
- **all the practices carried out on the soil after crop establishment is known as intercultivation**
- **Maximum tillage is the standard method and it is a traditional method**
- **minimum preparation of field to maintain rapid seed germination and successful crop cultivation is referred to as minimum tillage**
- **planting seeds/seedlings with the minimum destruction of soil is zero tillage**
- **minimum tillage and zero tillage are not traditional methods**
- **there are advantages and disadvantages in the above methods**
- **puddling is the land preparation method adapted in paddy cultivation**

Competency level 5.3 : Selects appropriate equipment for land preparation.

Duration : 05 periods.

Learning outcomes :

- Names various types of equipment that can be used in land preparation.
- Classifies land preparation equipment according to the stage of use and power applied.
- Expresses ideas about the necessity of proper land preparation for successful crop cultivation.
- Explains method of selecting proper equipment for land preparation activities.
- Lists different land preparation equipment used at various stages.

Teaching-learning process

Engagement :

- Display land preparation equipment or pictures of equipment to the class.
- Lead a discussion to highlight the following.

  That,
  - Various equipment are used for land preparation
  - These equipment could be classified according to the stage of land preparation and power used to operate them
  - There are three types according to stage of land preparation as,
    - primary land preparation equipment
    - secondary land preparation equipment
    - intercultivators
  - There are three types according to the power used to operate them such as,
    - equipment that are operated using man power
    - equipment that are operated using animal power
    - equipment that are operated using mechanical power

Proposed instructions for learning :

- Pay attention on one of the following topics given to your group
  - equipment that are operated using man power
  - equipment that are operated using animal power
  - equipment that are operated using mechanical power
- Prepare a list of land preparation equipment in relation to the topic given to your group
- Classify these equipment
- Describe the equipment using figures in relation to your topic

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following:**

  That,

  - **Suitable equipment should be used to prepare an appropriate soil environment for crop establishment**
  - **These equipment could be classified according to the stage of land preparation and power used to operate them**
  - **These are of three types according to stage of land preparation as,**
    - **primary land preparation equipment**
    - **secondary land preparation equipment**
    - **intercultivators**
  - **Examples for primary land preparation equipment are mammoties, forks and ploughs**
  - **Examples for secondary land preparation equipment are mammoties, harrows and rakes**
  - **Examples of intercultivators are mammoties and hoe**
  - **These are of three types according to the power used to operate them such as,**
    - **equipment that are operated using man power**
    - **equipment that are operated using animal power**
    - **equipment that are operated using mechanical power**
  - **Examples of land preparation equipment that are operated using man power are mammoties, forks, Japanese rotary weeder**
  - **Examples of land preparation equipment that are operated using animal power are light iron plough, tine toothed harrow and country plough**
  - **Examples of land preparation equipment that are operated using mechanical power are disc plough, Japanese reversible mould board plough, rotervator , disc harrow, tine tiller and mould board plough**

Competency level 5.4 : Inquires about different methods of crop establishment.

Duration : 04 periods.

Learning outcomes :

- Describes crop establishment methods.
- Discusses the advantages and disadvantages of these methods, comparatively.
- Names the equipment used in crop establishment.
- Draws figures of the crop establishment equipment.
- Describes the methods of operating crop establishment equipment.

Teaching-learning process

Engagement :

- Display a poster which shows sowing or planting seedlings to the class.
- Lead a discussion to highlight the following points.

  That,
  - Crop establishment is the establishing of planting materials (seeds or seedlings) in the field
  - Crop establishment methods are,
    - planting as seeds
    - planting as seedlings (transplanting)

Proposed instructions for learning :

- Pay attention on one of the following topics given to your group.
  - Sowing and planting as seeds
  - transplanting
- Explore your topic along the following themes.
  - Introduction
  - Equipment used for crop establishment
  - Methods of operating these equipment
  - Advantages and disadvantages of these methods
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,
  - Crop establishment method is varied in term of the crop, environmental factors and available resources

- Planting seeds and transplanting are the crop establishment methods
- There are regular and irregular methods of seeding and transplanting
- Sowing is the commonly used method of establishing cereal crops
- This method can be used to establish legumes and sesame crops, too.
- Seeders are use to establish seeds in rows
- Following are the examples of seeders,
  - *'Johnpulle'* seeder
  - Upland seeder
- There are advantages and disadvantages of sowing
- Placing seeds in soil for seed establishment is named "planting seeds"
- The following methods are used to plant seeds
  - Planting by hand
  - Planting using seeders
- There are advantages and disadvantages in these methods
- Various seeders are used to plant seeds
- Establishment of seedlings obtained from plant nurseries in the field, is called transplanting
- There are regular and irregular methods of transplanting
- The following are the regular methods of transplanting
  - Single row planting
  - Double row planting
  - Triangular planting
  - Square planting
  - Pentagon type planting
  - Hexagon type planting
- There are advantages and disadvantages in these methods
- Sowing of seedling plants is a method of crop establishment used in paddy cultivation

Competency level 5.5 : **Prepares plant nurseries using different methods**

Duration : **05 periods.**

Learning outcomes :

- **Describes the types of plant nurseries.**
- **Explains the advantages in the production of nursery plants.**
- **Produces nursery plants using various nursery techniques.**
- **Maintains nursery plants.**
- **Explains methods of post cultural practices in nurseries**

Teaching-learning process

Engagement :

- **Display a poster of a plant nursery to the class.**
- **Lead a discussion to highlight the following points.**
  That,
  - **It is advantageous to plant nursery seedlings**
  - **Various nursery techniques are used to produce seedlings for planting**

Proposed instructions for learning :

- **Pay attention to one of the following topics given to your group.**
  - **Raised nurseries, Sponge nurseries**
  - **Sunken nurseries, Compact nurseries, Tray nurseries**
  - **Pot nurseries, Noridoko nurseries,**
- **Review the resource book.**
- **Briefly explain the method of preparing the plant nursery given to you using steps and figures**
- **Describe the importance of preparing plant nurseries.**
- **Engage in the activity given, at the work station.**
- **Briefly explain the problems and the strategies to minimize these problems.**
- **Discuss the method of maintaining nursery plants efficiently.**

Instruction for the preparation of work stations

- **Prepare 3 work stations for 3 groups with the equipment and materials given.**
  - **Raised nursery, Sponge nursery**
  - **Sunken nursery,Tray nursery**
  - **Pot nursery, Noridoko nursery**

Common inputs for all work stations

- Strained top soil
- Strained compost/dried cow dung
- Water
- A metallic pan
- Measuring tape .
- Coir rope
- watering cans
- A mammoty
- Albert fertilizer mixture
- Wedge

Special inputs for work station 1

- Straw
- Fungicide/hot water
- Crow bar
- Tray/shallow pan
- 20cm × 30cm sized sponge sheet
- Paddy husk
- seeds suitable for nurseries
- Rake
- spade

Special input for work station 2

- Straw
- A fungicide/hot water
- Crow bar
- Pieces of bricks (2cm)
- Various containers and materials that can be used to prepare a nursery
- Spade
- Piece of timber
- seeds suitable for nurseries
- A wooden frame (length, width and height 25cm , 25cm and 5 cm respectively.
- Paddy husk
- Rake
- Decomposed leaves
- Nursery tray

- small bucket

Special input for work station 3

- Polythene
- Straw
- seeds suitable for nurseries

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following:
  That,
  - There are two types of plant nurseries,
    - Raised nurseries
    - Sunken nurseries
  - Raised nurseries are suitable for areas with high rainfall and for clay soil
  - Sunken beds are suitable for the dry zone
  - Pot nurseries are used in situations with,
    - low space in the field
    - less requirement of plants
    - low productivity of the soil
  - Permanent or temporary containers/pots can be used to prepare pot nurseries
  - Noridoko nursery, sand nursery, sponge nursery, compact nursery and tray nursery are special types of nurseries
  - Suitability of the plant nursery varies with the crop to be planted
    eg.
    Raised nursery - Chillie, Brinjal, Tomato
    Noridoko nursery - Cabbage, Snake gourd, Bottle gourd
  - A suitable site should be selected to prepare a plant nursery.
  - Climatic factors, availability of water, location of the site and nature, transport facilities should be considered in the preparation of plant nurseries
  - High quality nursery plants can be obtained by practicing accurate and recommended nursery techniques
    eg.
    - Turning of soil
    - Removal of weeds, stones, gravel and underground parts
    - Preparation of drains
    - Preparation of nursery beds, taking the Recommended length, width and height of the nursery into consideration

- Preparation of the nursery mixture
- Sterilization of nursery beds
- Application of seeds
- Mulching

- Relevant nursery mixture should be prepared and applied to each nursery type
- Mulching is necessary to maintain temperature and moisture at a suitable level
- Maintenance activities such as water management, nutrient supply, pest control, shading and hardening of plants should be done regularly to obtain plants necessary for a proper plantation.
- High quality seedlings can be obtained by following proper practices.

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

Competency level 6.1 : **Decides on the necessity of irrigation according to the requirement.**

Duration : **04 periods.**

Learning outcomes :

- **Names factors that affect on irrigation.**
- **Describes soil factors that determine irrigation requirement.**
- **Describes climatic factors that determine irrigation requirement.**
- **Explains the importance of water for plants.**
- **Describes damages caused by improper irrigation.**

Teaching-learning process

Engagement :

- **Assign two students to read the following dialogue to the entire class and inquire about their opinions.**

Dialogue

Younger sister : I watered this flower pot, yesterday. But, it has wilted today.
Elder sister : It is necessary to supply more water for plants because of the dryness these days.
Younger sister : Let's put some coir dust to the pot and we'll leave this pot in the shade. Then plants can tolerate this dry condition.
Elder sister : It's wonderful. This Euphorbia plant never wilts. Produces a whole bunch of flowers.

- **Lead a discussion to highlight the following.**

  That,

  - **Water can be applied to prevent wilting of plants**
  - **Frequent water application is needed under dry climatic conditions.**
  - **It is possible to reduce the irrigated water requirement and extend irrigation interval by maintaining optimum soil conditions**
  - **Some crops require a small amount of water.**

Proposed suggestions for learning :

- Each group should study one of the following topics , related to irrigation.
  - Crop factors
  - Soil factors
  - Climatic factors
- Explore the topic given to your group in relation to the following topics.
  - Introduction of topic
  - Effect of the factor given to your group, in the determination of the requirement of irrigated water .
  - Importance of water to crop cultivation
  - damage through improper irrigation
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,
  - the following factors are important in determining crop water requirements,
    - Soil factors
    - Climatic factors
    - Crop factors
  - the following soil factors are important in determining irrigation requirements
    - Soil texture
    - Soil structure
    - Depth of soil
    - Topography
    - Soil moisture content
  - the following crop factors are important in determining irrigation requirements
    - Type of the crop and variety
    - Growth stage of crop
    - Plant population
    - Duration of crop in field
    - Cropping season
  - Water is important for various functions of the crop
    - Plant photosynthesis
    - Translocation of food
    - Hormone synthesis

- Transpiration of the plant
- Protect plants from extreme heat

➢ the aims of irrigation are,

- Facilitate land preparation
- Optimize crop growth
- As a factor for seed germination
- Facilitate harvesting of tuber crops
- As a weed control method
- Medium for absorption of plant nutrients
- As a pest control method
- To dissolve excess salt in the soil (As treatment for salinity)

- Various types of damage can be caused through improper irrigation

Competency level 6.2 : Selects suitable water sources for irrigation

Duration : 04 periods.

Learning outcomes :

- Describes the term 'water source'.
- Classifies water sources.
- Lists factors to be considered in the use of water sources.
- Describes factors to be considered in the selection of a water source.
- Explains artificial water sources with examples.

Teaching-learning process

Engagement :

- Display photographs/pictures of various water sources to the class.
- Lead a discussion to highlight the following.

