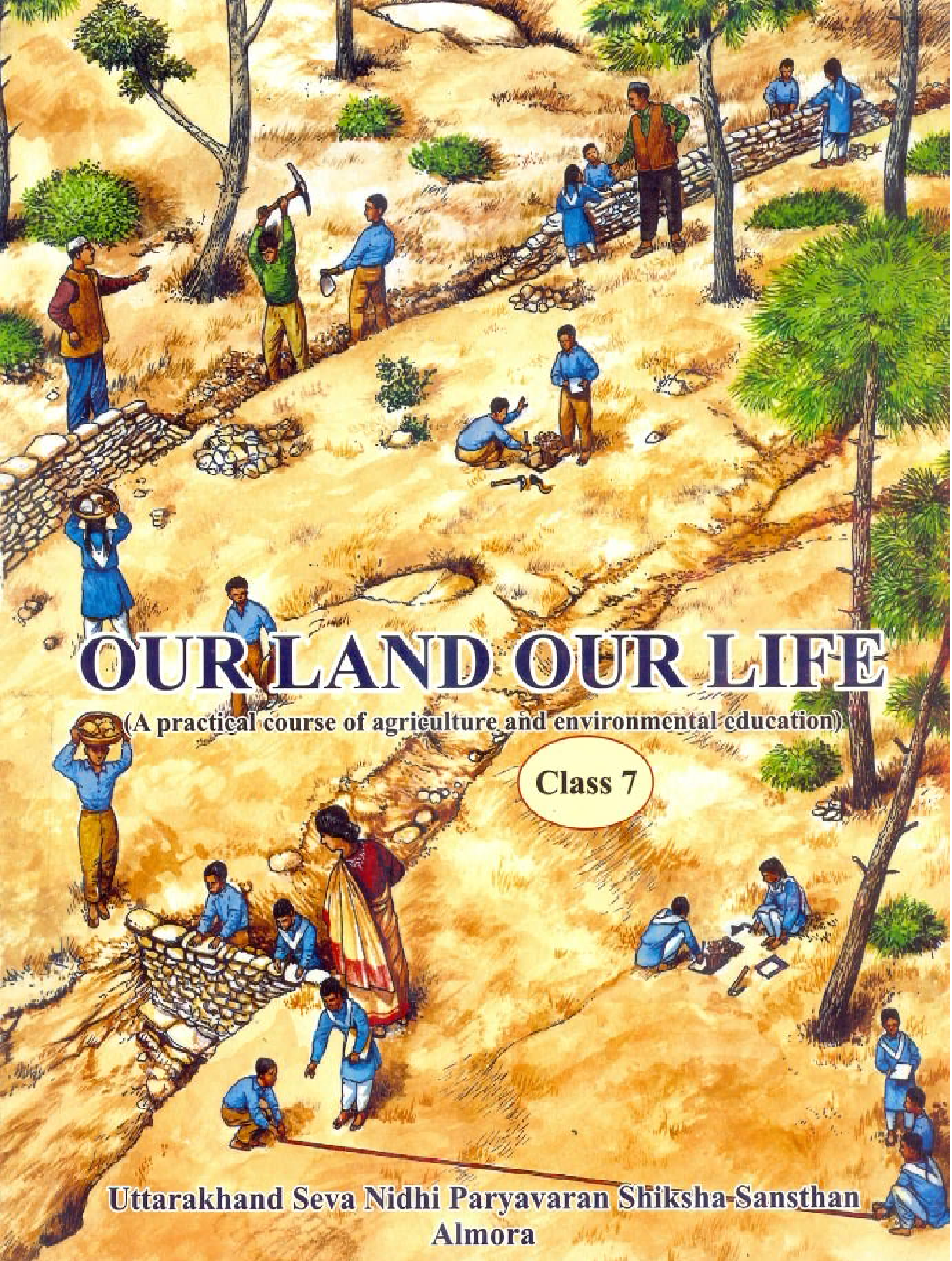

OUR LAND OUR LIFE

(A practical course of agriculture and environmental education)

Class 7

Uttarakhand Seva Nidhi Paryavaran Shiksha-Sansthan
Almora

THIS WORK BOOK BELONGS TO

Student's name	:	....
Class	:	....
Year	:	....
Team number	:	....
Name of school	:	....
Name of principal	:	....
Name of environmental education teacher	:	....
Name of study village	:	....
Name of block	:	....
Name of district	:	....

OUR LAND
OUR LIFE

Class Seven

A practical course of agriculture and environmental education for classes six to ten in the Schools of Uttarakhand

2012

Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan,
Almora, Uttarakhand

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Foreward

This set of five workbooks constitutes a single, continuous course to be offered to students of classes 6-10. It is being published in English for the benefit of those outside the state of Uttarakhand who do not know Hindi. As explained in the brief account of the history of the course that follows, it has not yet been possible to introduce the full five year course for lack of space in the prevailing school curriculum, but only the 6th to 8th class portion.

