Book 1

Year 9

Agricultural Science

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Year 9 Book One

GOVERNMENT OF SAMOA
DEPARTMENT OF EDUCATION

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The Department of Education would like to thank the following writers for their vision, patience and hard work in putting together this valuable book.

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Unit 1: INTRODUCTION TO AGRICULTURAL SCIENCE

Objectives

At the end of this unit you should be able to:

1 Define what agriculture is.

2 Discuss the importance of learning agricultural science.

3 Discuss and define sustainability in your own words.

Introductory Questions

1 Does your family have a home garden or keep animals?

2 Name what plants grow in your garden and animals you keep.

3 Explain in your own words what agriculture is all about.

4 Does your family sell anything from a plantation to other people or to the market?

5 How do you think studying agriculture in school helps improve agriculture in Samoa?

6 What are the bad and good points of working in a plantation?

Background Information

Agriculture is the planting of food plants and raising of animals (pigs, chicken and cattle) for everyday family food, and earning money by selling some of this produce to the local market, or to other people to meet family, social, cultural and religious obligations.

Students in year 9 will study:

1 The history and the importance of agriculture.

2 The importance of soil.

3 Management, economics and marketing.

4 Crop production in Samoa

5 Animal production in Samoa.

6 Tools, equipment and facilities.

Through learning agricultural science in high school we can apply scientific knowledge to enhance agricultural development for sustainable food production in the country. ***"Sustainable" means to be able to meet the needs of society now and in the future, while at the same time conserving our natural resources***

(soil, water and forest). Careful and wise use of land for farming will ensure the continuous use of our natural resources for the present and future generations.

The year 9 agricultural science course will cover the following areas:

1 **Agriculture in Samoa**

This topic will look at the history and importance of agriculture in Samoa. It will also look at the changes that have occurred to agricultural practice over the years and the role of agriculture in the Samoan economy.

2 **Learning about soils**

This topic will give you a basic understanding of what soil is made of - the physical properties of soil and the soil profile. You will also be exposed to some commonly used scientific terms used in soil study. A good knowledge of the concepts of soil and its physical properties will help you manage soil properly to maintain its fertility.

3 **Variations and genetics**

To maintain self-sufficiency in food crop production a plant improvement programme is of great significance to agricultural development. Year 9 students will be introduced to the different types of important food crops in Samoa; crop variability due to environment and genetic background; differences in improved (high yielding) varieties, local varieties and wild species; examples of taro improvement in Samoa; different types (cultivars) of taro; and the importance of conserving a wide variety of food crops.

4 **Learning about crops**

In this section you will learn about the importance of growing different crops in terms of their nutritional value and their role in home use for food and marketing.

In year 9 students will learn how to grow vegetables (Chinese cabbage, dwarf beans, cucumber and laupele) and field crops (ginger, banana and coconuts).

Students will also carry out practical work in the field like:

- Site selection for gardening
- Land preparation
- Preparing nurseries for seedlings
- Planting and transplanting
- Pest and disease control
- Weed control
- Harvesting and marketing.

5 **Learning about animals**

Year 9 students will learn about poultry farming (raising chickens). This topic deals with the science of the structure of the chicken (anatomy). Students will also be taught about the

importance of management practices - like shelter, health, feed/water and selecting good birds for breeding (raising more chickens).

6 **Tools and equipment**
In this section you will have the opportunity to learn about commonly used garden tools, their use, maintenance and storage.

7 **General safety – safe handling of tools, chemicals and first aid**
In this section you will learn about safety procedures to be used while handling tools and agricultural chemicals. Students will discuss the dangers that can occur from careless handling of tools and agricultural chemicals. They will also have the opportunity to learn about some first aid measures that could be taken in the case of accidents or emergency.

8 **Managing an agricultural farm**
This section will introduce you to the principles of management, basic economic principles and marketing.

FOLLOW-UP QUESTIONS

1 What is agriculture? Explain in your own words.

2 Why is sustainability important?

ACTIVITY A

Brainstorming Session

Materials/Equipment

- Marker Pens
- Sheets of brown or white paper (Your teacher will provide you with these materials)

Instructions

1 Split into four groups and study the pictures that follow.
2 Discuss and explain what the pictures are about.
3 Present your opinions to the class for discussion.

Picture A

Picture B

Picture C

DISCUSSION QUESTIONS

1 Do you want to be a farmer? If yes - list out all reasons. If no - why?

2 What is agriculture? From the pictures on these pages, and your own understanding, write a short paragraph.

Picture D

Unit 2: HISTORY OF AGRICULTURE

Objectives

At the end of this unit you should be able to:

1. Understand the type of agriculture in Samoa before the missionaries came.
2. Compare the differences between farming before the coming of Europeans and the present day.
3. Define some of the agricultural terms used in the text and activities.

Introductory Questions

1. How has agriculture in Samoa changed over the last two hundred years?
2. How have these changes affected our environment and our ways of life?
3. In your own words, define these terms - crops, livestock and vegetables.

ACTIVITY A

Presentation

Materials/Equipment

- No equipment needed for this activity

Instructions

1. Invite any agriculturist from the Ministry of Agriculture or from the USP to make a presentation about the history of Agriculture in Samoa. Handouts of the presentations should be available for students. (Teacher makes contact).
2. Divide the class into groups. One group will welcome the guest; one group will give the vote of thanks and everyone prepares questions.
3. You are to listen, take notes and write your own summary report of the presentation.

ACTIVITY B

Brainstorming

Materials/Equipment

- No equipment needed for this activity

Instructions

1. Divide your class into groups of four or five. Each group read extracts 1 to 4 and discuss the questions given. Select a group member to present your findings.
2. The teacher must help the students if they have any difficulties. If necessary provide marker pens and brown or white paper for each group.
3. After your group presentations the teacher will explain any missing points. Write the class summary in your own note book.

DISCUSSION QUESTIONS

- What changes in the farming of staple food are mentioned by the author?
- Why do you think these changes happened?
- Draw a map of your island and show where the various crops are grown using the information from Extract 2.

Extract 1 **Changes in staple food in Samoa**

In Samoa, writings of early missionaries and others provide some accounts of land use at the time of European contact and changes that took place. The crops and *farming practices* used in village agriculture have not changed much since the first European arrival in the 1830's. An early Christian missionary wrote that the *staple food* of Samoans were breadfruit, taro, yams, banana and coconuts. One writer states that Samoans relied heavily on breadfruit for about half the year and that taro was the principal staple for the rest of the year.

Some crops have declined while others have increased in importance. Yams were once grown as the main crop on some plots, but today, yams are only a minor crop grown among taro and other crops.

In contrast to some of the food crops, banana increased in importance and area. As one writer cited that banana was not extensively grown in Samoan villages until seedless bananas (fai palagi) were introduced by missionaries.

Deborah Paulson.

Extract 2 **Farming systems in Samoa**

Slash and burn of new areas for gardening has been and still is the common practice of cropping in the country. Apart from the European plantation method of agriculture, the majority of Samoan cultivated land was primarily for *subsistence* (home use) food production. But with increased travelling of Samoan people overseas, which created a *market* for *export crops*, coupled with the added desire to gain wealth, people started to plant large plantations of taro to meet this need.