  That,
  - A water source is defined as a body of water that can provide the required amount of water for crop cultivation.
  - There are 2 types of water sources.
    - Natural water sources
    - Artificial water sources
  - A water source makes a massive contribution to successful crop cultivation

Proposed suggestions for learning :

- Each group should pay attention to the topic given about water sources that are used in irrigation,
  - Natural water sources
  - Artificial water sources
  - Climatic factors
- Review the given reading materials.
- Identify suitable water sources in relation to your topic.
- Explore the factors that should be considered when using a source of water .
- Explore the factors that should be considered when selecting a source of water .
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following.**
  That,
  - **Rivers, lakes, streams and rainfall are natural sources of water which have developed without human interference.**
  - **There are 3 types of rivers according to the way water is received and flows.**
    - **rivers which flow slowly**
    - **rivers which flow fast**
    - **seasonal rivers**
  - **Natural source of water are called surface water sources**
  - **Maximum advantages can be obtained from monsoon rains by cultivating crops at the correct time in conformity to the cropping season**
  - **water sources which have prepared through human interference are called artificial water sources**
  - **'Sinhala - *Wewa,* Tamil - *Kulam'* (tank), agro wells, artesian wells and '*Amuna'* (aniouts) are artificial sources of water .**
  - **'Sinhala - *Wewa,* Tamil - *Kulam'* is a man made water source which is prepared by constructing a bund at a place containing natural depression on the earth.**
  - **Retention of water in a 'Sinhala - *Wewa,* Tamil - *Kulam'* varies with the time according the source of water**
  - **Construction of agro wells is a solution for water deficit in highlands of the wet zone and in the dry zone.**
  - **Agro wells are suitable for the cultivation of additional food crops**
  - **An artesian well is a water source prepared by inserting a pipe through the soil up to the ground water level close to parental rock**
  - **The following steps can be taken to prevent wastage of water obtained from agro wells and artesian wells, in irrigation**
    - **spreading polythene at the base of canals**
    - **supplying water through alkathene tubes**
- **the following factors should be considered in the selection of a water sources**
  - **ability to fulfill the requirement of water necessary for crops in the field**
  - **ability to obtain water at the required time**
  - **quality of water and its being free of waste materials**
  - **cost needed for the preparation of water source and lifting water to the field**
  - **compatibility of the water source with the existing irrigation method**
  - **Distance between water source and crop field**

Competency level 6.3 : Plans suitable water lifting methods.

Duration : 04 periods.

Learning outcomes :

- Lists various water-lifting methods.
- Explains the functions of centrifugal pumps.
- Describes the principles of water-lifting.
- Compares the advantages and disadvantages of water-lifting methods.
- Explains methods of installation and maintenance of water pumps.

Teaching-learning process

Engagement :

- Show pictures of traditional and modern water lifting methods to the class and let students explore the pictures.
- Lead a discussion to highlight the following.

  That,
  - water lifting is necessary to increase the pressure of the irrigated water when it is difficult to lift water from the source using gravitational force
  - there are various water-lifting methods
  - techniques/technologies used to lift water changes with time
  - efficient irrigation can be practiced using modern water-lifting methods

Proposed suggestions for learning :

- Each group should pay attention to the topic given below.
  - Group A - centrifugal water pumps
  - Group B – displacement water pumps
  - Group C - traditional water pumps
- Identify the suitability of water sources for methods mentioned above.
- Draw a diagram of the water -lifting method given, and label it's parts
- Identify functions of the water-lifting method given.
- Compare the water-lifting method given to your group with other water-lifting methods.
- Compare the advantages and disadvantages of the water lifting method given to your group.
- Explain the method of installation and maintenance of the water lifting method given to your group.

- Observe the structure and functions of centrifugal pump given.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.
  That,
  - pressure that is necessary to lift water should be increased when it is difficult to lift water from the source using gravitational force
  - water pumps should be used to lift water
  - the main types of water-lifting methods are traditional and modern types
  - use of pulleys, '*Andiya*' wells (Tamil-'*Thula*'), string pump and 'Yoththa' (Tamil-'*Kamali*') are traditional water-lifting method
  - centrifugal pumps and displacement pumps are modern water-lifting methods
  - water pumps are required to lift a liquid from one level to another level and to pump water to a closed tank by exceeding the internal pressure of the tank
  - water is lifted by creating a vacuum in a chamber, in displacement pumps
  - centrifugal action is used to lift water in centrifugal pumps
  - 'Andiya wells' are used to lift water from shallow wells in the dry zone
  - pulleys are used to lift water from shallow wells in the wet and dry zones
  - string pumps are used to lift water from deep wells in the dry zone.
  - 'Yoththa' (Tamil-'*Kamali*') is used to lift water from small tanks, lakes, streams and canals
  - reciprocal type displacement pumps are used to lift underground water
  - centrifugal pumps are used to lift water from agro wells, domestic wells and shallow and deep wells in agricultural farms
  - centrifugal pumps can be operated using electric power or another source of power
  - several factors should be considered in the installation and maintenance of centrifugal pumps

Competency level 6.4 : Inquires into different methods of irrigation and selects methods according to the situation.

Duration : 06 periods.

Learning outcome :

- Describes various irrigation methods.
- Draws diagrams of various irrigation methods.
- Describes the suitable irrigation method according to various factors.
- Names parts of a sprinkler irrigation system.
- Lists advantages and disadvantages of irrigation methods.

Teaching-learning process

Engagement :

- Display pictures of different irrigation methods to the class.
- Let students answer the following questions.
  - What is shown in these pictures?
  - Classify these using suitable criteria?
- Lead a discussion to highlight the following,
  - irrigation is the replacement or supplementation of water form another source in order to grow crops (artificial watering of the land)
  - irrigation methods can be classified as follows
    - Surface irrigation
    - Subsurface irrigation
    - Sprinkler irrigation
    - Drip irrigation

Proposed suggestions for learning :

- Each group should pay attention to one of the following topics given to your group.
  - Surface and subsurface irrigation methods
  - Sprinkler irrigation method
  - Drip irrigation method
- Explore your topic along the following themes, using resources given.
  - Definition of the topic
  - Various irrigation methods related to your topic
  - Diagrammatic representation of the topic
  - Environmental conditions suitable to use the method for nursery plants

- Advantages and disadvantages of the method

- Be prepared to present your findings creatively, to the entire class.

Instructions for subject matter explanations :

- Lead a discussion to highlight the following.

  That,

  - Surface irrigation system can be classified into 2 as controlled and uncontrolled irrigation.
  - Flooding of the land is practiced in uncontrolled irrigation.
  - There are advantages and disadvantages in the method above.
  - controlled irrigation can be classified according to the land preparation method,
    - Basin irrigation (sunken beds)
    - Ridge and furrow irrigation
    - Strip irrigation
    - Ring irrigation
  - There are advantages and disadvantages in these irrigation methods
  - subsurface irrigation
    - supply of water through open drains or porous pipes in depth of 30-100cm from soil surface is called subsurface irrigation
    - this method is suitable for permeable soils of uniform texture which provides ability for water to flow vertically and horizontally
    - supply of water using porous clay pots is also a subsurface irrigation method
    - there are advantages and disadvantages in these methods
  - drip irrigation
    - supply water as droplets to the root zone in drip irrigation
    - equipment prepared to discharge water to the root zone is called emitters
    - this method can be used for crops cultivated both in the field and under controlled conditions
    - bubble irrigation is an adaptation of the drip irrigation
  - Sprinkler irrigation
    - supply water as a spray in sprinkler irrigation
    - water sprinkles through a nozzle at high pressure in sprinkler irrigation
    - the following are the main parts of a sprinkler system,
      - Main line
      - Lateral lines
      - Riser pipes
      - Nozzle

- Height of riser pipe can be varied with the type of the cultivated crop
- Maximum height of the riser pipe should be slightly shorter than the height of the crop
- Pressure of water and rotation speed of the nozzle determines the spray distance
- Various types of nozzles are used to spray water
- There are advantages and disadvantages of this method

Competency level 6.5 : **Applies necessary calculations to maximize the efficiency of irrigation**

Duration : **04 periods.**

Learning outcomes :

- **Explains methods of increasing irrigation efficiency.**
- **Defines the term 'irrigation requirement'**
- **Describes factors that determine the irrigation interval.**
- **Explains the methods of measuring soil moisture conditions.**
- **Explains water use efficiency.**

Teaching-learning process

Engagement :

- **Let a student to read the following newspaper article to the entire class.**

> **Newspaper article**
>
> **Though, we think water is available abundantly in Sri Lanka, this is not the reality, according to recent experiences. Water is a limited factor for domestic purposes as well as for Agricultural needs. A great amount of water is used for irrigation is wasted. Therefore, water conservation methods should be adapted in irrigation. Cultivation of crops that consume small amounts of water might be a solution for the shortage of water.**

- **Lead a discussion to highlight the following:**
  That,
  - **wastage of water is high due to improper irrigation methods.**
  - **it is possible to irrigate large extents of land by conserving water**
  - **irrigation at the correct time is a way of conserving water**

Proposed instructions for learning :

- **Explore one of the following topics given to your group.**
  Group 1 - Irrigation requirement
  Group 2 - Irrigation interval
  Group 3 - Irrigation efficiency
- **Discuss the topic on the following themes**
  - **Describe the topic**

- Calculations relevant to the given topic
- Importance of these findings

- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following:

  That,

  - Irrigation requirement can be calculated in 2 different ways
    - Net irrigation requirement
    - Gross irrigation requirement
  - Net irrigation requirement is the expression of water requirement as a height needed to bring the soil up to the field capacity.
  - This can be calculated from wilting point or any other condition of the soil
  - Water use efficiency of crops affects the net irrigation requirement
  - Water use efficiency is defined as the amount of yield produced by consuming one cubic meter of water
  - This can be varied with the crop
  - Gross irrigation requirement is the amount of water needed to maintain the soil in the field capacity
  - Gross irrigation requirement = Net irrigation requirement + wastage of water
  - $$\text{Gross irrigation requirement} = \frac{\text{Net irrigation requirement}}{\text{Efficiency of irrigation}}$$
  - Determination of irrigation interval is very important
  - There are two methods to determine the irrigation interval,
    - Irrigation with the consideration of soil moisture conditions
    - By using the crop as an indicator
  - Soil moisture conditions can be measured using several methods,
    - Gravimetric method
    - Tensiometer method
    - Gypsum block method
  - Use of 'Tensiometer method' is easy
  - Crops can be used as an indicator
  - Irrigation efficiency can be defined as the percentage of water absorbed by the crop from the applied water
  - $$\text{Irrigation efficiency} = \frac{\text{Amount absorbed by the crop} \times 100}{\text{Amount of irrigated water}}$$

- The following are the methods to improve irrigation efficiency
  - Prevention of adverse climatic factors
  - Management of soil characteristics
  - Selection of suitable crops
  - Management of irrigation systems to minimize water wastage
  - Selection of efficient irrigation methods
  - Selection of cropping methods and farming systems which can conserve water
  - Weed control
  - Use of appropriate technology

Competency level 6.6 : **Plans suitable drainage methods**

Duration : **05 periods.**

Learning outcomes :

- **Explain drainage methods.**
- **Defines the term 'Drainage'.**
- **Describes strategies which can be used to improve drainage.**
- **Explains adverse effects of improper drainage.**
- **Plans drainage systems.**

Teaching-learning process

Engagement :

- **Introduce 2 pots with seedlings planted in well drained and poorly drained conditions, to the class. (These pots should be prepared one week prior to the lesson)**
- **Allow students to observe the pots.**
- **Get the students' views on these plants.**
- **Lead a discussion to highlight the following:**
  That,
  - **Excess water in the soil should be drained for proper crop growth.**
  - **Crops cannot be grown properly or there may be adverse effects under poor drainage conditions**
  - **When excess water is not drained naturally from the soil it should be removed artificially.**
  - **Various methods can be used to remove excess water from the soil**

Proposed instructions for learning .

- **The following are some strategies that could be used to improve drainage conditions of soil.**
  - **Surface and sub surface drainage methods**
  - **Pumping and use of plants**
  - **Designing drainage systems**
- **Explore the given topic along the following themes.**
  - **Define the term 'drainage'**
  - **Explain the method of improving soil drainage in relation to your topic**
  - **Discuss the possible problems in the use of the method**
  - **Suggest means of overcoming these problems**

- Explain the adverse effects that arise with the failure of these drainage methods
- Be prepared to present your findings creatively, to the entire class.

Instructions for subject matter explanation :

- Lead a discussion to highlight the following.