Using these workbooks as a general model, it should be possible to design similar courses for any region of the country.

We hope to receive comments from readers of this English version. The course is an on-going experiment, and efforts are continually being made to improve it as we go along.

Almora
January, 2012

Lalit Pande
Director
Uttarakhand Seva Nidhi
Paryavaran Shiksha Sansthan
Almora (Uttarakhand)

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COURSE HISTORY

This course is the outcome of the collaboration between 1986 and 2000 of the Mirtola Ashram, Dhauladevi Block, District Almora, the Uttarakhand Environmental Education Centre, Almora, the Gandhi Intermediate College, Panwanaula, Dhauladevi Block, District Almora, the Department of Education, Government of Uttar Pradesh (Uttarakhand after 2000) and the Department of Education, Ministry of Human Resources Development, Government of India, New Delhi.

The idea of an environmental education course in the schools and intermediate colleges of the hill region of Uttar Pradesh was endorsed by the National Planning Commission's Task Force on Hill Development and by the Departments of Education, Governments of India and Uttar Pradesh in 1986. The Uttarakhand Environmental Education Centre (UEEC) offered to implement the course.

The initial version of the course was designed for students of classes nine and ten. In 1987 it was offered in the Gandhi Intermediate College, Panuwanaula. Between 1988 and 1992 forty more schools and intermediate colleges volunteered to participate in the project. Five-day, in-service teacher-training camps were held every year in June at the Gandhi Intermediate College. Later, in 1998, these camps were transferred to the USNPSS training center in Almora.

In 1991-92 a major stocktaking was done by all the participants with the result that the course was recast as a five-year course for classes six to ten. A slot in the junior high school (classes six to eight) curriculum was found and the revised course was taken up by junior high schools, high schools and intermediate colleges. By 2002 the combined number of all these had increased to 1000. No slot however, could be found for the ninth and tenth class part of the revised course, and the sixth to eight class part was revised to make a self-contained course. A course for the plains region of the state was made. These courses were introduced from July 2002 as an optional subject in all schools and intermediate colleges in the State in a phased manner, as rapidly as teachers could be trained. The major responsibility for the administration of the course (the printing of workbooks, in-service teacher training and examinations) was taken over by the Department of Education from the UEEC in that year. Master trainers in the District Institutes of Education and Training were trained by UEEC staff in 2002.

In 2008 the course was expanded by incorporating subject matter had earlier featured in the agriculture course, and the hill and plains versions were merged. This revised course was made a compulsory part of the curriculum in 2009.

TO TEACHERS AND PARENTS

The modernisation of our country has brought us many benefits. Compared to 50 years ago we are healthier and better educated today. Roads and telephones make travel and communications easier and faster. There are many manufactured goods in the market to make life easier and more enjoyable. Farming is more productive where there is irrigation and food production has increased greatly.

Along with these benefits we now realise that many serious problems have arisen. Factories, cars, trucks and buses are causing severe air pollution in our cities. The wastes from our factories and cities are polluting our waterways. Both air and water pollution are causing many new diseases and aggravating old ones.

In the rural areas of our country forests are rapidly disappearing resulting in a lack of fuelwood and fodder, and giving rise to soil erosion. In hill areas the loss of forests also causes water sources to dry up. In addition to deforestation and soil erosion, the fertility of our soil is decreasing where modern agricultural practices have been taken up. Wells in the plains are going dry due to the excessive pumping of ground water to irrigate crops. Pesticides are polluting our soils, ground water and food, which adversely affects our health.

The increasing awareness of these problems leads us to the conclusion that modernisation in its present from cannot be sustained. If our environment – our air, water, land and forests – is harmed there can be no real modernisation or development. We must find solutions to these problems and apply them in our daily lives and livelihood pursuits.

Most of us are not fully aware of these problems; they hardly existed when we were children. Nor do we understand how our own actions give rise to them. In this course children are made aware of these environmental problems and helped to acquire the knowledge and skills that are needed to solve them.

This school programme also provides an opportunity for parents to learn along with their children. Further, parents have an indispensable role to play in the course; indeed, the course can only be effective if parents contribute some time and effort to helping their children learn. In many cases parents can share their traditional knowledge and skills; these are being forgotten but they can help us solve many of our current environmental problems.

As teachers we too have much to learn about environmental problems and how children and parents can be helped to deal with them. Indeed, learning about the environment is a collaborative effort of teachers, students and parents. All are equal partners in this learning process.