Farmer using digging stick

The farming systems in use in the country are either subsistence or *plantation crops* confined to the lowlands, and extending up to the foothills. Areas along the coast are classified as *coconut zones* mixed with several food crops, mainly for subsistence production, like breadfruit, banana, yams, cassava and the taro & taamu.

Further inland are mainly plantation plots or crop planted mainly to earn money and *fallow zones*, where coconuts and cocoa were the main plantation crops. However more recently, these areas mixed with banana and taro planted as either cash or food crops, until the outbreak of *taro leaf blight*.

Areas extending up to *forest-land* were classified as *taro fallow zone* and *pasture* for cattle farming. These forest lands were recently used for the establishment of large taro plantations mainly for export.

Tolo Iosefa.

Extract 3 **The economic structure: The subsistence sector**

According to reports by people who studied the economy of Samoa in the 1980s, the country's economy is dominated by agriculture. Over 50% of the national income (Gross Domestic Product) is from agriculture, and up to 70% of this comes from the *subsistence village sector*, which employs over 70% of the total labour force. Most of the output of this sector is for home use, and any surplus is sold to the local market or exported. In the *rural village economy*, fruits and vegetables of many varieties grow with little or limited *cultivation* and all villages keep chicken and pigs, with the sea providing marine products like fish and shellfish.

In village subsistence, the levels of *farming practices* are very low, with equipment simple and limited in supply. The *mixed-crop system* has a small range of marketable products; bananas, cocoa, coconuts, taro, handicrafts and vegetables. In many cases difficulties in transport limit participation in the market.

One of the advantages of the Samoan village economy is that even though cash incomes are low, there remain untouched *resources* in the form of unused land and forest.

In purely subsistence terms, Samoa enjoys a fairly high standard of living and it is only when we consider the economy by European standards or *modern development* that the situation changes.

Te'o Fairbairn.

- Discuss and list the advantages and disadvantages of subsistence farming in the economy of Samoa.

- Improving agriculture will improve the living standards and diet of families in the village. Do you think this is true? If yes – explain your reasons. If not – explain why.

Extract 4 **Village agriculture: For better living standards or not?**

The main opportunity for increasing employment and raising living standards lies in the *agricultural sector*. The greatest potential would appear to lie in making more intensive use of land already cultivated by application of new ideas or techniques of production and management.

The basic economic problem is to improve incomes on productive efforts in agriculture. This will make sure that farmers can sell their produce at good price. It also means improving conditions related to the farmer's supply of agricultural products: better production methods and improved transport. While much depends on the motivation and attitude of village farmers, government has a part to play in preparing plantation access roads in every village, money for loans and *agricultural extension services* as well as agricultural training and research.

The important area to look at is the improvement of some of the major *cash crops* where these have declined as a result of insect pests and diseases or plants getting old. Crops which need improvement are banana, cocoa, coconuts and taro. Since these crops are already well known to village farmers, proper government action to reduce cost of chemicals to maintain them and to improve and secure market price for farmers seems encouraging.

Other potential agricultural farming which needs to be included for money earning in the village economy is: pigs, chickens, cattle, ornamental plants (togalaau teu fale), kava and a *variety* of vegetables.

On the whole, *commercial production* by villagers is still at a beginning stage, so there is a need for further government action to speed up development. There is a need to provide farmers with better information, technical advice, looking for more markets and *subsidies* as well as practical assistance including demonstration units.

Te'o Fairbairn.

Use of tractors

FOLLOW-UP QUESTIONS

1 List what farmers in Samoa do to sustain food production.

2 Compare the advantages and disadvantages of agriculture in the past and today.

Unit 3: THE IMPORTANCE OF AGRICULTURE

Objectives

At the end of this unit you should be able to:

1. Define the importance of agriculture to the Samoan economy.
2. Discuss the importance of agriculture to the social and cultural life of Samoa.
3. List and explain the importance of growing various crops and raising livestock.
4. List some common cash crops grown in Samoa.

Introductory Questions

1. Why do we produce food?
2. List the agricultural produce sold in the local market.
3. What food products are usually bought for your family?
4. Do you sell some of the crops or animals you or your family planted?

Background Information

Agriculture is very important for Samoa because it:

- provides food for people
- is a source of income to meet basic needs (clothing, foods etc.)
- provides employment for people
- earns foreign exchange - through exports
- plays an important role in Samoan culture and way of life.

The most common methods of farming in Samoa include shifting cultivation, mixed cropping (multiple cropping) and rotational cropping. These methods are generally used to produce food for home consumption, social obligations such as feasts, weddings, funerals, church or school openings and others. Any surplus may be sold for cash. Such food crops are taro, taamu, banana, yam and vegetables.

The crops grown mainly for cash include kava, coconut, coffee, cocoa and vegetables.

We have no natural resources like oil, gold or coal as a source of revenue

and yet Samoa is importing a lot of goods. Payment for these goods are made through export earnings from agriculture products such as coconut cream, coconut oil, copra and kava.

People of Samoa can have a better standard of living by improving agricultural production. This means people will eat healthier food, live in better houses and live a healthier and happier life.

ACTIVITY A

Products for home use and sale

Materials/Equipment

- No equipment needed for this activity

Instructions

1. Work in groups of 5 or 6 students.
2. Discuss and list some crops and livestock raised for family food use.
3. List some crops and livestock that can be sold for cash.
4. List the crops and livestock you raise, if any, for cash only.

ACTIVITY B

State of Agriculture in the South Pacific

Materials/Equipment

- No equipment needed for this activity

Instructions

Below is an extract taken from the welcoming address given by Prof. Tuaopepe F. S. Wendt to the Directors of Education from the South Pacific Island Countries on the "*State of Agriculture in the South Pacific Island Countries.*"

Read the extract and discuss in groups the questions that follow:

(Your teacher will assist you if you have difficulty in understanding any part of this extract).

The Importance of Agriculture

> Agriculture is basic to the life of South Pacific peoples. All South Pacific Island countries rely heavily on income from agricultural production. Agriculture also contributed very much to the diets of the people. In addition to providing the largest sector of the *GNP (Gross National Product)* and most *foreign exchange* with other countries, agriculture also employs the largest numbers of the populations of these countries.
>
> Population growth rates in all South Pacific Island countries continue to be high, in most cases higher than 3%. Available information indicates that the extent of the need to provide jobs in the 1990's for those born in the 1970's will not be cut short by the lower birth rates. The major problems therefore in

DISCUSSION QUESTIONS

1 How important is agriculture to the life of the South Pacific people?

2 List down five (5) reasons given by Prof. Wendt for teaching agriculture in secondary schools.

3 Do you think agriculture should be taught in all secondary schools? Why?

4 What are the reasons given by Prof. Wendt for not giving much importance to agricultural education in the South Pacific?

5 According to Prof. Wendt a vast majority of secondary school students will return home to their villages and land. What problem does he have with this? Suggest some solutions to the problem.