  That,
  - Removal or removing of excess water from a soil profile can be described as the drainage
  - Excess water is retained in the soil
  - Retention of excess water in the soil badly affects successful crop cultivation
  - The following are the harmful effects of excess water
    - barrier to root respiration
    - water and nutrients are not absorbed properly due to disturbances of permeability of root cells
    - poor growth of plants in uplands
    - yellowing of leaves and wilting of plants
    - produce low yield
    - proliferation of root disease
    - accumulation of toxic substances such as S, Al, Fe
    - increase concentration of some elements such as Fe^{2+}
    - reduce decomposition of organic matter
    - damages soil structure
    - difficulties in the use of farm equipment
  - Factors that affect poor drainage conditions are,
    - Soil type (highly clay soils)
    - Shallow ground water level
    - seepage of water from various water sources to agricultural fields
    - frequent accumulation of water in lowlands
    - compaction of sub soil
    - frequent tillage of soil for a definite depth
  - It is possible to plant crops successfully in well drained soils
  - Different strategies can be applied to improve soil drainage and these methods should be used appropriately.

    eg.
    - Surface drainage methods (open drains)
    - Sub surface drainage methods (wooden drains, stone drains, tube drains)
    - Use of pumps

- Use of plants

- Plants with high evapo-transpiration should be used when cultivating in poorly drained soils
- Proper designing of drainage systems are needed for efficient drainage
- the following types of drains should be designed for proper drainage
  - Herring bone method
  - Gridiron method
  - Parallel drain method
  - Random drain method

Competency 7 : Exhibits readiness to improve crop yield

Competency level 7.1 : Explores seed development and germination types.

Duration : 04 periods

Learning outcomes :

- Identifies the parts of a given flower
- Names parts of a typical seed.
- Explains seed germination methods by observing seedlings
- Names factors necessary for seed germination.
- Differentiates between monocotyledonous and dicotyledonous seedlings.

Teaching-learning process

Engagement :

- Use a suitable engagement procedure.
- Lead a short discussion based on the engagement, to highlight the following.
  That,
  - Gametes fertilize after pollination and produce seeds in flowering plants.
  - New plants can be produced using these seeds.
  - Propagation of plants using seeds is known as sexual propagation.

Proposed instructions for learning :

- Go to the relevant work station.
- Identify the seed sample given.
- Review the literature given.
  - Identify the type of the seed given to your group
    i.e. monocotyledonous seeds or dicotyledonous seeds
  - Review the parts of a typical seed in relation to your topic.
  - Collect information on factors necessary for seed germination.
- Plant the given seeds in a pot and allow them germinate.
- Identify the parts of the flowers given to you.
- Review following,
  - differences between given flowers and typical flower
  - development stages of a seed
  - methods of pollination in plants that belong to the type of seeds you have planted

- Observe the seedling given to you and identify it's characteristics
- Observe the seedlings which you have planted and identify the type of germination i.e. hypogeal germination or epigeal germination
- Explain characteristics used to identify the type of germination.
- Review physiological changes and the processes in seeds at germination
- Review literature and collect information about,
  - differences between the seedlings you obtained by planting and the seedling given to you at the work station
  - importance of sexual propagation
- Be prepared to present your findings creatively, to the entire class. (use figures, tables, flow charts when necessary)

Instruction for the preparation of work stations

- Prepare 2 work stations with the equipment and materials given

work station 1

- 2 monocotyledonous seed samples that have been soaked
  - sample 1: Seeds obtained from a plant with monocotyledonous, unisexual flowers e.g. *Zea maize* (corn)
  - sample 2: Seeds obtained from a plant with monocotyledonous, bi-sexual flowers e.g. paddy
- Two small pots with a suitable medium for planting.
- water
- A seedling/ photograph which shows poly embryogenesis (with the seed)
- Bi sexual flower

work station 2

- 2 dicotyledonous seed samples that have been soaked
  - sample 1: Seeds obtained from a plant with dicotyledonous, unisexual flowers e.g. Cucurbitaceae seeds
  - sample 2: Seeds obtained from a plant with dicotyledonous, bi-sexual flowers e.g. Fabeceae seeds (Legume seeds)
- Two small pots with suitable medium for planting.
- water
- A seedling/ photograph that shows poly embryogenesis (with the seed)
- Two unisexual flowers (female and male flowers)

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.

  That,

  - there are two types of plant propagation as follows,
    - sexual propagation by seeds
    - asexual propagation by vegetative parts
  - structure necessary for sexual propagation is the flower
  - flowers are composed of male parts, female parts and parts which are neither male nor female parts
  - different parts of plants perform special functions
  - there may be different flowers according to structure such as,
    - Bisexual flowers
    - Male flowers
    - Female flowers
  - These plants may be dioecious plants or monoecious plants with unisexual flowers, according to the occurrence of flowers
  - pollination of flowers and fertilization is necessary for fruits and seeds to form.
  - The two types of pollination are,
    - self pollination
    - cross pollination
  - there are different adaptations in flowers for self pollination or cross pollination
  - diploid zygotes are formed as a result of fertilization of monploid pollens and ovules
  - Special functions inside the ovary and anther help the process fertilization
  - Ovules and parts of the ovary develop to seeds and parts of the fruit at the end of this process
  - There are two types of seeds according to structure such as,
    - monocotyledonous seeds
    - dicotyledonous seeds
  - There are special differences between these seeds
  - Seeds are composed of different parts necessary for the formation of a new plant
  - Each of these parts are responsible for special functions
  - Different factors affect seed germination
  - There are different stages in the seed germination process

- **The two types of germination are,**
  - **hypogeal germination**
  - **epigeal germination**
- **Some of the seeds show poly-embryogenesis in germination**
- **Seeds are important as dispersal structures**

Competency level 7.2 : Plans methodologies to protect viability of seeds.

Duration : 04 periods.

Learning outcomes :

- Describes seed viability.
- Describes factors affecting seed viability.
- Explains reasons for the destruction of seed viability.
- Describes ways of safeguarding seed viability.
- Explains steps to protect seeds through the maintenance of seed viability.

Teaching-learning process

Step :

- Let a student to present the following newspaper article, to the class.

> **Newspaper article**
>
> **'Seeds fail to germinate. Farmers are in a critical condition'**
>
> Farmers of the *Kolabissa* area complain that most of the vegetable seeds used in the *'Yala'* season have not germinated. They had purchased these seeds from an unregistered private producer and it has been discovered that these seeds were old by a few years and also, have been stored in conditions unsuitable to retain the viability. The agriculture officer of this area says that these seeds are not viable though, they look good.

- Lead a discussion to highlight the following.

  That,

  - Seed viability is necessary for seed germination
  - Viability of seeds used as planting materials should be protected.

Proposed suggestions for learning :

- Review the resource book and collect information on,
  - Seed viability
  - Need for protecting seed viability

- Each group should collect information on the following themes in relation to the topic given to your group
  - Group 1: Maintenance of seed viability by considering internal factors that affect seed viability
  - Group 2: Maintenance of seed viability by considering external factors that affect seed viability
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,
  - seed viability is the potentiality or ability of a seed to germinate under favourable conditions
  - protection of seed viability is a need with seeds used as planting materials
  - apart from this, protection of seed viability is important for the following,
    - as a source of food
    - as a material for genetic resource conservation
    - as raw material in industries
  - the various factors that affect seed viability are as follows,
    - internal factors
      - genetic factors
      - percentage of moisture in the seed
      - weaknesses that occur during seed maturity
    - external factors
      - moisture content of the environment
      - temperature of the environment
      - aeration
      - diseases, pests and mechanical damage
      - mutants
  - the following strategies can be used to maintain seed viability
    - drying
    - storage in dried, air tight and moisture tight containers
    - storage of dried seeds under low temperature conditions
    - mixing various materials with seeds to prevent pest and disease attacks

Competency level 7.3 : **Examines seed quality for successful cultivation**

Duration : **04 periods.**

Learning outcomes :

- **Explains the necessity of seed testing.**
- **Names methods that are used to determine the germination percentage and moisture percentage of seeds.**
- **Tests the germination percentage of a given seed sample.**
- **Calculates moisture percentage of a seed sample.**
- **Selects suitable seeds for cultivation.**

Teaching-learning process

Engagement :

- **Let students present the following dialogue as a role play.**
- **This is a dialogue between two farmers; Sunil and Shantha on the way to the paddy field.**

> **Sunil** : **Quality of the seed paddy used during the last season was not good. Most of the plants were** *Echinochloa spp* **(Sinhala-***maruk,* **Tamil-***Vagai) and Aeschynomene indica (***Sinhala-***diya siyambala,* **Tamil-***Neerpuli).* **Also, some paddy plants did not bloom.**
>
> **Shantha:** **Why? Didn't you test before planting? Usually I test seed paddy to check the germination and purity before planting. Therefore I never face such problems.**

- **Lead a discussion to highlight the following:**
  That,
  - **suitable seeds should be planted for successful cultivation**
  - **seeds should be tested before planting for successful cultivation**
  - **purity and germination percentage are the main factors that should be considered in seed testing**
  - **In addition, there are various characteristics in seeds suitable for planting.**

Proposed suggestions for learning :

- Each group explore the topic given to your group
  - Group 1: Determination of seed viability and moisture percentage
  - Group 2: Determination of seed germination and seed purity
- Review the resources given in your work station
- Explore methods used in seed sampling.
- Prepare a composite sample by using the given sample
- Engage in the activity using the composite sample
- List the results of the test
- Name the other methods that can be used for the above test
- Analyze the results of the test
- Determine the suitability of the seed sample for planting
- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of workstations:

- Prepare 4 paddy seed samples, approximately about the size of a matchbox, for each workstation.
- Each seed sample should consist of a few empty seeds, weed seeds, sand/gravel and seeds.

Workstation 1

- Four seed samples
- Four Petri dishes
- Filter paper
- Water
- Electric oven
- Weighing balance capable of measuring to decimal places
- Evaporation pans
- Pieces of paper or newspapers

Workstation 11

- Four seed samples
- Piece of cotton cloth
- Small, round shaped piece of twig/timber (length should be 1 ft)
- Piece of twine
- Water
- Beaker

- Piece of metal/glass sheet(size should be 1 ft^2)
- Strainer with 2 mm holes
- Pieces of paper or newspapers

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - seeds of suitable condition should be selected for planting
  - testing of seed germination is important
  - random sampling is done for seed testing
  - there are standard conditions that should be followed in random sampling
  - types of seed purity are physical purity and genetic purity
  - It is important to test physical purity before planting
  - various steps can be followed in testing physical purity
  - It is important to test seed germination percentage before planting
  - Petri dish method, Ragged doll methods and Nursery box methods are the methods used in testing seed germination percentage.
  - Gravimetric method and moisture meter method are used to test seed moisture content
  - Seed germination test can be used to test seed viability, too.
  - In addition, measuring CO_2 content and X-ray test can also be used

Competency level 7.4 : **Removes seed dormancy to enhance germination.**

Duration : **05 periods.**

Learning outcomes :

- **Explains seed dormancy.**
- **Describes factors that affect seed dormancy.**
- **States the agricultural importance of seed dormancy.**
- **Explains the various types of seed dormancy.**
- **Prepares dormant seeds for germination.**

Teaching-learning process

Engagement :

- **Display a board/poster with the following questions, to students.**
  - **Explain the reason for the failure to produce seedlings when seeds of a ripe tomato are planted without any treatment?**
  - **Why a planted coconut does not produce a plant for 3-4 months?**
- **Lead a discussion to highlight the following.**

  That,
  - **seed dormancy is the inability of a mature seed to germinate under favorable conditions necessary for germination**
  - **seed dormancy occurs as a useful condition for the seed**
  - **there are various types of seed dormancy**

Proposed suggestions for learning :

- **Go to the work station assigned to your group.**
- **Review the resources given.**
- **Explore about seed dormancy, importance of seed dormancy and reasons for seed dormancy.**
- **Complete the following table using the information collected through activity.**

Type of the seed	Reasons for seed dormancy	Strategies that could be used to remove the seed dormancy

- Divide each seed sample into 2 samples.
- Treat one sample to remove dormancy and plant in polythene bags
- Keep these bags until the seeds germinate.
- Plant the other sample of seeds in polythene bags without seed treatment.
- Observe these bags for one week and write your conclusions.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of work stations:

- Prepare 2 work stations with common materials as given below.
  - Polythene bags filled with nursery mixture suitable to plant seeds in
  - Water
  - Sand paper
  - Small hammer/ knife
  - Ash
  - Diluted Sulphuric acid

Special inputs for work station 'A'

- Paddy seeds
- Mango seeds
- Tamarind seeds
- Teak seeds
- Okra seeds (Ladies fingers)
- Papaya seeds
- Cucumber seeds

Special inputs for work station 'B'

- Paddy seeds
- Bitter gourd seeds
- Winged bean seeds
- Sri Lankan olive seeds (Sinhala-*Veralu,* Tamil-*Veralikai maram*)
  Melia koenigii seeds (Sinhala-*Lunumidella,* Tamil-*Malaivembu*)
- Passion fruit
- Cucumber seeds (Marrow)

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - seed dormancy is the inability of a mature seed to germinate under favorable conditions necessary for germination
  - seed dormancy is agriculturally important in some instances
  - seed dormancy is disadvantageous in some instances
  - causes/reasons for seed dormancy are,
    - characteristics of the seed coat
    - inhibitors
    - immature embryos
    - light sensitivity
  - strategies that can be used to remove seed dormancy are,
    - removal of thick seed coat, splitting or scarification of seeds
    - burning of seed coats
    - expose to temperature changes
    - hot water treatment
    - use of chemicals
    - providing light
    - soak in water
    - removal of inhibitors by washing

Competency level 7.5 : Applies suitable seed treatment

Duration : 04 periods.