The name of this course is 'Our Land, Our Life' and it deals with the problem of land and forest degradation, with ways of rehabilitating them, and with managing them for high and at the same time sustainable production. Our main natural assets in Uttarakhand are land and forests, and our development will depend primarily on managing them well. Most of our children will remain in the village and it is our duty to ensure that they have the motivation and the means (knowledge and skills) to make a comfortable and secure future for themselves.

Some of our children will, of course, leave their village or the state to earn their living. For them too this course of is valuable. Everywhere in our country, and indeed in the world, environmental education in some form or other is now a part of the school curriculum. Increasingly, a knowledge of environmental problems and their solutions is required for employment. The nature of environmental problems and the means of solving them vary with location but the principles are the same everywhere, North, South, in the city and in the village. The challenge is similar to that of language education: language differs in different parts of the country, but in all schools learners are expected to be proficient in their regional language (i.e., in reading, writing and speaking).

In this course children do much of their learning outside the classroom. They study the village first-hand, collecting information and data, analysing it, and experimenting with new ways of land, forest, crop, water and animal management. The table of contents of this workbook indicates the variety of topics they study. They work in small teams and they will ask you, their parents, for help and information. You may also help them by questioning them about what they are doing and why. As teachers you will teach them the concepts they will need and guide them in their work. Encourage them to ask you questions. You are partners with them and their parents in this learning exercise.

We hope everyone – parents, teachers and children – will enjoy this course. Send us your suggestions, through your school principal, for improving the course in the future.

SUGGESTIONS TO TEACHERS FOR CONDUCTING THE COURSE

This course extends over five years, classes six to ten. The subject matter topics of the course are: land, water, trees, crops, compost, animals, fodder, fuelwood, people and ecosystem. Students gain knowledge, concepts and skills, step-by-step as the course proceeds.

The village ecosystem is the central theme of the course. Subordinate themes are: species diversity, species adaptation, sustainability, community and carrying capacity. The village community an integral part of the village ecosystem. Students learn these concepts through practical work.

The contents of the course are presented in a workbook format. As more emphasis is given to the exercises they are placed before the boxes.

The objective of, and procedure for, each exercise is explained at the beginning of the exercise. Notes for the teacher are also given in some exercises where it seems necessary. Most exercises are accompanied by one or more boxes. Boxes explain concepts, give detailed directions for doing the exercise, give necessary background information, and clarify concepts through stories.

A village is the laboratory in this course. Students undertake a thorough and systematic quantitative and qualitative study of a particular village over a period of five years. Therefore at the beginning of class six a study village is to be selected, in which, students will work continuously for five years (classes six to ten). Every new batch of students entering class six will be assigned a new study village. About one-fourth of the exercises will be done in the study village; the rest will be done in the school campus or classroom. In class seven, Exercises 13, 14, 15 and 21 must be done in the village.

A block of four periods (about one-half day) will be needed for village visits. This will have to be arranged with the headmaster/principal. Before starting the course it will be necessary for you to visit the study village to meet the residents and explain the course to them and to request them to provide their help and support. Without their participation the course cannot be carried out effectively. Their participation will take the form of helping students with their investigations and sharing local, traditional knowledge with them. By participating in the course the residents will learn about their village from a different point of view.

For doing practical work the class should be divided into about ten teams of two to five students each. The purpose of forming teams is: to help students learn team work; to obtain several estimates of each parameter; to ensure that all students participate; and to make the class easier to manage. The averages of the estimates of a given parameter from the several teams can be calculated in the classroom after the village visit.

Teachers are urged to adopt a discussion mode in conducting the course. Students already know many things about their local environment. The role of the teacher is that of a discussion leader, helping to bring out what students know, to express their opinion/ideas, and to provide the concepts that are necessary for discussing facts/opinions in meaningful ways.

There are important differences between high and low altitude villages in land, water, trees and crops. In the boxes examples from both have been included. Students in all schools should study all the boxes, even if the examples are from a different altitude zone than their own village. The mountains and plains of Uttarakhand are interconnected and all students should learn about their entire state.

At the beginning of the year prepare an annual calendar of the course, indicating the month for doing each exercise. Some exercises can only be done at definite times of the year. For example, the exercises on measuring fodder consumption and milk yield are season bound.

Date: ....

Code : Land 3
Month : April

EXERCISE 13

LAND AREA MEASUREMENT TECHNIQUE 2. IRREGULARLY-SHAPED FIELDS

INTRODUCTION

Using the basic principles of land measurement we learned in Exercise 2, let us now determine the area of an irregularly shaped cultivated field.

REQUIREMENTS

1. Measuring tape, 15 m – one

PROCEDURE

1. In your study village, request the head of one of the families to allow your class to measure one of their fields. There should be no crop in the field at the time of measring. All teams will do this exercise together.