6 As a student of agricultural science, what things do you really want to learn and what things do you really like to do?

the next two decades will be the employment of young people leaving school.

Avenues for productive employment are exceedingly narrow. Village agriculture is, and will be for a long time to come, the main occupation. Statistics show in the rural areas upwards to 75% of the male populations are engaged in village agriculture, and that even in the urban centres agriculture is still a major industry providing work for upward to one third of the male work force. Furthermore, women in the rural areas are mostly active in village agriculture.

In all South Pacific Island countries one third to half of the total population are children under the age of 15 years. Primary school enrolments for the age group 5-14 years are in excess of 90% for almost all countries. (The Solomon Islands has only about 13% to 15%).

At the Secondary School level only the smaller states of the Cook Islands, Tonga, Gilberts and Tuvalu, and Niue have the majority (over 90%) of their secondary school age group children in the classroom. Of the larger states, Fiji has about 58% in class, Western Samoa 30%, and the Solomon Islands only some 3%.

The *foreseeable* future will undoubtedly see further increases in numbers of children attending both primary and secondary education. But what is evident now is that the larger proportion of these young people will not continue further for higher education. Between one half (1/2) and three quarter (3/4) of all who start school will have left (dropped out) by the end of form 3 or year 9.

The majority of young people who *"dropped out"* of school, for whatever reason, return home to the village and the land. However there is an *obvious deficiency*, and in some cases the complete lack of education and training in the field of agriculture and in the preparation of young people for a future life of agricultural production and living in a rural environment.

Throughout these countries, there is general acceptance of education as the means whereby the young will develop skills and abilities which will enable them to look for jobs other than agriculture. In *national policy*, the priorities accorded education reflects its recognition as an *essential element* in development. But this does not in itself answer the question concerning the kinds of education which should be the country's goal. Should education be primarily agricultural in the interest of economic

development? Or should it be general with emphasis on the orientation of people towards personal and *economic productivity*, community action, and democratic leadership? It is suggested by some that from the viewpoint of economic development, a good general education with some agricultural and vocational training would be highly appropriate. Likewise there is general consensus that in view of the great dependence on agriculture, the need is for systems of agriculture education by which technological advances in agriculture can be introduced, accepted, and practised by both practising farmers and would be farmers. ”

Review

After reading Units 1, 2 & 3, you need to answer these questions. You may need to read the texts again to make sure of your answers. For some questions you need to apply your own understanding of the units. Your teacher will provide a copy of the following for you to fill in.

1 True or False

Write **True** or **False** in the spaces provided for each of the statements below.

a) _____ Starchy foods like breadfruit, taro and bananas were provided by the early missionaries when they came to Samoa.

b) _____ Taro and breadfruit have been the main staple foods of Samoans over the last two centuries.

c) _____ Shifting cultivation is a traditional farming system.

d) _____ Taro leaf blight is the current major disease of all food crops in Samoa.

e) _____ Subsistence farming is for home use only.

f) _____ Agriculture is the backbone of the economy in Samoa.

g) _____ The agricultural sector is the main employer for school "drop outs".

h) _____ All South Pacific Island countries rely heavily on income from agricultural production.

i) _____ In rural areas, women are more active than men in agricultural activities.

2 Fill in the missing words

a) Agricultural science is the study of _____

b) Animal anatomy is the _____

c) Cash crops are _____

d) Some examples of cash crops are _____

Unit 4: COMPARING CHARACTERISTICS OF ANIMAL BREEDS AND CROP VARIETIES

Objectives

At the end of this unit you should be able to:

1 Explain the terms "animal breed" and "crop variety".

2 Identify common characteristics of different breeds and varieties.

3 Compare the characteristics of different breeds and varieties.

Introductory Questions

1 What is an "animal breed" or "crop variety"?

2 What are some differences between different breeds of animals?

3 What are some differences between different varieties of crops?

4 Why do we keep only a certain breed(s) of chicken or plant only one or two type(s) of banana?

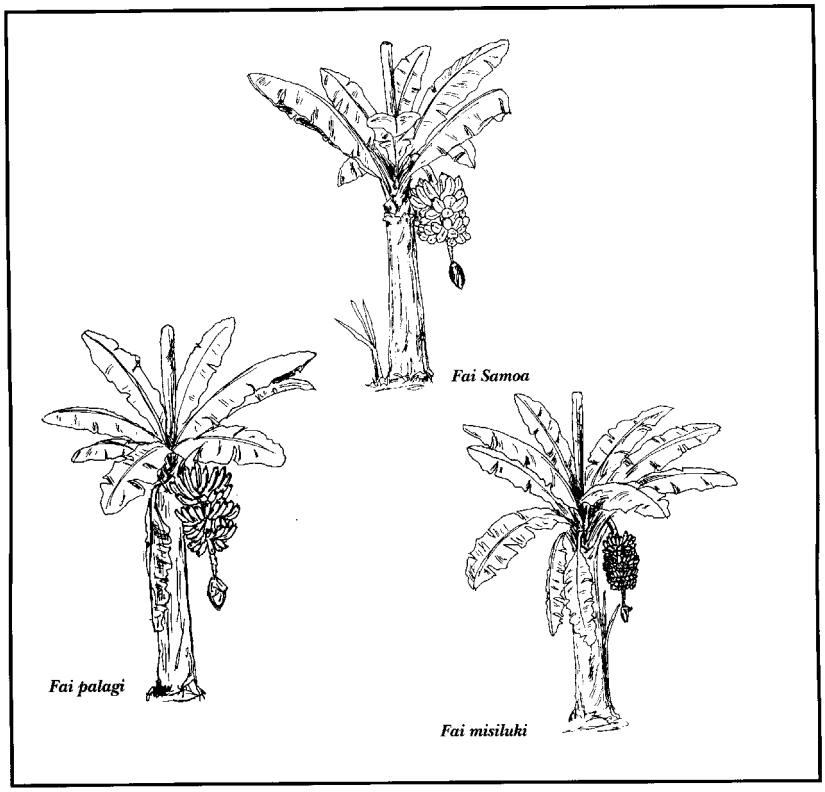
5 Why are there many different breeds of animals and varieties of crops?

6 Does a certain breed or variety serve a certain function or use?

Background Information

A **variety** is a group of plants of the same species or group having similar characteristics. For example three common varieties of banana in Samoa are Fai palagi, Fai Samoa and Fai misiluki (see illustrations on next page). Plant varieties have similar characteristics and grow well under certain environmental conditions. Most varieties of plants are planted because they have some useful characteristics. For example, Fai Samoa is planted by most growers because it has big fruit, is resistant to most diseases and has a good taste.

A **breed** is a group of animals of the same species or group having similar characteristics like colour, size or weight and shape. Some breeds are more suited to Samoa than others, for example the local chicken breeds, Australorp and White Leghorn. These breeds of chicken are adapted to the local weather conditions and grow well in local conditions. Some of their characteristics are given in the table on the next page.