Learning outcomes :

- Explains the term 'seed treatment'.
- States the importance of seed treatment.
- Follows appropriate seed treatment.
- Uses appropriate chemicals for seed treatment.

Teaching-learning process

Engagement :

- Use a suitable engagement procedure and lead a discussion to highlight the following That,
  - there are various problems in agriculture when use seeds as planting material
  - various forms of seed treatment are used to overcome these problems
  - productivity can be increased by following seed treatment

Proposed suggestions for learning :

- Go to the work station assigned to your group.
- Identify the seed samples in the work station.
- Review the given materials and collect information on treatment that can be applied prior to seed planting
- Complete the following table using the information collected through the activity.

Type of the seed	Type of the treatment before planting	Objectives of seed treatment
	.	

- Prepare seeds for planting by practicing suitable seed treatment.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of work stations:

- Prepare 2 work stations 'A' and 'B' with the common materials given below.
  - water

- salt crystals
- two eggs
- sand
- paddy husk
- fungicide
- empty pots (according to requirement)

Special inputs for work station A

- 2 kg of paddy seeds
- a small amount of mustard seeds
- a small amount of brinjal seeds
- a small amount of cotton seeds

Special inputs for work station B

- 2 kg of paddy seeds
- a small amount of tobacco/carrot seeds
- a small amount of chillie seeds
- a small amount of soybean seeds

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

  That,

  - practices applied to seeds before planting to obtain a successful crop are called seed treatments.
  - objectives of seed treatment are,
    - removal of empty seeds and half filled seeds
    - accelerate germination
    - prevention of damage by insects and fungal damage
    - facilitate planting
    - removal of seed dormancy
    - to obtain a vigorous and healthy crop
    - to obtain a plantation of equal spacing
  - seeds are treated with fungicides, insecticide, etc. before planting to obtain a vigorous and healthy growth
  - small seeds are mixed with sand or paddy husk in broadcasting or planting to provide proper spacing between plants
  - floating of seeds helps to remove empty seeds and half filled grains
  - soaking seeds in water and removal of seed coat are used to accelerate germination
  - seed inoculation is done to introduce Nitrogen fixing bacteria to legumes
  - treatment applied to remove seed dormancy is also a seed treatment
  - In addition, seeds can be treated for hardening and to create drought resistance

Competency level 7.6 : **Inquire into the methodology of certified seed production.**

Duration : **03 periods.**

Learning outcomes :

- **Describes the importance of planting certified seeds.**
- **Explains the process of certified seed production.**
- **States the importance of standards in certified seed production.**
- **Explains the standards of seed paddy.**

Teaching-learning process

Engagement :

- **Present labels of certified seed packages.**
- **Lead a discussion to highlight the following.**

  That,
  - **certified seeds are distributed among farmers for cultivation**
  - **there are 4 steps in certified seed production**
  - **The Department of Agriculture and various institutes join farmers in the production of certified seeds**

Proposed suggestions for learning :

- **Each group is given one of the following topics.**
  - **Breeder seeds, Foundation seeds**
  - **Registered seeds, Certified seeds**
- **Explore the production procedure of the seed type given to your group, in the seed paddy production.**
- **Explain about the given seed production in relation to field crops and vegetable crops.**
- **Explore the method of identifying certified seeds according to the labels.**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following.**

  That,
  - **New improved varieties and high quality seeds are required to improve agricultural production**
  - **Plant breeding is important for efficient seed production process**

- Following are the steps in the seed production procedure designed by the Department of Agriculture
  - Variety improvement and maintenance
  - Protection of the purity of varieties and maintenance
  - Production of breeder seeds, foundation seeds and certified seeds
  - Testing rules and regulations relevant to seeds, train people to control standards of seeds by seed certification
  - Give necessary training to seed growers and sellers
- There are seed certification centers in the Department of Agriculture e.g.. Gannoruwa, Maha-Illuppallama
- The aim of the seed certification service is to produce high quality vegetable seeds and other seeds
- there are set standards for seeds which are used as planting materials in Sri Lanka
- Standard labels are used for seed lots in the certification process
- Necessary information and specific colour is used on the labels of seed packages.
- In addition to the Department of Agriculture, some private companies are also involved in the seed production process e.g. CIC company

Competency level 7.7 : **Propagates plants vegetatively using natural propagation structures**

Duration : **04 periods.**

Learning outcomes :

- Names plants that produce natural vegetative propagation structures, with examples.
- Describes that plants have different vegetative propagation structures.
- Propagates plants using natural vegetative propagation structures.
- Describes the treatment used in the preparation of planting materials.
- Classifies underground stems with examples.

Teaching-learning process

Engagement :

- Show different natural vegetative propagation structures to the class. Ask students about the possibility of obtaining plants after establishing these planting materials.
- Lead a discussion to highlight the following,

  That,
  - vegetative propagation is the process of production of plants from parts of plants other than seeds
  - there are different types of natural vegetative propagation structures
  - plants can be obtained from natural vegetative propagation structures

Proposed suggestions for learning :

- Pay attention to one of the following topics given to your group
  - Underground stems
  - Runners, stolons, bulbils, suckers
- Review the given resources and identify the importance of using natural vegetative propagation structures in crop cultivation.
- Plant the given propagation materials.
- Describe the method of propagating plants using natural vegetative propagation structures given to your group.
- Give examples of other plants except the given specimens for vegetative propagation methods.
- Give strategies to minimize problems that arise in the planting of vegetative propagation structures.
- Be prepared to present your findings creatively, to the entire class.

Instructions for the preparation of work stations:

- **Prepare 2 work stations using the given equipment and materials for the following topics.**
  - **Underground stems**
  - **Bulbils, stolons and suckers**
- **Common inputs for all work stations**
  - **Sieved compost**
  - **Sieved top soil**
  - **Water**
  - **Sand**
  - **Knife**
  - **Plant hormones**
  - **Wood ash**
  - **A fungicide**

Special inputs for work station 1

- **under ground stems such as ginger , colocasia, onion, potato**
- **Suitable pots/containers, prepared beds**

Special inputs for work station 11

- **plant parts such as runners, bulbils, suckers and stolons**
- **Suitable pots/containers, prepared beds**

Instructions for the explanations of subject matter :

- **Present findings to the entire class and lead a discussion to highlight the following. That,**
  - **various natural vegetative structures can be used in vegetative propagation of plants**
  - **type of the natural vegetative structure that is used for planting can be varied with the type of plant parts of roots**
    eg Curry leaves (Sinhala-karapincha, Tamil-Kariveppilai), *Aegle marmelos* **(Sinhala-Beli, Tamil-Villvai) parts of stems e.g roses, sweet potato, shoe flower**
  - **nature of the underground stems can be classified as follows**
    - **Rhizomes - Ginger ,Turmeric**
    - **Corms -***Alocasia* **,***Colocasia*
    - **Bulbs - Onion**
    - **Tubers - Potato**
  - **various treatments are used in the preparation of planting materials**
    eg. Application of ash on banana corms or dipping banana corms in 2% Copper Sulphate solution

Competency level 7.8 : **Propagates plants artificially using different planting materials.**

Duration : **05 periods.**

Learning outcomes :

- **Names improved vegetative propagation methods.**
- **Describes the importance and advantages of using improved vegetative propagation methods.**
- **Propagates plants using various improved vegetative propagation methods.**
- **Practices various layering methods.**
- **Practices various budding methods.**
- **Proposes solutions for problems that arise in various plant propagation methods.**

Teaching-learning process

Engagement :

- **Introduce a picture of layering or budding to the class.**
- **Ask student about the method of plant propagation.**
- **Lead a discussion to highlight the following:**
  That,
  - **vegetative propagation done with human interference are called improved vegetative propagation methods**
  - **improved vegetative propagation methods can be used to improve the productivity and profit.**

Proposed suggestions for learning :

- **Pay attention to one of the following topics given to your group.**
  - **Air layering, H budding, W edge grafting**
  - **Simple layering, T budding, inarching (inarch grafting)**
  - **Compound layering, Patch budding**
- **Practice the vegetative propagation method given.**
- **Describe the method of propagating plants using the given improved vegetative propagation methods.**
- **Explain the importance of improved vegetative propagation methods in crop cultivation.**
- **Give strategies that can be adapted to minimize the problems that arise in using these vegetative propagation methods.**

- Be prepared to present your findings creatively, to the entire class.

Instructions for preparation of work stations:

- Prepare 3 work stations for the following topics using equipment and materials given.
  - Air layering, H budding, W edge grafting
  - Simple layering, T budding, inarch grafting
  - Compound layering, Patch budding
- Common equipment for all work stations
  - Budding knives
  - Three secateurs
  - Polythene strips
  - Three pairs of scissors
  - Polythene bags
  - sieved top soil
  - W ood ash
  - Sieved compost
  - W ater
  - Sand
  - Knife
  - Fungicide
  - Plant hormones
- Special inputs for work station A
  - Suitable scion (shoots with buds) and stocks
- Special inputs for work station B
  - Suitable scion (shoots with buds) and stocks

Instructions for the explanations of subject matter :

- Let students present their findings to the class and lead a discussion to highlight the following.

  That,
  - stems that are used for planting can be classified as soft wood, hard wood and semi hard wood, according to the nature of maturity.
  - plants can be propagated by leaves or parts of roots
  - different treatments are applied to prepare planting materials for field establishment
  - layering is, inducing of rooting on a stem while the stem is attached to the parent plant
  - There are several layering methods as follows
    - Simple layering
    - Tip layering
    - Compound layering
  - Ground layering is done for plants which can bent up to the earth,
  - Air layering is practiced for branches that cannot be bend up to the earth
  - Necessary steps should be followed in layering
  - The plant part that are connected to the soil with the root system is called the stock and the bud or shoot that is fixed to the stock is called the scion

- The characteristics of a stock and a scion should be considered in budding and grafting
- There are some characteristics to be considered in selecting a stock and a scion
- The use of buds as scions is called as budding
- The following are the budding methods
  - Patch budding
  - T budding
  - H budding
- Selection of a shoot as a scion for budding is called grafting
- The following are the grafting methods
  - Wedge grafting
  - Inarch grafting
  - Stone grafting (green grafting)
- Correct steps should be followed in grafting/budding
- Correct budding/grafting methods should be selected according to the type of plant
- There are advantages in grafting/budding
- High quality plants can be obtained from grafting/budding using correct and appropriate techniques

Competency level 7.9 : **Explores rapid vegetative propagation methods**

Duration : **6 periods.**

Learning outcomes :

- **Explains "Tissue Culture".**
- **Describes requirements for tissue culture.**
- **Explains the possibility of obtaining a large number of plants within a short time using tissue culture techniques.**
- **Describes the use of tissue culture to produce larger quantities of food as a remedial measure for food crisis.**
- **Selects suitable nutrient media for various plant types**

Teaching-learning process

Engagement :

- **Show a poster or a picture related to tissue culture.**
- **Let students observe the picture and lead a discussion to highlight the following. That,**
  - **tissue culture is the process of producing plants using tissues or cells separated from the mother plant, in a nutrient media by providing the necessary conditions artificially under aseptic conditions**
  - **tissue culture should be practiced in sterilized conditions**
  - **various plant parts can be used in tissue culture**

Proposed suggestions for learning :

- **Pay attention on to of the topics given to your group.**
  - **Group I**
    - **meristum tissue**
    - **buds**
    - **embryos**
  - **Group II**
    - **callus**
    - **anther/pollen**
    - **protoplasm**
- **Collect information on the following themes in relation to your topic.**
  - **ability to use the given plant parts for tissue culture**

- procedure of producing plants using these plants/cells in tissue culture
- importance of producing plants using tissue culture

- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.