Banana Varieties

Characteristic	Breed of Chicken		
	Local (A)	**White Leghorn (B)**	**Shaver 579 (C)**
Average weight (kg)	1.5-2.0	2.5	3.0
Type of comb	single/rose	rose	single
Colour of earlobe	red/white	white	red
Egg colour	white/brown	brown	brown
Skin colour	white/yellow	yellow	white
Egg number	100-160/yr	180-240/yr	180-200/yr

Breeds of Chicken

ACTIVITY A

Comparing different chicken breeds

Materials/Equipment

- Different varieties of banana (Fai palagi, Fai Samoa and Fai misiluki).
- Photographs or diagrams of different breeds of chickens (Local, White Leghorn and Shaver 579).
- Ruler or measuring tape.

Instructions

For this activity you can either go to a nearby farm and do your observations and fill in the table, or your teacher will give you photographs and pictures of the different chicken breeds for you to observe.

1. Divide and work in groups of 4 or 5 students.
2. Observe the following pictures, discuss and label the different breeds of chicken.
3. Discuss your observations together with the information given and write down the characteristics of the different breed of chickens in the table below.
4. Each group is to explain their table to the class.

Breeds of Chicken

1 White Leghorn chicken

2 Local chicken

3 Shaver 579 chicken

Characteristics	Chicken Breed		
	Local chicken	White Leghorn	Shaver 579
1 Colour (feather, egg, skin)			
2 Size			
3 Weight			
4 Type of comb			
5 Egg number per year			

ACTIVITY B

Comparing different banana varieties

Materials/Equipment

- No equipment needed for this activity

Instructions

For this activity you can either go to a nearby garden to do your observations and fill in the table, or your teacher can bring into the classroom the three varieties of banana for you to observe.

1 Divide and work in groups of 4 or 5 students.

2 Study the banana plants, discuss and identify the different varieties of banana.

3 Discuss and list the characteristics of the different varieties in the table over the page.

4 Each group is to explain what is in their table to the class.

Characteristics		Banana variety		
		Fai palagi	Fai Samoa	Fai misiluki
Flower	1. Shape			
	2. Color			
	3. Size			
	4. Number			
Fruit	1. Shape			
	2. Color			
	3. Size			
	4. Number			
Leaf	1. Shape			
	2. Color			
	3. Size			
	4. Number			
Stem	1. Shape			
	2. Color			
	3. Size			
	4. Number			

FOLLOW-UP QUESTIONS

1 What is the difference between a local and an imported breed of chicken?
2 Why do poultry farmers keep the **White Leghorn** breed of chicken?
3 Why do most farmers only plant **Fai palagi** ?
4 Commercial poultry farmers in Samoa do not keep local chicken breeds. Why?
5 How do/can farmers develop breeds of chicken or varieties of crops that they want?

Review

Instructions

Do this revision activity as a take-home assignment. In this activity you will be required to select any crop and animal in the following table and compare the characteristics of two varieties and breeds of your choice.

1. Select an animal from the table given below.
2. Select two breeds of this animal and compare their characteristics.
3. Fill in the table for animal breeds.
4. Select a crop and fill in the table for two varieties.

Crop			Animal
Coconut	Taro	Taamu	Pig
Bean	Cabbage	Tomato	Cattle
Cucumber			Goat

Student: _____

Animal: _____

Characteristics	Animal Breed	
	Breed 1:_____ (Write down name of breed)	Breed 2:_____ (Write down name of breed)
1. Colour		
2. Size		
3. Weight		
4. Temperament		
5. Mothering ability		
6. Horn (For cattle)		
7. Other		

Student: _____

Crop: _____

Characteristics		Crop Variety	
		Variety 1:_____ (Write down name of variety)	Variety 2:_____ (Write down name of variety)
Flower	1. Shape		
	2. Color		
	3. Size		
	4. Number		
Fruit	1. Shape		
	2. Color		
	3. Size		
	4. Number		
Leaf	1. Shape		
	2. Color		
	3. Size		
	4. Number		
Stem	1. Shape		
	2. Color		
	3. Size		
	4. Number		
Root	1. Type		
	2. Shape		
	3. Color		
	4. Size		

Unit 5: THE IMPORTANCE OF SOIL

Objectives

At the end of this unit you should be able to :

1. Explain what soil is.
2. Explain why plants depend on soil.
3. Explain why people depend on soil.

Introductory Questions

1. What is soil?
2. Where does soil come from?
3. Why do plants and animals depend on soil?
4. If soil is so important to plants and animals what should be done to reduce its being washed away?

Background Information

"What are soils?" and "what uses do they have for people?":

To a farmer: Soil is the substance in which plants grow. A farmer may describe soil as the crucial material in which he or she can grow plants for cropping and grazing animals.

To a chemist: Soil is a vessel or test tube into which mineral matter has been placed by natural agencies and into which fertilizers are poured to provide nutrients for plant growth.

To others: Soil is a dirty material.

These are two definitions of soil:

1. "Soil is the natural medium for the growth of plant on the surface of the earth."
2. "Soil is a natural body on the surface of the earth in which plants grow and is composed of organic and mineral materials."

Soil as a natural resource

Soil is one our most important natural resources. Plants depend on soil for nutrients, water and support for growth and development. Animals depend on plants for food and oxygen and we also depend on plants and animals

for food, oxygen and other materials. Soil is a very valuable resource not only to us but our children in the future. Therefore it is our responsibility to see that soil is used in the proper way and not damaged or polluted.

Soil and civilization

In the past when people depended mainly on agriculture, they lived only where crops grew well and where there was good grass for animals. They would shift from place to place depending on the fertility of the soil.

Today with new and modern technology, people can maintain and improve soil fertility and therefore do not need to shift from place to place as they did in the past. This is one reason why civilizations are more stable today.

Factors of plant growth

Plant growth and development depend on nutrients, light, air, water, temperature, mechanical support and environmental factors. Under favourable conditions plants will grow and develop well and produce high yields. However, if one or more of these factors is missing or lacking, then plants may not grow and develop well, and as a result plants will not produce good crops.

The farmer's responsibility then is to make sure that plants get all the things they need in order to grow and develop well and produce good quality crops.

ACTIVITY A

Concepts of Soil

Materials/Equipment

- No equipment needed for this activity

Instructions

1 Copy the statement below in your exercise book.

2 Read the statement and answer the questions that follow.

"People are dependent on soils, and conversely, good soils are dependent on people and how they use land".

L.G. G. Yappa.

DISCUSSION QUESTIONS

1 Do you agree with the above statement? If you do, try and explain the meaning of the statement.

2 If you disagree, explain why.

Have you tried to explain or define what soil is? Try to define the term ***soil*** in your exercise book.

Compare your answer with the two definitions in the background information.

Did you write down something similar to the given definitions?

You had your own idea of what soils are and likewise different people have different concepts or their own ideas of what soils are.

ACTIVITY B

Soil as a Natural Resource

DISCUSSION QUESTIONS

1 What did past civilisations depend on for survival?

2 Why do the river valleys have fertile soils?

3 What bad practices did past civilizations follow?

4 What happened as a result of their bad practices?

5 How could past civilisations have prevented soils becoming infertile and useless?

Instructions

Read the articles and follow the instructions that follow.

1 Divide into groups of four.
2 Select and read one paragraph each from Article 1.
3 Explain to your group what your paragraph means.
4 Answer the discussion questions as a group.
5 After you have answered the questions discuss your answers with the whole class. Your teacher will lead the discussions.

Article One: Soils and Civilizations

"Soil is one of the most valuable natural resources of a nation. In agriculture they are an important part of the ecosystem which produces our food. For crops soil serves as a medium which supports the plants as well as store water and food for plant growth. For livestock soil supports the growth of grass which animals eat to produce animal products like meat, milk, eggs and cheese.

Most great civilizations have depended on good soil. The old nations of the Nile in the Middle East were made possible by fertile soils which produced good crops. Likewise the fertile soils of the river valleys in India and China were places where civilization flourished in the past. Because soil fertility was frequently replenished by natural flooding, their valley soils provided continued and abundant food supplies. These soils made possible their organized communities and even cities.

Just as good soils helped to build flourishing civilizations, soil destruction or bad management was a contributing factor in their downfall. The destruction of forests resulted in erosion and topsoil loss. Irrigation systems were not often maintained, and this resulted in accumulation of salts. Consequently, the good soil became infertile and useless. The proud cities of the river valleys fell into ruin, and the people moved elsewhere.

Even today, many do not fully recognise the long-term importance of soils. We must be fully aware of what soils are, what they have meant to past generations, and what they mean today and to future generations."

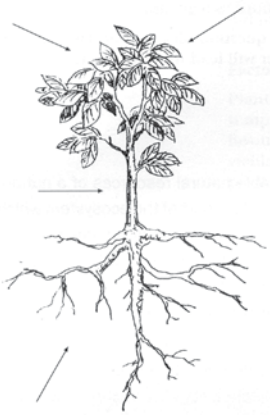
Read the next article and complete the activities that follow.

Article 2: Factors of Plant Growth

"Six factors control plant growth and development. These factors are light energy, heat energy, air, water, nutrients and mechanical support.

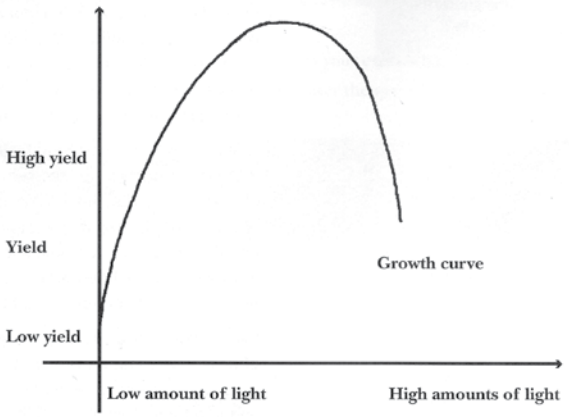
Soil is the supplier of nutrients and mechanical support and is involved in all the above factors except light.

Another important factor that affects plant growth and is sometimes included as the seventh factor is environmental conditions; insects, disease, weeds, pollution, fertilisers, etc."



1 Draw and label a diagram similar to the one on the left of a plant showing the parts where the seven factors enter or affect the plant.

2 The graph below shows the growth curve of a plant under favourable conditions. Copy the graph showing how the graph would look if the plant is affected by poor soil.



DISCUSSION QUESTIONS

1 What is soil?

2 Why do plants depend on soil?

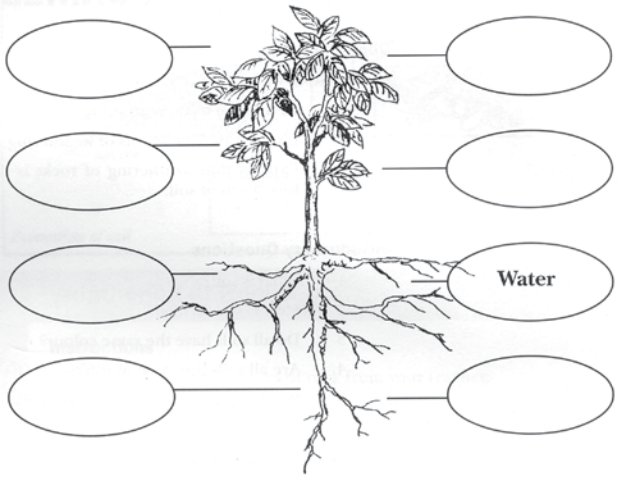
3 Why do people depend on soils?

4 Why is soil important?

Review

1 Mind map

Complete the given mind map by filling in the circles with factors that plants need for good growth and development. One example is done for you.



2 Matching

Match the term with the statement that best describes it by writing the number in the appropriate space.

_____	a)	Soil	1. A general term including soil, organisms, air, water and rocks.
_____	b)	Concept of soil	2. Composed of the part of the land surface in which plants grow.
_____	c)	Land	3. Factors needed for plant growth and development e.g., light, water, air, temperature, environmental factors, nutrients and mechanical support.
_____	d)	Growth factors	4. Ideas of what soils are e.g., farmers think that soil is a habitat for plants.

Unit 6: HOW SOIL IS FORMED

Objectives

At the end of this unit you should be able to:

1. Define the term weathering.
2. List at least four agents of weathering.
3. Explain that weathering of rocks is the starting point in the formation of soil.

Introductory Questions

1. What is soil?
2. How is soil formed?
3. Do all soils have the same colour?
4. Are all soils the same or different? Discuss.
5. What happens to plants and animals when they die?

BACKGROUND INFORMATION

All rocks are broken down into smaller pieces when exposed to the weather. This is known as weathering.

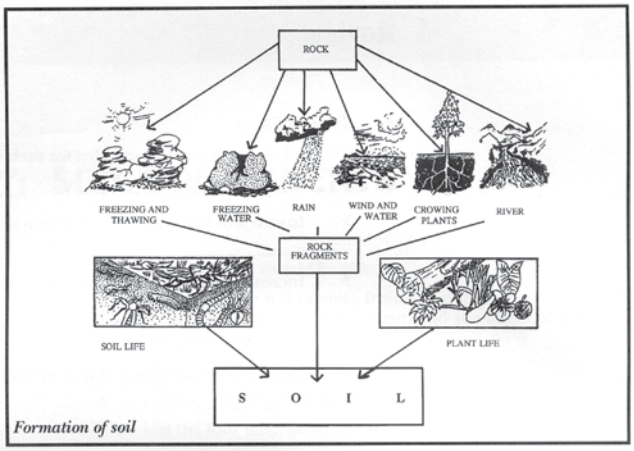
There are two general categories — the mechanical (physical) process and the chemical process.

Mechanical process

The mechanical process breaks down rocks into smaller pieces without affecting their chemical make-up. Temperature fluctuations expand and contract rocks thus breaking them into smaller pieces. The action of water, wind and ice also results in the breaking down of rocks. Lichens and plant roots grow into rocks, and over time break them down. The action of animals walking on rocks also contributes to their breakdown.