That,

- the foundation of the tissue culture is the ability of any cell to regenerate a whole plant and this is called totipotency
- but, the tip of the bud and root tip are the most active plant parts
- semi hard wood have the optimum potential of generating cells
- the following conditions should be fulfilled for the success of the totipotency
  - detachment of the tissue from the plant
  - physical, physiological and chemical conditions necessary to regenerate the tissue
  - sterilized environmental conditions
- the following are the important steps in tissue culture
  - proper planning of laboratories
  - preparation of tissue culture media
  - sterilization measures
  - follow basic principles of tissue culture
  - practice of tissue culture techniques
- tissue culture is the main type of micro propagation
- the main stages of micro propagation are
  - mother plant selection and maintenance
  - establishment stage
  - multiplication stage
  - rooting stage
  - acclimatization stage (hardening of plants)
- plant parts that are used for tissue culture vary with the type of the plant
- the following are the weaknesses of tissue culture
  - microbial infections
  - blackening or browning of tissues
  - mutations in plants
  - differences in identity
  - late flowering of hardened plants
  - high initial cost

Competency 8 : **Plans plant breeding methods to increase qualitative and quantitative crop yield**

Competency 8.1 : **Plans different methods of producing high quality planting materials**

Duration : **04 periods.**

Learning outcomes :

- **Explains the methods of transferring hereditary characteristics from one generation to another**
- **Describes Mendel's first law (Law of segregation)**
- **Describes Mendel's second law (Law of independent Assortment)**
- **Explains inheritance of characteristics according to Mendel's laws using simple problems.**
- **Shows the importance of knowledge of genetics in plant breeding.**

Teaching-learning process

Engagement:

- **Assign a student to present the following incident to the entire class.**

> **Mala got a few dry seeds of red coloured** *Seeniyas spp* **from Kumudunie and planted them in her garden.**
>
> **The flowers that bloomed in her garden were not as much red in colour as she expected. Some of the plants bloomed white, yellow and pink.**
>
> **Mala was worried about the reasons for producing flowers of different colours in plants which were planted from seeds obtained from a red flower.**

- **Ask the students to express their ideas on the above incident.**
- **Lead a brain storming discussion to highlight the following points. .**

  That,
  - **characteristics of parents transfer to offspring**
  - **sometimes characteristics of the progeny differ from those of parents.**
  - **scientific knowledge of these theories is important to produce new generations of high quality plants.**

Proposed suggestions for learning :

- **Each group should pay attention to one of the following posters given to your group.**

Poster 1

Cross X

Parental plants → **Plants with long pods** X **Plants with curved pods**

↓

F_1 Generation → Plants with long pods

↓ self pollination

F_2 Generation → Plants with long pods - 305

Plants with curved pods - 108

Poster 2

Cross Y

Parental plants → **Tall plants with round shaped fruits** X **Short plants with long fruits**

↓

F_1 Generation → Tall plants with round shaped fruits

↓ self pollination

F_2 Generation → Tall plants with round shaped fruits - 906

Tall plants with long fruits - 298

Short plants with round shaped fruits - 306

Short plants with long fruits - 104

- Review the given resources and identify 2 main factors that determine the characteristics of plants.
- Study the poster given to your group.
- Identify the characteristics of parental plants.
- Compare the characteristics between parental plants with the progeny and find the similarities and differences.
- Review the resource book and find information to explain reasons for these similarities and differences using Mendel's laws.
- Describe Mendel's laws that can be used to explain the information given in your poster.
- Discuss methods of improving crop yield using the knowledge gained from the activity.

Instructions for the explanations of subject matter:

- Lead a discussion to highlight the following.

That,

- Mendel is the father of Genetics and his research findings were the basis of genetics.
- The following can be discovered from Mendel's research findings,
  - factors in plants are important to regulate hereditary characteristics of plants.
  - these factors transfer from one generation to another.
  - these factors can be expressed in two aspects.
  - these are responsible for the control of factors different from each other
    e.g. Height: tall and short
  - one factor suppresses the opposite of the particular character
    e.g. Factor responsible for the production of tall plants suppresses the factor that produces short plants in pea (*Pisium sativum)*
  - these factors exist as pairs in living beings.
  - offspring get one of these from father while the other one is from the mother
  - these factors are named genes
  - factors which highlight the characteristics are named dominant genes and factors which suppress the characteristics are named recessive genes
  - these genes segregate independently to produce gametes
  - this is explained in Mendel's law of segregation
  - factors which were segregated in the production of gametes show independent assortment in the fertilization of gametes
- Improvement of qualitative and quantitative crop yield is an agricultural need.
- Knowledge of genetics is important to improve crop yield.

Competency level 8.2 : **Plans different methods to enhance inheritance variabilities to improve plants.**

Duration : **05 periods.**

Learning outcomes :

- **Describes various plant breeding methods.**
- **Explains methods of plant improvement through breeding**
- **Describes various plant breeding methods, comparatively.**
- **Explains the use of gene technology in plant breeding.**
- **Describes hybrid seed production procedure.**

Teaching-learning process

Engagement :

- **Assign a student to present the following report to the entire class.**

> **Report**
>
> **Florescent Ornamental Plants**
>
> **It is a glorious experience for us, the decoration the night by emission of light from the body of fire flies. It is possible to create beautiful gardens, if there are such ornamental plants. According to a study of bio technologists, it was discovered that the enzyme *luciferace* is the substance which provides the ability for fire flies to emit light.**
>
> **Scientists can develop this ability in plants by incorporating the genes which are responsible to produce this enzyme in plants.**
>
> **It's amazing; Bio technology helps you to make your garden a wonderful place.**
>
> *"Saru"- 2004*

- **Ask the students to present their views on facts given in the report.**
- **Lead a discussion to highlight the following: .**

  That,

  - **plant improvement can be done according to the needs of human beings**
  - **Various plant improvement strategies are described as plant breeding**
  - **there are various plant breeding techniques**

Proposed instructions for learning :

- Each group should pay attention to the topic given to your group.

Group 1

- Use of "Selection" as a plant breeding method
- Advantages and disadvantages of selection

Group 2

- Use of "Hybridization" as a plant breeding method
- Hybrid seed production
- Advantages and disadvantages of hybridization and hybrid seed production

Group 3

- Use of "Gene Technology" as a plant breeding method
  e.g. Gene recombination, Recombinant gene technology
- Advantages and disadvantages of mutation breeding

- Explain terms; chromosomes, genes, alleles, homogenous chromosomes, dominant genes, recessive genes, homozygous, heterozygous
- Explore the materials given and collect information on the relevant plant breeding technique assigned to your group.
- Be prepared to present your findings creatively, to the entire class.

Instructions for subject matter explanation :

- Lead a discussion to highlight the following points.
  That,
  - following techniques are used in plant breeding
    - selection
    - hybridization
    - mutation breeding
    - gene technology
  - choose of plant with favorable characteristics from a large population is done in "Selection"
  - characteristics in selected plants should be transferred to the progeny
  - pedigree selection and mass selection are used in "selection" of plants
  - selection is used as the basic stage in hybridization and mutation breeding
  - it is difficult to do changes in plants that need for human, only by the "selection"
  - therefore, hybridization is done to fulfill human requirements
  - pollination of two plants with favorable characteristics, to produce offspring with both favorable maternal and paternal characteristics is known as hybridization

- various strategies are used to fix characteristics of parents in the progeny
- 'hybrid vigor' is produced in plants at hybridization
- hybrid vigor is produced due to heterozygous alleles
- characteristics the progeny with hybrid vigor are better than characteristics of parents
- hybrid seeds produce commercially as planting materials
- plants obtained by planting seed of the hybrid plants do not exist favorable characteristics as in hybrid plants
- there is a tendency to use gene technology because it takes long time to breed plants in hybridization
- composition of genes in plants are been changed in gene technology
- gene recombination and recombinant DNA technology are gene technology strategies
- various methods are used to produce mutants in mutation breeding
- mutations change genes in plants
- gene technology is used to induce mutations in mutation breeding
- there are advantages and disadvantages in mutation breeding

Competency level 8.3 : **Plans methods to conserve genetic resources.**

Duration : **05 periods.**

Learning outcomes :

- **Explains the importance of conservation of genetic resources.**
- **Describes different methods of genetic resource conservation.**
- **Presents reasons for the essentiality of conservation of genetic resources, today.**
- **Contributes to the conservation of protected lands.**

Teaching-learning process

Engagement :

- **Assign a student to read the following newspaper article related to bio diversity in Sri Lanka to the entire class.**

> **Newspaper article**
>
> **Number of plant species that have evolved in Sri Lanka, are 1099. Among these 673 species are under threat and 37% of these endangered plant species are reported as plants under severe threat. Also, 412 plant species of Sri Lanka are indigenous plants. These plants might become extinct in the future due to the loss of their natural habitat.**

- **Ask students to express their ideas about the information given in the article.**
- **Lead a brain storming discussion to highlight the following: .**
  That,
  - **some of the genetic resources in Sri Lanka are under threat and may become extinct**
  - **genetic resources that have already become extinct cannot be regenerated**
  - **therefore conservation of genetic resources is a must**
  - **necessary actions should be taken to conserve genetic resources**

Proposed instructions for learning :

- **Select the topic relevant to your group.**
  A: In-situ conservation of genetic resources.
  B: Ex-situ conservation of genetic resources.

- Describe "conservation of genetic resources".
- Collect information about the "Red list" of plants.
- Find reasons for the extinction of genetic resources.
- Discover the importance of genetic resource conservation
- Collect information about methods of genetic resource conservation.
- Collect information on the following themes, in relation to your topic.
  - Methods of genetic resource conservation
  - Places where genetic resources are conserved
  - Issues and challenges related to genetic resource conservation
  - Strategies to overcome these issues and challenges
- List out the plants in your area that are under threat
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.
  That,
  - plants were domesticated a long time ago.
  - Large numbers of genotypes are being rejected or not used, in the selection of suitable plants for current requirements.
  - A large number of plant species have become extinct from the earth naturally and through human interference
  - These plants are listed in a book called 'Red List'
  - plants or genotypes which are destroyed from the earth cannot be regenerated
  - genetic variability of crops is narrowing in modern agriculture
  - old varieties of paddy, indigenous to our country, have become was extinct as a result of modern agriculture
  - Therefore, genetic resource conservation is very important
  - there are two methods of conservation of genetic resources
  - 'In-situ conservation' and 'Ex-situ conservation' are the methods of conserving genetic resources
  - maintenance of protected forests like '*Sinharaja forest*' is a method of In-situ conservation of genetic resources
  - it is important to protect such places
  - seeds, vegetation propagation and tissue culture are used in ex-situ conservation
  - there are advantages and disadvantages in these methods
  - various methods are being used in ex-situ conservation of genetic resources

Competency 9 : Plans controled environmental conditions to obtain qualitatively and quantitatively increased crop yields.

Competency 9.1 : Selects suitable strategies to control different environmental conditions

Duration : 05 periods.

Learning outcomes :

- Names different plant growth structures that are used to control environmental conditions
- Describes different strategies used to control the environmental conditions
- Explains solutions for problems that arise in protected agriculture
- Explains the importance of planting crops under controlled environmental conditions.
- Describes the methods of controlling environmental conditions in plant growth structures.

Teaching-learning process

Engagement:

- Display a picture that shows a plantation inside a green house or a banana bunch that is covered, to the class.
- Lead a discussion to highlight the following.