Chemical Process

The chemical process changes the chemical make-up of material and minerals. These processes are: hydrolysis, hydration, carbonation, oxidation and related acidic processes.



Formation of soil

ACTIVITY A

Weathering of Rocks

Materials/Equipment

- Two pieces of porous rock
- A piece of paper

Instructions

1. Collect two pieces of rock from your teacher.
2. Rub the two rocks together several times over a piece of paper.
3. Watch what falls on to the paper. Try to feel it. Describe what you have seen and felt in your exercise book.
4. Write down other ways you think rocks can be broken down into small pieces.

Rubbing together two rocks

FOLLOW-UP QUESTIONS

1. Do you think soil is formed from the breaking down of rocks? Explain.
2. What other materials make up soil?
3. Looking at the process of weathering, do you think soil formation is a fast or slow process? Explain your answer.
4. If the process is slow what should we do about it?

Review

A True or False

Write True or False in the spaces provided for each of the statements below.

1 When rock is heated it expands? _____

2 Insects and earthworms do not help in weathering of rocks.
_____

3 Increased rate of rainfall decreases the rate of weathering.
_____

4 Soil formation is a slow process. _____

5 The force of wind also helps in the weathering process.
_____

B Short answers

1 List the two processes of weathering.

i)

ii)

2 List six ways rocks can be naturally broken down.

i)

ii)

iii)

iv)

v)

vi)

3 Explain two ways how we can protect our soils.

i)

ii)

Unit 7: SOIL COMPONENTS

Objectives

At the end of this unit you should be able to:

1. Investigate two soil samples from two different areas for their colour, plant and animal content, and the effect of water on these soil samples.
2. Define soil texture and structure.
3. List any four physical characteristics of soil.
4. List the four main components of soil.
5. Define organic matter, soil air, soil water and soil organisms.
6. Investigate and calculate the percentage by volume of air in a sample of soil.
7. Carry out simple experiments that will demonstrate the presence of inorganic matter, organic matter, soil air, soil water and soil organisms in soil.

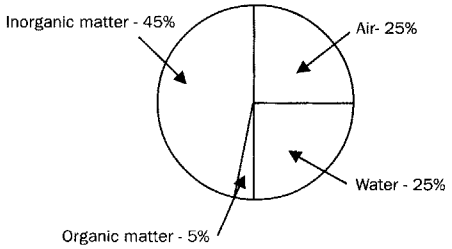
Introductory Questions

1. What kind of soil do you find around your home?
2. What happens to the soil around your home when it is wet?
3. Is it easier to dig a hole in your plantation or is it easier to dig a hole in the sand on the beach?
4. Is it easier to dig a wet or dry soil?
5. Is there air in soil?
6. Is there water in soil?
7. Are soil air and water important for living things in soil?

Background Information

Soil is made up of inorganic matter from weathered rocks, organic materials from plants and animals, air and water which fills up the spaces between soil particles and soil organisms.

Composition of a loam soil by volume



Inorganic matter

The weathering (breaking down) of rocks resulted in the formation of soil particles namely, sand, silt and clay. The mineral (inorganic) matter in soil can be defined as that part of the soil coming from weathered rocks. It is the mineral inorganic matter that provides the elements needed for healthy plant growth.

Soil composition

Forty five percent of the soil per unit volume is made up of inorganic matter. On the basis of their size, mineral matter is divided into sand, silt and clay.

Organic matter

All living and dead things found in or on the top surface of the soil are called organic matter. Organic matter in the soil originally comes from either plants or animals. The greater bulk of organic matter in the soils comes from decaying plant materials such as roots and leaves. The decaying organic material in soil is usually known as the **humus.**

Soil air

Soil air is the air located in the soil pore spaces between solid soil particles. This air is needed by soil organisms for survival and energy release. Plant roots also need oxygen for respiration. When water enters the soil, it fills up all the spaces or pores in the soil. This forces the soil air out from the soil and is lost to the atmosphere. When all soil pores are filled up with water, the soil is said to be saturated. When the soil remains saturated for a long time, it is called waterlogged. Water logging prevents air from entering the soil and deprives oxygen needed for plant growth. Waterlogged soils also tend to get acidic. Therefore waterlogged soils are not good for planting.

Soil Water

Water present in the soil spaces or soil pores is called soil water. It is the water that dissolves and releases nutrient elements for plant growth and acts as a medium for transportation of plant nutrients. The water is absorbed by roots and is used as a raw material for photosynthesis. Water is important for normal functioning of plant cells, cooling of plants by transpiration, maintaining good texture of soil, chemical weathering of rock minerals and for the decomposition of organic matter.

Soil Organisms

Soil organisms help soil in several ways. Some organisms act as decomposers. They break down and release nutrients from dead organic matter. The nitrogen fixing bacteria in legume plants convert soil air nitrogen into nitrogen fertiliser. Worms open up soil for aeration and drainage. They mix the organic matter through the soil. The presence of many living things in the soil is a sign of fertile soil.

Soil texture

Soil texture is the relative proportions of sand, silt and clay in a soil. Texture can be determined by feel or use of the texture triangle. For plant growth, medium textured soils such as sandy loam or silt loam are probably the most ideal. These soils have varying amounts of sand, silt and clay. They are easy to dig and work, well aerated and drain well. Fine textured soils like clay are very difficult to dig or work as they become very sticky when wet and hard when dry. Such soils have very poor aeration and drainage hence they easily become waterlogged.

Soil structure

Soil structure is used to describe the arrangement of soil particles such as sand, silt and clay which form soil units called "peds". The shape and size of the peds determines the soil structure. The formation of soil structural units leads to the formation of pores of various shapes and sizes. These pores are important for water storage and movement, aeration and temperature control.

The soils near the beach are called sandy soils. The chunks of mud in a paddy or muddy field are due to sticky clay. Soil structure can be improved by adding organic matter. Organic matter improves the aeration of clay soil and water and nutrient holding capacity of sandy soils.

The chart over the page shows the main types of soil structures.

Diagrammatic Definition and Location of Various Types of Soil Structure

Structure Type	Ped Description	Diagrammatic	Common Horizon Location
Granular	Relatively nonporous, small, and spheroidal peds; not fitted to adjoining peds.		A horizon
Crumb	Relatively porous, small and spheroidal peds; not fitted to adjoining peds.		A horizon
Platy	Peds are plate-like. Plates often overlap and impair permeability.		E horizon in forest and clay-pan soils
Blocky	Block-like peds bounded by other peds whose sharp angular faces form the cast for the ped. The peds often break into smaller blocky peds.		Bt horizon
Subangular blocky	Block-like peds bounded by other peds whose rounded subangular faces form the cast for the ped.		Bt horizon
Prismatic	Column-like peds without rounded caps. Other prismatic peds form the cast for the ped. Some prismatic peds break into smaller blocky peds.		Bt horizon
Columnar	Column-like peds with rounded caps bounded laterally by other columnar peds that form the cast for the peds.		Bt horizon

Adapted from *Soils Laboratory Exercise Source Book*, Am. Soc. of Agron., 1964.

ACTIVITY A

Inorganic Matter

Materials/Equipment

- Spade
- Plastic bags

DISCUSSION QUESTIONS

1 Where do you think these particles of soil come from? Discuss your answer briefly.

2 How do you think these particles were formed?

Instructions

In this activity you will try to identify the soil particles - namely gravel, sand, silt and clay - in the soil sample you will collect from the field.

1 Go to an area of land chosen or prepared by the teacher.

2 Using the spade, randomly collect soil samples in plastic bags.

3 Mix the collected soil samples on a flat surface and draw some soil from it.

4 Sort out various soil particles based on their sizes.

ACTIVITY B

Organic and Inorganic Matter

Materials/Equipment

- Spade
- Plastic bags
- Some newspaper or a sack

Instructions

1. Go to an area in your school garden chosen by your teacher and dig up a spade-full of soil.
2. Spread the soil on a newspaper and sort out the dead and the living things you find.
3. Put all the dead and livings things into two separate tins.
4. Record your findings under the headings set out in the chart below.

Organic Matter		Inorganic Matter
Living Matter	Dead Matter	

DISCUSSION QUESTIONS

1. What happens to living things when they die?
2. How important are the living and dead matter to the soil?
3. Name a few common soil organisms found in soil, but which were absent in the soil sample you examined.

ACTIVITY C

Soil Air

Materials/Equipment

- 1 x 250ml measuring cylinder
- 1 x 250ml beaker
- Air dried soil. You can prepare air dried soil by spreading some soil on a newspaper on a table and leaving it to dry for 2-3 days.
- Some water.

Instructions

In this activity you will try to find out if soil really contains air.

1. Half fill the beaker with air dried soil. Record the volume of the soil.
2. Measure out 125ml of water in the measuring cylinder.
3. Pour enough water from the beaker just to cover the soil completely.
4. Observe what happens and record your observations in your exercise book.
5. Gently tap the beaker of soil to release the air bubbles.
6. Pour more water if needed to just cover the soil.

7 Record the volume of water poured into the beaker.

8 Calculate the volume of water used to just cover the soil.

$$\text{The volume by percentage of air in the soil} = \frac{\text{Volume of water used (ml)}}{\text{Volume of soil (cm}^3\text{)}} \times \frac{100}{1}$$

DISCUSSION QUESTIONS

1 What happened when you covered the soil with water in the beaker?

2 Why did the bubbles come out of the soil when you added water?

3 Do you think the amount of air present is the same for different soils?

4 Do you think there would be the same amount of air in a soil after rain?

5 What will happen if all the air in the pore spaces in the soil is replaced with water?

ACTIVITY D

Soil Water

Materials/Equipment

- A wide mouth bottle or a 250ml beaker
- A piece of glass or plastic
- Garden soil

Instructions

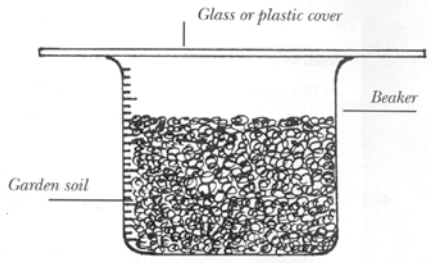
1 Half fill the bottle or beaker with garden soil.

2 Cover the bottle or beaker with a glass or plastic top.

3 Put the bottle out in the sun.

4 After half an hour observe what is happening.

5 Record your observations.



DISCUSSION QUESTIONS

1 What did you observe on the glass/plastic cover top and sides of the bottle?

2 Where do you think the water came from?

3 What caused this?

ACTIVITY E

Soil Texture

Materials/Equipment

- Soil sample from the garden
- Water
- 250ml measuring cylinder

In this activity you will determine soil texture by ***feel*** and using the ***texture triangle.***

Texture by feel:

Instructions

1. Take a tablespoon full of soil and moisten it with water until it feels like putty.
2. Squeeze the soil between your thumb and first finger. Press your thumb forward and try to form the sample into a ribbon.
3. Determine the soil texture using the table below.

Result of the Test	Texture by Feel	Soil Texture
Ribbon forms easily without breaking when bent slightly	Fine	Clay
Ribbon forms but breaks easily	Fine to smooth	Clay Loam
It is hard to make a ribbon which then breaks	Fairly smooth	Loam
No ribbons forms but feels a bit smooth	Gritty	Silt
No ribbon forms at all and feels rough	Gritty and coarse	Sand

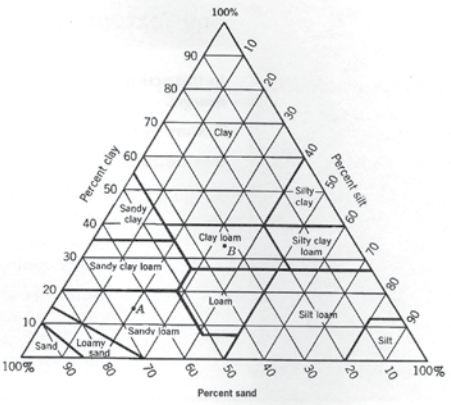
Texture by mechanical analysis (texture triangle):

Instructions

1. Divide class into groups of five.
2. Each group is to fill the measuring cylinder quarter full with the same soil sample from the garden used in the previous activity.
3. Fill the measuring cylinder three quarters full with water.
4. Close the top and shake the cylinder of soil solution for 3-5 minutes.
5. Let the cylinder stand overnight.
6. Measure the amount of sand, silt and clay in the cylinder.
7. Calculate the percent of sand, silt and clay.
8. Using the texture triangle determine the texture of the soil.
9. Compare the results with the *feel* method of determining soil texture.

DISCUSSION QUESTIONS

1 What is the texture of the soil that can easily form a ribbon?
2 What is the texture of the soil that forms no ribbon and feels rough?
3 What is the texture of the soil that forms a ribbon but then breaks?
4 Which method is more accurate?
5 Why is texture important to farmers?
6 How can texture be improved?



Texture triangle

ACTIVITY F

Soil Structure

Materials/Equipment

- Three soil samples of different soils labelled Soil 1, Soil 2, and Soil 3.
- Microscope
- Magnifying glass

In this activity you will look at the soil structure of three different soil samples using a microscope or magnifying glass.

Instructions

1 Form groups of six students.
2 Each group is to take a tablespoon of soil from each of the three soil samples.
3 Each pair is to observe a soil sample and fill in the table on the next page.
4 Observe the soil structure under the microscope or magnifying glass.
5 Draw the soil structure for each soil sample in the table on the next page.
6 Compare the soil structure of each soil sample with the soil structure chart and name the type of structure of each soil sample.
7 Discuss and rank the soil samples in terms of suitability for farming.
8 Each group is to give a three minute presentation to the class, using your table.