  That,
  - planting crops under controlled atmospheric and soil conditions is known as the protected agriculture
  - the following are the strategies used to control environmental conditions
    - Mulching
    - Fruit covers
    - Temporary plant propagators
    - Semi-permanent and permanent plant propagators

Proposed suggestions for learning :

- Each group should pay attention to one of the following topics given to your group.
  - Temporary plant propagators
  - Lath houses and plant propagators
  - Poly tunnels and green houses
  - propagation structures used to conserve water

- Review the resources given and explore the following
  - method of construction of the plant growth structure given.
  - environmental conditions controlled in the given plant growth structure
  - types of plants which can be planted
  - advantages and disadvantages
  - importance of protected agriculture
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.
  That,
  - crops could be planted by controlling rainfall, temperature, humidity, wind, insect pests and diseases
  - crop yield can be obtained throughout the year by controlling rainfall
  - bio chemical processes of plants are regulated by controlling relative humidity
  - it leads to increase crop yield by improving the leaf area and photosynthesis
  - able to get a high quality yield as it minimizes insect pest attacks
  - able to minimize limitations of planting crops in zones by controlling temperature
  - it minimizes mechanical damage for crops by controlling wind
  - capital investment is comparatively high to create controlled conditions in these plant growth structures
  - plants that need cross pollination should be pollinated artificially inside plant growth structures
  - conditions created in plant growth structures due to green house effect should be controlled
  - use of materials such as polythene might create a negative impact on the environment
  - sterilized tools are necessary to control diseases in plant growth structures and needs extra costs to maintain such conditions
  - easy to use irrigation and fertilizer application methods in plant growth structures and these can be practiced efficiently.
  - able to minimize the application of chemicals such as insecticides, weedicides and fungicides
  - use temporary plant propagators to protect seedlings at various sensitive stages of growth
  - the following can be used as temporary plant propagators
    - single plant covers
    - raw covers
    - bed covers
  - there are advantages and disadvantages in the use of temporary plant propagators
  - green houses are permanent structures

- all the environmental conditions can be controlled inside green houses
- various structures and strategies are used in green houses to control environmental conditions
- there are advantages and disadvantages in the use of green houses
- poly tunnels, lath houses and plant propagators are semi permanent structures
- when constructing poly tunnels, materials such as galvanize, timber and P.V.C. tubes are used to make the frame
- the frame of the poly tunnel is covered using polythene
- environmental conditions such as temperature, relative humidity, rain fall, and wind can be controlled in poly tunnels
- plants such as tomato, bell pepper, strawberry and gherkin can be planted in poly tunnels
- there are advantages and disadvantages in the use of poly tunnels
- lath houses are constructed using wooden strips, ropes and mesh
- it is possible to provide shade in lath houses and plants can be protected from the wind and macro pests
- moisture and relative humidity is controlled up to some extent in lath houses
- lath houses are used mostly in planting ornamental plants such as Anthurium, Orchid, leafy ornamental plants
- there are advantages and disadvantages in the use of lath houses
- simple solar propagators and solar propagators are used as plant propagators
- simple solar propagators are used to plant a single plant and solar propagators are used to plant a large number of plants
- these are mostly used for rooting stem parts
- it is possible to make a simple plant propagator using polythene bags or plastic mega bottles
- solar propagators can be made by covering an arch shaped structure using polythene
- there are advantages and disadvantages in the use of solar propagators
- temperature and relative humidity is controlled in solar propagators
- coir dust, straw, leaves/branches can be used as mulching materials
- there are advantages and disadvantages in mulches
- the base of the water conserving propagation structures are filled with organic materials
- water that is absorbed by the organic materials in these structures during the rainy season, can be used during the dry season

Competency level 9.2 : **Plans soil less cultures for qualitative crop yield**

Duration : **04 periods.**

Learning outcomes :

- **Describes the importance of soilless culture**
- **Explains the nutrient media and cultivation media used in soilless culture**
- **Explains the management practices of various soilless cultures, comparatively**
- **Describes problems related to soilless culture**
- **Suggests measures to minimize these problems**

Teaching-learning process

Engagement :

- **Assign two students to present the following dialogue to the entire class.**

Dialogue

Teacher : **Children, can you remember the plants that we have seen at the exhibition? Especially, plants grown in hanging bags inside a polythene house.**

Children : **Yes, teacher .We saw strawberry plants with fruits. We liked it. mmmm.....**

Teacher : **Have you observed the planting media?.**

Children : **Yes, teacher . It was coir dust. But... How does it get fertilizer?**

Teacher : **Didn't you see small tubes inserted to bags? It is the method of supplying liquid fertilizer .**

Children : **Yes, Yes, we did.**

Teacher : **OK, It is called soilless culture. Today we are going to learn more about this.**

- **Lead a discussion to highlight the following.**

  That,

  - **plants can be grown without soil**
  - **nutrients can be supplied as liquid fertilizer in soilless culture**
  - **it is possible to minimize problems which might arise as in normal plantations**

Proposed instructions for learning :

- Each group should explore the following themes in relation to the topic given to your group.
  - Soilless culture in circulatory media
  - Soilless culture in non circulatory media
  - Solid media culture and aeroponics
- Select the relevant topic
- Use resource materials and other learning aids
- Explore the following themes in relation to your topic
  - Importance of soilless culture
  - Nutrient media and planting media used in soilless culture
  - Standards which should be maintained in nutrient media and planting media
  - Maintenance and other cultural practices relevant to your topic
  - Problem in soilless culture
  - Means to minimize these problems
- Discuss your findings within the group
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following.
  That,
  - there are advantages in soilless culture
  - Albert's solution and Alan Cooper solution are used as nutrient solutions in soilless culture
  - electrical conductivity and pH value of the media should be maintained within the proper range
  - water and solid materials can be used as the planting media in soilless culture
  - pH value, salinity, Sodium chloride, Boron, and Bi carbonate should be present in the proper percentages suitable for plants when water is used as the medium
  - several materials can be used as solid media in soilless culture
    e.g. gravel, granite chips, saw dust, coir dust, coir fiber
  - the following factors should be considered when solid materials is used as the medium
    - flexibility
    - friability
    - water holding capacity
    - optimum aeration
    - well drainage

- buffering capacity

- solid materials are used to fix plants in hydroponics
- soilless culture is done according to different methods
  - there are different techniques in nutrient flow methods
  - shallow nutrient film technique
  - deep flow technique
- the following are the different methods of non circulatory soil less cultures
  - Root dipping cultures
  - Planting tuber crops
  - Floating cultures
  - Capillary action culture
- the following are the different methods of planting in solid media
  - Use of hanging bags
  - Grow bags placed on the ground
  - Gully or basin method
  - Pot method
- there are different management practices used in soilless culture
- some problems may arise in soilless culture
- different measures can be followed to minimize these problems

Competency 10 : **Exhibits readiness to obtain a higher yield by optimizing plant physiological processes.**

Competency level 10.1 : **Plans different methods to optimize the photosynthesis.**

Duration : **04 periods.**

Learning outcomes :

- **Defines photosynthesis.**
- **Names the factors that affect photosynthesis.**
- **Describes the steps of the photosynthetic process.**
- **Describes the importance of photosynthesis in increasing crop yield.**
- **Explains the agricultural strategies that are applied to enhance the efficiency of photosynthesis**

Teaching-learning process

Engagement :

- **Display a turf to the class.**
- **Ask students about reasons for the greenish colour of the grass and other factors that affect photosynthesis other than chlorophyll.**
- **Lead a discussion to highlight the following,**
  That,
  - **photosynthesis is the process of producing food using simple inorganic compounds with the help of solar energy**
  - **factors other than chlorophyll also, affect photosynthesis**
  - **glucose (**$C_6H_{12}O_6$) is produced using Carbon dioxide (CO_2) and water (H_2O) in this process
  - **plants can be divided into 2 groups as** C_3 and C_4 plants according to the process of photosynthesis.
  - **yield can be increased through efficient photosynthesis using various crop management practices.**

Proposed suggestions for learning :

- Each group should pay attention to the topic given related the factors affecting photosynthesis.
  - Light, CO_2 ,inhibitors, pollutants
  - Chlorophyll, water , temperature
- Collect information about the photosynthetic process.
  - define photosynthesis and explain photosynthesis using a simple equation
  - explain the steps in photosynthesis
- Refer to the resource book and identify the factor that affect photosynthesis, given to your group.
- Describe the limits of the above factor on photosynthesis by demonstrating the effect using a graph.
- Describe the effects of the factor given to your group to increase crop yield.
- Explain strategies that can be applied to control the above mentioned factor to enhance the efficiency of photosynthesis
- Be prepared to present your findings creatively, to the entire class.

Instructions for the explanations of subject matter :

- Lead a discussion to highlight the following.
  That,
  - photosynthesis is the process of producing food using simple inorganic compounds with the help of solar energy
  - the following factors are important for photosynthesis
    - Water
    - Light
    - Carbon dioxide
    - Chlorophyll
    - Temperature
    - Inhibitors and Pollutants
  - There are various methods to obtain these factors
  - Leaves are adapted as follows to obtain these factors efficiently
    - Structural adaptations
    - Functional adaptations
  - Various adaptations can be seen in plants for efficient photosynthesis
    - To obtain more solar radiation
    - To use light efficiently
    - To exchange air efficiently
    - To distribute water efficiently
    - To manage production of the photosynthesis efficiently

- There is the possibility of using photosynthesis to produce various functions in the plant
- Yield can be increased by providing necessary conditions for efficient photosynthesis eg.
  - Management of crop canopy for optimum light interception
  - Management of spacing between rows and plants
  - Supplying nutrients properly
  - Management of pests and diseases
  - Use of correct pruning methods

Competency level 10.2 : Plans different methods to optimize plant respiration.

Duration : 04 periods.

Learning outcomes :

- Describes the respiration of plants.
- Explains the importance of regulating plant respiration.
- Describes the management practices suitable to regulate plant respiration to increase crop yield.
- Names the factors affecting respiration.
- Explains the relationship between respiration and temperature.

Teaching-learning process

Engagement :

- Display posters with the following statements.

> "Ornamental plants kept in bedrooms should be placed outside the room at night"

> "Higher yield can be obtained by cultivating potato in cool climatic conditions like Nuwara Eliya than cultivating in the low country"

- Allow students to read the above statements and discuss the following
  - there is no harm in keeping plants inside rooms during the day time
  - there are harmful effects when plants are kept inside rooms during the night
  - potatoes produce yield both in the low country and up country but, the yield is comparatively high when cultivate up country
- Lead a discussion to highlight the following

  That,
  - respiration is the process of using energy for biological reactions inside the body by the combustion of food, in living beings
  - plants respire
  - respiration is affected by various external and internal factors
  - there is a direct relationship between crop yield and the respiration process

Proposed suggestions for learning :

- **Each group should pay attention to the topic given from the following.**
  - **respiration is regulated when manipulating plant propagation materials**
  - **respiration is regulated when crops are in the field**
- **Review the resource book.**
- **Discuss the factors affecting respiration.**
- **What do you mean by "Regulation of respiration process in crop cultivation"?**
- **Discuss strategies related to your topic for improving crop cultivation.**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanations of subject matter :

- **Lead a discussion to highlight the following.**

  That,
  - **Respiration is the main metabolic process of plants**
  - **Food in the plant is used for the above process**
  - **the energy in food is released through the above process**
  - **Energy is released in several steps**
  - **Respiration is a reaction controlled by enzymes**
  - **Energy released by respiration is stored in ATP**
  - **O_2** is used in aerobic respiration and O_2 is not used in anaerobic respiration
  - **CO_2**, ethyl alcohol and energy are the end products of anaerobic respiration
  - **Respiration should be regulated at an optimum level to increase yield**
  - **Various strategies are used in Agriculture to regulate respiration**
  - **Anaerobic respiration is used in various industries**

Competency level 10.3 : **Plans different methods to optimize transpiration.**

Duration : **05 periods.**

Learning outcomes :

- **Describes the transpiration process.**
- **Values transpiration as an important and essential process in plants.**
- **Uses strategies to maintain transpiration optimally.**
- **Explains the importance of conservation of water in plants.**
- **Explains the adaptations of plants to minimize the transpiration.**

Teaching-learning process

Engagement :

- **Show a potted plant covered using polythene kept under sunlight for 30 minutes.**
- **Let students explore following statements.**
  - **"Sometimes, water is sprayed on cut leafy vegetables in the market".**
  - **"Portions of leaves are removed in planting banana plants".**
- **Ask students views on the following.**
  - **Method of forming droplets of water, when a branch of a plant is covered by a polythene bag.**
  - **Reasons why leafy vegetables do not wither when sprayed with water**
  - **Advantage of cutting the leaves of a banana when planting**
- **Lead a discussion to highlight the following:**

  That,
  - **The emission of water as vapour from the leaves of plants is called transpiration.**
  - **Various external and internal factors affect transpiration.**
  - **Transpiration should be controlled to minimize water losses in crop cultivation.**
  - **Various strategies can be used to control transpiration.**

Proposed instructions for learning :

- **Pay attention to one of the following topics given to your group.**
  - **External factors that affect transpiration**
  - **Internal factors that affect transpiration**
- **Refer resources to identify the factors related to your topic.**
- **Explain how these factors affect transpiration.**
- **Collect information on the transpiration process.**
- **What are the other ways of removing water from plants? Compare these methods with transpiration.**

- Explain adaptations of plants that minimize transpiration.
- What is the necessity of controlling transpiration in plants? What are the various strategies that can be used for this?
- Be prepared to present your findings to the entire class.