	Soil Sample 1	Soil Sample 2	Soil Sample 3
Sketch of soil structure			
Type of structure			
Ranking of soil			

FOLLOW-UP QUESTIONS

1 Name the three common soil particles?
2 Where do you think the soil particles originated from?
3 Can you form a ribbon with clay soil?
4 How would clay feel if you squeezed it between your fingers?
5 Would sandy soil form a ribbon also?
6 How does sandy soil feel?
7 What is soil texture?
8 Why is fine textured soil not good for cultivation?
9 Briefly describe soil structure.
10 Why is soil structure important?
11 Where is the air located in the soil?
12 What happens to the air when waters enters the soil?
13 From the experiment how did you know the soil has air?
14 Explain why soil air is important.
15 Why should soil need good aeration?
16 What is organic matter?
17 Briefly explain the process involved in the breaking down of rocks.
18 List the main soil particles you studied in the class.
19 What is soil made of?
20 What is organic matter?
21 Why is the decomposition of organic matter important?
22 What is humus? Why is humus important to soil?
23 List the organic matter you have identified in the soil from the school garden.

Review

1 List the four main components of a soil.

a)

b)

c)

d)

2 Which soil component is the most important for plant growth? Give reasons for your answer.

3 Define the terms **structure** and **texture**.

a) Structure

b) Texture

4 Which soil structure is best for farming? Explain why.

5 Which soil texture is best for farming? Explain why.

Unit 8: THE SOIL PROFILE

Objectives

At the end of this unit you should be able to;

1. Explain what a soil profile is.
2. Identify the basic soil layers in an ideal soil profile.
3. Name and describe the basic layers in a soil profile.

Introductory Questions

1. Have you observed the sides of a quarry or a freshly cut hill on a roadside?
2. Can you find any soil layers there?
3. Do all soils have the same colour?
4. What could be the colour of the top layer?

Background Information

A soil profile is a vertical section through a soil, showing different soil layers. An ideal soil profile has five major soil layers or horizons. We should always remember that all soils are different, and that not all soils will have each of these horizons. In most of our soils the border between two horizons will not be well defined. This is because soil horizons tend to mix with one another.

The "O" horizon

This horizon is formed from the accumulation of organic materials deposited on the surface of the soil. The horizon contains high amounts of organic matter and is often dark in colour and is very thin in some soils.

The "A" horizon

This layer is also called the surface or top soil. This is the first mineral horizon of the soil profile and is usually dark and contains high amounts of organic matter. Top soil is affected by weathering. Clay and minerals are leached (carried down by water) to the bottom of the layer. The topsoil has the most biological activity.

The "B" horizon

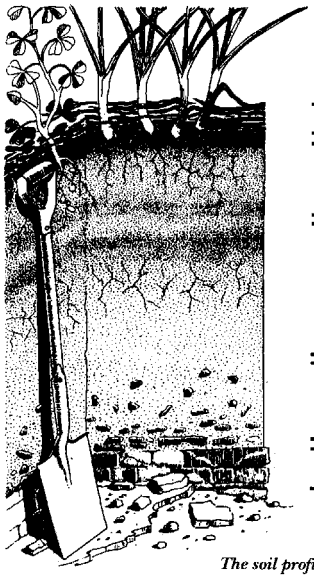
This layer is also called the subsoil and contains more clay and less organic matter than the top soil. The subsoil contains clay, iron, minerals and humus that were moved down from the topsoil. This layer is usually grey or light coloured.

The "C" horizon

The "C" horizon is the loose material underlying the topsoil (A and B horizons). It is below the zones of major biological activities.

The "R" horizon

Also called the bedrock. It is the hard rock that has not been broken down. It does not contain any soil and most plant roots cannot get into it.



The soil profile

ACTIVITY A

Observing a Soil Profile

Materials/Equipment

- Spades
- Measuring Tape
- 1 metre long ruler
- Specific area of land

For this activity you will be accompanied by your teacher to a site where a soil profile has been dug or to a river bank, road bank or quarry where you can easily observe a soil profile.

Instructions

1. Use the spade to cut the side of the trench, river, road or quarry bank to expose the different soil layers (soil profile).
2. Observe and draw the different soil layers you can see.
3. Measure the thickness of each exposed soil layer.
4. Note the soil colour, plant root, soil organisms and organic matter of each soil layer. Record this information in the table below.

Soil layer	Thickness of layer (cm)	Soil colour	Plant Roots (quantity – many, some, none)	Organic matter (quantity – many, some, none)	Soil organisms (type and number)
Topsoil					
Subsoil					
Parent material					
Bedrock					

DISCUSSION QUESTIONS

1. How deep is the top layer?
2. Which layer/horizon has more stones? Why?
3. Which layer has most roots?
4. Which layer has a darker colour? Why?
5. How can you tell the age of a soil?

FOLLOW-UP QUESTIONS

1. Briefly describe the top soil.
2. Briefly define soil profile.
3. In which layers will you find most biological activity?
4. Which layers will have the least biological activity and why?
5. Topsoil is usually dark in colour. Why?

Review

1 Name the main soil layers or horizons found in an ideal soil profile.

i)

ii)

iii)

iv)

2 **Matching:** Write the soil layer or horizon in the space next to the statement that best describes it (e.g. "A" Horizon).

_____ a) A mineral horizon where clay and nutrients have been removed by leaching.

_____ b) A layer of rock which does not have any soil.

_____ c) A horizon forming from accumulation of organic material deposited on the surface.

_____ d) The zone of maximum accumulation of clay and iron compounds.

Anatomy	Scientific study of the structure of animal bodies.
Breed	(i) To produce the offspring of animals, insects and plants; (ii) A group of animals of the same species or group having similar characteristics like colour, size or weight and shape.
Cash crop	Crops planted for sale.
Commercial farm	Farming as a business.
Crop rotation	Changing the type of plants planted in an area after a season.
Decomposer	Organism that breaks down organic material and uses the decomposition products to supply it with energy, e.g., fungus and bacteria.
Fallow	The practice of leaving land uncropped for periods of time to accumulate and retain water and nutrient elements.
Feeds	Generally refers to commercial food for animals.
Fertilizer	Any organic or inorganic material, natural or artificial, that is added to the soil to supply one or more elements essential to plant growth.
Genetics	Study of inheritance.
Habitat	The natural environment or place where an organism lives.
Humus	The fraction of soil organic matter remaining after the major portion of added plant and animal residues have decomposed. Usually it is dark in colour.
Inorganic matter	Materials produced from rocks or chemicals.
Mixed cropping	Planting more than one crop.
Organic matter	Material from plants and animals.
Pest	An unwanted insect or animal.
Shifting cultivation	Planting in an area for a few years before moving to another new area.
Soil	The unconsolidated mineral matter on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
Soil profile	The different layers of soil.
Soil structure	The arrangement of primary soil particles into secondary particles, units or peds.
Soil texture	The relative proportions of gravel, sand, silt and clay in a soil.

Species	A group of living things that can interbreed.
Subsistence	Farming for food.
Variety	Differences among members of a group. In taxonomy, a group below the level of the species.
Weathering	All physical and chemical changes produced in rocks, at or near the earth's surface, by atmospheric agents.
Weeds	Unwanted plants.