Instructions for the explanation of subject matter :

- Lead a discussion to highlight the following:
  That,
  - The emission of water as vapour from the leaves of plants is called transpiration.
  - Transpiration can be divided into 3 main types
  - Root pressure affects guttation
  - Transpiration is a simple diffusion process
  - Transpiration and vaporization are 2 different phenomena.
  - External factors as well as internal factors affect transpiration

External factors (environmental factors)	Internal factors
- Temperature - Light - Wind - Soil moisture - Relative humidity	- Leaf area - Direction of the leaf - Sunken stomata - Thickness of the leaf surface - Presence of hairs on leaves - Distribution and number of stomata - Amount of water in the plant

  - There are various adaptation in plants to control transpiration
  - Various strategies are used to control transpiration for optimal crop growth in agriculture
  - There may be damage to plants due to a high transpiration rate

Competency level 10.4 : **Plans methods to regulate absorption and transportation of materials in plants.**

Duration : **05 periods.**

Learning outcomes :

- **Describes absorption of materials to plants.**
- **Describes translocation of materials in plants.**
- **Plans necessary post handling practices suitable for efficient absorption and translocation of materials.**
- **Describes ways of increasing yield through efficient absorption and translocation.**
- **Explains the structural adaptations of plants for absorption and translocation of materials.**

Teaching-learning process

Engagement :

- **Introduce a** *Hydrocera triflora/Bolsom spp (Sinhala-Koodalu, Tamil-Kasiththumbai)* **plant placed on a dye solution, approximately for about 24 hours.**
- **Allow students to observe the plant and lead a discussion to highlight following statements That,**
  - **Materials dissolved in water are absorbed by the plant through the root system and translocated throughout the plant.**
  - **Absorption and translocation of materials are essential processes for the survival of plants.**

Proposed instructions for learning :

- **Explore the topic given to your group from the following.**
  - **Absorption of materials into plants**
  - **Translocation of materials through the plants**
- **Define your topic and describe the relevant process. (Identify scientific principles related to the topic).**
- **Explain the structural adaptations of the plant for the above process, using diagrams.**
- **Identify the active stages of the above process in plants.**
- **Describe the ways of controlling the above processes to increase yield.**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **plants absorb water , air and minerals in various ways.**
  - **absorbed water , minerals and produced food in the plants are translocated to various parts of the plant.**
  - **water and minerals are mainly absorbed through the root system and absorption of air takes place through stomata and lenticels by simple diffusion**
  - **the vascular system is important for translocation of materials**
  - **materials are absorbed by the plants through 2 main processes such as passive absorption and active absorption**
  - **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. Also, this is used to absorb water under water deficient conditions**
  - **passive absorption is the process of absorbing of materials from a high concentration into a low concentration without using metabolic energy**
  - **diffusion is the flow of materials as particles from a high concentration gradient to a law concentration gradient**
  - **Adsorption of water molecules by hydrophilic materials is called as imbibition**
  - **movement of water through a semi permeable membrane from higher concentration gradient to lower concentration gradient is called osmosis**
  - **movement of solutions as solutes or sediments with the influence of gravity or pressure gradient is called mass flow**
  - **Facilitated diffusion helps to transport water molecules as well as other molecules**
  - **plant structural characteristics also contribute to material absorption and translocation processes of plants, in addition to the theories above**
  - **Water is absorbed from soil solution to plant roots through root hairs by osmosis**
  - **Radial movement of water from root epidermis to xylem is effected by three pathways vacuolar , symplast and apoplast**
  - **diffusion and mass flow is used in the translocation through apoplast**
  - **water is transported by osmosis in symplast**
  - **water and minerals are transported by osmosis in the vacuolar pathway .**
  - **The upward translocation of water through the xylem tissues is called as ascent of sap.**
  - **Water and minerals are moved through the apoplast pathway i.e. through xylem vessels, tracheids and xylem fibers).**
  - **Xylem vessels and tracheids are non living and walls are lignified**

- Ascent of sap mainly occurres through vessels using mass flow.
- There are several theories about upward movement of water through the xylem
- Cohesion-adhesion forces and transpiration pull are important in transpiration pull theory/ cohesion-adhesion theory
- root pressure and capillary action is also used in the upward movement of water through the plant.
- Plant physiological processes can be improved to increase crop yield by increasing the efficiency of absorption and translocation
- Transportation of food produced by photosynthesis into various parts of the plant is called phloem translocation
- Active transport and osmosis are important for the above process
- Phloem transport can be proved by using radio-active traces (elements) and stripped off the bark as a ring
- stripped off bark as a ring can be used to increase yield

  eg.
  - use of slant cuts in rubber tapping
  - removal of bark as a ring and winding of metal wires for plants which do not produce fruits.

Competency level 10.5 : **Plans to increase of crop production using growth regulators**

Duration : **05 periods.**

Learning outcomes :

- **Defines a plant hormone.**
- **Describes the methods of regulating plant growth, development and fruiting through hormones.**
- **Describes ways of improving productivity of agricultural crops using plant regulators.**
- **Explains hormone synthesis.**
- **Explains how hormones are destroyed.**

Teaching-learning process

Engagement :

- **Introduce two pots of pineapple plants (of same age) with flowers and without flowers (Date of Planting dates should be displayed on labels).**
- **Allow students to observe these plants.**
- **Lead a discussion to highlight the following.**
  That,
  - **flowering of plants can be controlled by applying chemicals externally**
  - **these chemicals are called hormones/growth regulators.**
  - **productivity can be increased by inducing flowering in plants.**

Proposed instructions for learning :

- **Explore the topic given to your group from the following topics.**
  - **Auxins**
  - **Gibberellins**
  - **Cytokinins**
  - **Abscisic acid**
- **Define the term plant hormone.**
- **Explain the contribution of the relevant hormone group on physiological functions of plants.**
- **Explain the activities of the above hormone group with examples**
- **Members of all groups design a simple activity/apparatus to demonstrate the activity of auxins, and try out**
- **Be prepared to present your findings creatively, to the entire class.**

Instructions for the explanation of subject matter :

- **Lead a discussion to highlight the following.**

  That,

  - **Plant hormone can be defined as organic substances produced naturally in plants and important in small quantities to regulate physiological functions in places away from the place of production.**
  - **Plant hormones can be divided into 5 major groups**
    - **Auxins**
    - **Gibberellins**
    - **Cytokinins**
    - **Abscisic acid**
    - **Ethylene**
  - **Plant hormones function as follows**
    - **To increase the plasticity of the shoot cell walls and elasticity of the root cell walls**
    - **To increase permeability of water and water retention capacity**
    - **For active absorption against the osmotic gradient**
    - **To increase respiration rate**
    - **To increase the amount of pectin and cellulose in cell wall**
    - **As an enzymes stimulant**
    - **To synthesis proteins that have low levels of free amino acids**
  - **Hormones which are metabolically coupled to other low molecular weight compounds by covalent bonds are called conjugated plant hormones**
  - **Auxins is the group of hormone discovered first and the group that was researched more**
  - **Auxin is normally synthesized in the shoot tip**
  - **Auxin regulate some metabolic activities that affect crop productivity**

    eg.
    - **Elongation of cells**
    - **Secondary growth**
    - **Epical dominance**
    - **Parthenocarpy**
  - **Gibberellins, Cytokinins, Abscisic acid and Ethylene also regulate some metabolic activities that affect crop productivity**

    Gibberellins - Prevent stunting of plants

    Cytokinins - seed germination and seedling growth, cell division, differentiation of cells, controlling leaf senescence, root-shoot interactions

Abscisic acid - **closing stomata, plant growth, shoot dormancy, seed dormancy, abscission, formation of irregular leaves**

Ethylene - **Fruit ripening, stimulation of germination, induction of female flowers, prevention of lodging**

- **Agricultural productivity can be increased in different instances by using growth regulators,**

Auxins - **As a weedicide**
2-4 D, 2-4 5T, MCPA
NAA, 2-4 D **Prevention of forming abscission layer**
IAA **Continuous yield in mango**
IBA **rooting of shoots**

Gibberellins - **Removal of unnecessary buds in floriculture and orchards**

Ethylene - **Fruit ripening**
Stimulation of flowering in mango and pineapple plants

SCHOOL BASED ASSESSMENT

Introduction- School Based Assessment

Learning –Teaching and Evaluation are three major components of the process of education. It is a fact that teachers should know that evaluation is used to assess the progress of learning – teaching process. Moreover, teachers should know that these components influence mutually and develop each other .According to formative assessment (continuous assessment) fundamentals, it should be done while teaching or it is an ongoing process. Formative assessment can be done at the beginning, in the middle, at the end and at any instance of the learning teaching process.

Teachers who expect to assess the progress of learning of the students should use an organized plan. School based assessment (SBA) process is not a mere examination method or a testing method. This programme is known as the method of intervening to develop learning in students and teaching of teachers. Furthermore, this process can be used to maximize the student's capacities by identifying their strengths and weaknesses closely.

When implementing SBA programmes, students are directed to exploratory process through learning teaching activities and it is expected that teachers should be with the students facilitating, directing and observing the task they are engaged in.

At this juncture students should be assessed continuously and the teacher should confirm whether the skills of the students get developed up to the expected level by assessing continuously. Learning teaching process should not only provide proper experiences to the students but also check whether the students have acquired them properly. For this to happen, proper guiding should be given.

Teachers who are engaged in evaluation (assessment) would be able to supply guidance in two ways. They are commonly known as feed-back and feed- forward. Teacher's role should be providing feedback to avoid learning difficulties when the students' weaknesses and inabilities are revealed and provide feed-forward when the abilities and the strengths are identified, to develop such strong skills of the students.

Student should be able to identify what objectives have been achieved to which level, leading to success of the learning teaching process. Teachers are expected to judge the competency levels of students have reached through evaluation and they should communicate information about student progress to parents and other relevant sectors. The best method that can be used to assess is the SBA that provides the opportunity to assess students continuously.

Teachers who have got the above objective in mind will use effective learning, teaching, evaluation methods to make the teaching process and learning process effective. Following are the types of evaluation tools student and, teachers can use. These types were introduced to teachers by the Department of Examination and National Institute of Education with the new reforms. Therefore, we expect that the teachers in the system know about them well

Types of assessment tools:

1.	Assignments	2.	Projects
3.	Survey	4.	Exploration
5.	Observation	6.	Exhibitions
7.	Field trips	8.	Short written tests
9.	Structured essays	10.	Open book test
11.	Creative activities	12.	Listening tests
13.	Practical work	14.	Speech
15.	Self -creations	16.	Group work
17.	Concept maps	18.	Double entry journal
19.	Wall papers	20.	Quizzes
21.	Question and answer book	22.	Debates
23.	Panel discussions	24.	Seminars
25.	Impromptu speeches	26.	Role-plays

Teachers are not expected to use above mentioned activities for all the units and for all the subjects. Teachers should be able to pick and choose the suitable type for the relevant units for the relevant subjects to assess the progress of the students appropriately. The types of assessment tools are mentioned in Teacher's Instructional Manuals.

If the teachers try to avoid administering the relevant assessment tools in their classes there will be lapses in exhibiting the growth of academic abilities, affective factors and psycho- motor skills in the students.

Specimen Evaluation Plan

1. Evaluation term : 01

2. Competency level covered : 1.1, 1.2, 1.3

3. Subject content covered :
- Present status of the agriculture in Sri Lanka
- Contribution of agriculture to the economy
- Different sectors contribute to the Gross Domestic Production
- Employment opportunities in the agriculture sector
- Prosperity of ancient agriculture
- Recent changes in agriculture
- Threats and challenges which affect on modern agriculture and means to overcome these challenges

4. Nature of the instrument : A seminar of to make aware of students and the staff in the school on agricultural prosperity of the past, present status and potentials in the agriculture for the economic development of Sri Lanka.

5. Objectives :
- To make aware of students on contribution of the past and present agriculture for economic development in Sri Lanka.
- To develop the ability of providing suggestions suitable to get the contribution of agriculture to the economy of Sri Lanka, in future.
- To develop skills in extracting and organizing facts/ information on a given topic from different sources and present them creatively.
- To develop competency in organizing a seminar properly.

6. Instructions for implementation :

For teacher :
- Introduce the evaluation tool prior to the activity 1.1.
- Divide the class into three groups.
- Distribute following topics among groups.
  - Contribution of agriculture to the present economy of Sri Lanka.
  - Contribution of agriculture to the economy of Sri Lanka in the past.

- Potentials to get the contribution of agriculture for the economic development.

- nstruct students about time durations allocated to the activity.
  - First two weeks- Data collection
  - Third week-Preparation for the seminar
  - Fourth week-Conduct the seminar
- Monitor students at their activities

For student :
- Collect data/information from different sources in relation to your topic.
  - Central bank reports
  - Books, Magazines, News papers
  - Internet
- Discuss about the collected data/information within the group and among groups
- Be prepared to present your findings.
- Organize the seminar
- Conduct the seminar on the scheduled date

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1 Active participation 2 Collection of data/ information accurately. 3 Presentation skills 4. Completion of the activity on the scheduled date 5 Active participation				

Specimen Evaluation Plan

1. Evaluation term : 01

2. Competency level covered : 2.1, 2.2

3. Subject content covered :
- Measurement of major climatic factors
- Determination of climatic conditions of the area
- Effect of climatic factors on crop cultivation

4. Nature of the instrument : Measurement of major climatic factors: Rain fall, temperature, relative humidity, wind and evaporation

5. Objectives :
- To provide understanding on major climatic factors
- To give knowledge about measurement of major climatic factors
- To develop skills in measuring above climatic factors
- To develop the ability of providing suggestions on suitable crop cultivation practices based on the climatic condition of the area

6. Instructions for implementation :

For teacher :
- Prepare work stations and instruct students to do the activity.
- Instruct students to present a report on suitable practices that can be followed in crop cultivation after the analysis of collected data in the activity.

For student :
- Prepare a report on suitable practices that can be followed in crop cultivation after analyzing data collected in the activities given in competency level 2.1 and 2.2 and submit it on time. .

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1 Usage of instruments 2 Measurement of climatic factors. 3 Analysis of data 4 Conclusions 5 Presentation of the report				

Specimen Evaluation Plan

1. Evaluation term : 01

2. Competency level covered : 3.3, 3.4, 3.5, 3.6

3. Subject content covered :
- Soil physical properties:
  - Soil texture
  - Soil structure
  - Soil density
  - Soil porosity
- Soil chemical properties

4. Nature of the instrument : Developing a concept map representing effects of soil properties on crop production and manipulating these properties to improve the crop productivity.

5. Objectives :
- To introduce soil chemical and physical properties
- To provide skills in describing effects of these characteristics on crop growth.
- To develop the ability of representing information as a concept map

6. Instructions for implementation :

For teacher :
- Introduce the evaluation tool prior to the activity 3.3.
- Divide the class into two groups.
- Allow students to collect information when review literature at the activities given in the competency level 3.3, 3.4, 3.5, 3.6.
- Instruct students to construct a concept map after the activity
- Give sufficient time targets to complete the activity.

For student :
- Collect information at the activities given in competency level 3.3 to 3.6.
- Construct a concept map using collected information.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Collection of information 2.Construction of the concept map 3. Adequacy of information 4. Describing methodologies to manipulate soil properties to improve crop productivity 5. Presentation of the report				

Specimen Evaluation Plan

1. Evaluation term : **02**

2. Competency level covered : **4.1 to 4.7**

3. Subject content covered :
- Plant nutrients
- Functions and effects of essential plant nutrients
- Nutrient availability according to soil properties
- Direct and mixed fertilities mixtures
- Problems related to improper usage of fertilizers.
- Types of organic manure
- Strategies that can be applied to maximize the efficiency of fertilizer usage.
- The concept 'Integrated Plant Nutrient System (IPNS)' used in fertilizer application.

4. Nature of the instrument : Designing a poster to make aware of people on the concept 'Integrated Plant Nutrient System'.

5. Objectives :
- To give knowledge about plant nutrients and its' importance
- To provide skills in describing Integrated Plant Nutrient System
- To improve the use of fertilizer and organic manure in crop cultivation (Integrated Plant Nutrient System)

6. Instructions for implementation :

For teacher :
- Introduce the evaluation tool prior to the activity 4.1.
- Divide the class into four groups.
- Let students to collect information when review literature at competency 4.
- Instruct students to discuss among groups and design a poster after the activity.
- Instruct students to submit the poster within 2 weeks.
- Guide students when necessary

For student :
- Study the evaluation tool properly.
- Collect relevant information during activities given in the competency 4.

- Design a creative poster with the use of knowledge gained in the activity.
- Use new technology much as possible in designing the poster.
- Get the help of the teacher to clarify knowledge.
- Submit the poster on time.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Extraction of relevant information 2. Use of various sources to gather information (other that the literature given in the class room) 3. Creative presentation of information 4. Active participation 5. Submission of the poster on time				

Specimen Evaluation Plan

1. Evaluation term : 02

2. Competency level covered : 5.5

3. Subject content covered :
- Production of nursery plants
- Different types of plant nurseries.
- Preparation of plant nurseries
- Special types of plant nurseries
- Maintenance of plant nurseries

4. Nature of the instrument : Practical work related to different plant nursery techniques.

5. Objectives :
- To give knowledge about plant nurseries.
- To provide skills in preparation of different plant nurseries
- To provide skills in maintaining plant nurseries

6. Instructions for implementation :

For teacher :
- Conduct this evaluation tool in the activity 5.5.
- Let students to prepare different types of plant nurseries and prepare a report.
- Instruct students to submit the report on time.

For student :
- Prepare different types of plant nurseries given to each group.
- Prepare a report on following themes.
  - Method of preparing nursery
  - Seed establishment method
  - Post cultural practices in the management of plant nurseries
  - Problems aroused and suitable solutions to overcome these problems.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Extraction of relevant information 2 Planning and conducting the practical given 3. Success of the nursery 4. Submission of the report 5. Presenting suitable solutions for the problems aroused				

Specimen Evaluation Plan

1. Evaluation term : **02**

2. Competency level covered : **6.2, 6.4, 6.5**

3. Subject content covered :
- **Water sources**
- **Water lifting methods**
- **Different irrigation methods**

4. Nature of the instrument : **Designing a wall magazine including water sources, water lifting methods and different irrigation techniques.**

5. Objectives :
- **To give knowledge about different water sources (Natural and artificial water sources with examples).**
- **To provide skills to describe different traditional water lifting methods with diagrams.**
- **To provide opportunities to explain developed water lifting methods.**
- **To provide skills to classify different irrigation techniques.**
- **To develop presentation skills**

6. Instructions for implementation :

For teacher :
- **Introduce the evaluation tool prior to the activity 6.2.**
- **Divide the class into three groups and allow each group to explore one of the following topics given.**
  - **Water sources**
  - **Water lifting methods**
  - **Different irrigation methods**
- **Instruct students about time durations allocated to the activity.**
  - **First week- Collection of information**
  - **Second week- Group discussions on information collected**
  - **Third week- Designing the wall magazine**
- **Monitor students at their work**

For student :
- **Review literature and collect relevant information**
- **Discuss among groups on information collected.**
- **Design a wall magazine on time.**

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Planning the activity 2. Extraction of relevant information 3. Creativity 4. Completion of work on time 5 Active participation				

Specimen Evaluation Plan

1. Evaluation term : **03**

2. Competency level covered : **7.7, 7.8, 7.9**

3. Subject content covered :
- **Natural methods of vegetative propagation**
- **Artificial methods of vegetative propagation**

4. Nature of the instrument : **Exhibition on different vegetative propagation techniques.**

5. Objectives :
- **To give knowledge about different natural vegetative propagation structures.**
- **To provide skills to describe different natural vegetative propagation structures with live specimens.**
- **To provide opportunities to explain different artificial methods of vegetative propagation.**
- **To develop abilities to express ideas on producing tissue culture plants in laboratories.**
- **To develop competency in organizing an exhibition.**

6. Instructions for implementation :

For teacher :
- **Introduce the evaluation tool prior to the activity 7.7.**
- **Divide the class into two groups and allow each group to explore one of the following topics given.**
  - **Natural methods of vegetative propagation**
  - **Artificial methods of vegetative propagation**
- **Instruct students about time durations allocated to the activity.**
  - **First week- Collection of necessary materials for the exhibition.**
  - **Second to fourth week- Propagate plants using different vegetative propagation techniques.**
  - **Fifth week – Conducting exhibition**
- **Provide a suitable place to arrange the exhibition.**
- **Monitor students at their work.**
- **Guide students when necessary.**

For student : • Review literature and collect information relevant to the topic given.
• Collect necessary planting materials.
• Organize the exhibition.
• Conduct the exhibition on time.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Planning the activity 2 Collection of necessary planting materials 3 Creativity of the exhibition 4 Accuracy of labeling vegetative propagation methods. 5 Introduction of modern methods				

Specimen Evaluation Plan

1. Evaluation term : **03**

2. Competency level covered : **9.1, 9.2**

3. Subject content covered :
- Importance of controlling environmental conditions in crop cultivation
- Environmental conditions which should be controlled
- Different strategies use to control environmental conditions
- Soil less culture
- Different methods of soil less culture
  - Planting in nutrient media
  - Planting in solid media
- Problems related to soil less culture and suitable solutions to overcome these problems.

4. Nature of the instrument : Practical related to different methods of soil less culture.

5. Objectives :
- To describe the necessity of controlling environmental conditions in crop cultivation.
- To identify environmental conditions which should be controlled
- To try -out different methods used in soil less culture.
- To develop skills to minimize problems in practicing soil less culture.

6. Instructions for implementation :

For teacher :
- Introduce the evaluation tool prior to the activity 9.1.
- Divide the class into two groups and allow each group to explore one of the following topics given.
  - Planting in nutrient media
  - Planting in solid media
- Instruct students to follow the evaluation tool after completing activity 9.1 and 9.2.
- Provide necessary quality inputs.

- Monitor students at their work.
- Instruct students to present the report after completing the activity.
- Instruct students about time durations allocated to the activity.

For student :
- Review literature at the activities given in competency level 9.1 and 9.2 and using other sources.
- Practice the methods of soil less culture given.
- Get the help of the teacher to overcome problems related to the method given.
- Prepare a report with the help of your teacher.
- Submit the report on time.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1 Collection of necessary information 2 Planning and practicing the method given 3. Effectiveness of the out put. 4 Creative presentation of information in the report 5 Motivation to find solutions to over come different problems.				

Specimen Evaluation Plan

1. Evaluation term : 03

2. Competency level covered : 10.1, 10.2, 10.3, 10.4

3. Subject content covered :
- Photosynthesis
- Respiration
- Transpiration
- Translocation of materials.

4. Nature of the instrument : Open book test on physiological processes; photosynthesis, respiration, transpiration and translocation of materials

5. Objectives :
- To describe photosynthesis.
- To provide knowledge about factors affecting photosynthesis
- To practice different methods to improve the efficiency of photosynthesis
- To describe transpiration process.
- To explain factors affecting transpiration
- To explain different strategies use to control transpiration
- To explain methods of absorbing materials to plants and translocation.

6. Instructions for implementation :

For teacher :
- Introduce the evaluation tool prior to the activity 10.1.
- Divide the class into two groups and allow each group to explore one of the following topics given.
  - Photosynthesis and respiration
  - Transpiration and translocation of materials
- Provide necessary literature.
- Instruct students to complete the activities given in the evaluation tool and complete it on time.

For student :
- Review literature in relation to the topic given.
- Discuss your findings in the group.
- Prepare a report.
- Submit the report on time.

7. Marks :

Criteria for the evaluation	Marks			
	4	3	2	1
1. Collection of correct and relevant information 2. Organization of the information 3. Creative presentation of information in the report. 4 Active participation 5. Submission of report on time				

Grade 12
List of Practical Activities

	Name of the Practical	Competency Level
1)	Determination of climatic condition by measuring rainfall, temperature and relative humidity	2.1
2)	Study of a soil profile	3.1
3)	Determination of soil moisture content, field capacity and permanent wilting point	3.2
4)	Determination of soil texture using pipette method and rolling method	3.3
5)	Determination of soil colour and soil structure	3.4
6)	Determination of true density and bulk density of soil	3.5
7)	Determination of soil pH value	3.6
8)	Measurement of soil erosion	3.8
9)	Identification of plant nutritional deficiencies	4.2
10)	Identification of the physical characteristics of fertilizers (chemical)	4.4
11)	Preparation of organic manure	4.6
12)	Identification of land preparation equipment	5.3
13)	Preparation of different types of plant nurseries	5.5
14)	Identification of parts in a centrifugal type water pump and study its' functions	6.3
15)	Testing structure of seeds and different seed germination types	7.1
16)	Testing standards of a certified seed sample	7.3
17)	Practicing different treatments to remove seed dormancy	7.4
18)	Practicing different seed treatments	7.5
19)	Identification of different plant propagules vegetative propagation and propagate plants using them	7.7
20)	Propagation of plants using different budding and grafting methods	7.8