2. Proceed to measure your selected field according to the procedure given in Box 13-1. Record your observations below.

   Length of field .... m
   Width measurements .... m
   .... m
   .... m
   .... m
   .... m
   .... m

3. Now calculate the area of the field, showing all calculations on the following blank page. Write your answer here:

   Area of field = ... m^2

FOR THE TEACHER

Before beginning this exercise take up Boxes 13-1and 13-2. Box 13-1 describes an easy method for determining the area of irregularly shaped cultivated fields. This exercise has to be done when fields are free of crops.

PROBLEMS AND QUESTIONS

1. You have determined the area of your field in square metres. What is the area in terms of ares/nalis? Show your calculations on the opposite blank page.

   Answer : .... 'ares'/nalis

2. How much wheat seed would be needed to sow this field?

   Answer : ....kg

3. Assume that a crop of wheat grown in this field yields grain at a rate of 22 kg per 'are'. How many kilos of grain would this field produce?

   Answer : ....kg

4. Now suppose that you want to grow a crop of tomatoes in this field. How many plants would be required?

   Answer : ....plants

5. Rain water sometimes washes soil away from fields. Do you see any place in your field where this has happened? If so, where? What could be done to prevent this happening?

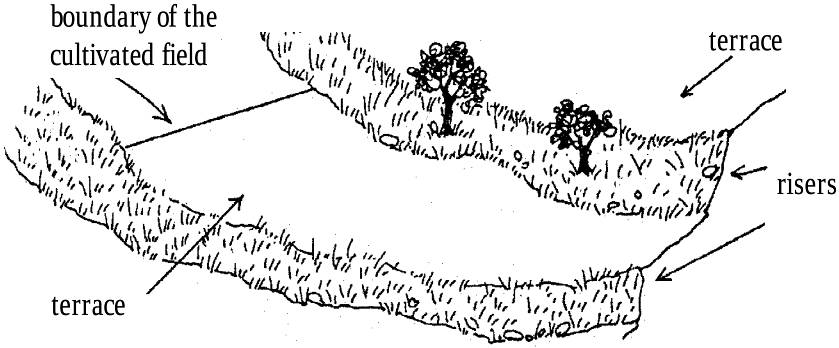
Teacher's signature:....................

Date:....................

BOX 13-1

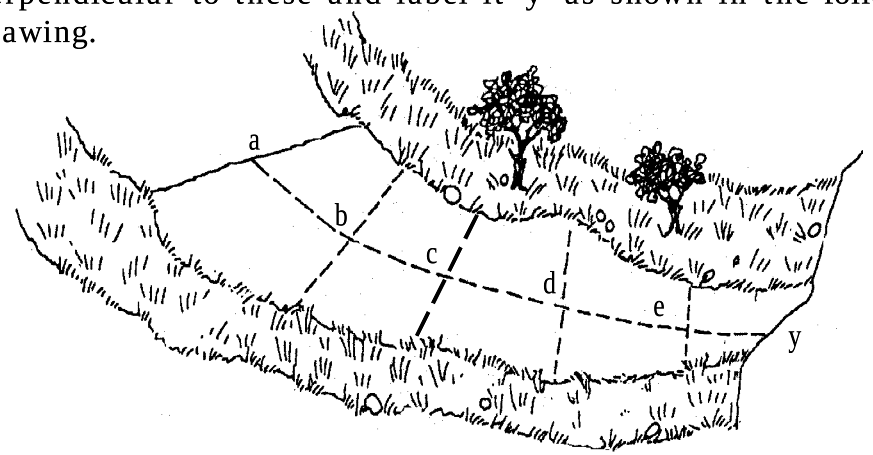
METHOD OF MEASURING THE AREA OF AN IRREGULARLY-SHAPED FIELD

In Exercise 2 (class six) you laid out 'fields' as neat squares and rectangles. By simply multiplying the length by the width of any of these, you easily calculated area. Many fields are in square or rectangular, but irregularly-shaped fields, such as shown in the drawing given below, are also seen.



The theoretical basis for determining the area of a field like this is to visualise it divided into several smaller 'fields' of regular rectangular or square shape.

To help this visualisation let us do an exercise on paper. Make a copy of the field given above. Next draw a number of parallel longitudinal lines. Label these lines a, b, c, d and e. Next, draw a line perpendicular to these and label it 'y' as shown in the following drawing.



The area of the field will be approximately:

$$\text{Area} = \frac{a + b + c + d + e}{5} \times y$$

Suppose ‘y’ is 50 m and ‘a’, ‘b’, ‘c’, ‘d’ and ‘e’ are 35, 28, 22, 20 and 15 m, respectively. The approximate area of the field can be calculated as follows:

1. Calculate the average width of the field as:

$$\text{Width} = \frac{35 + 28 + 22 + 20 + 15}{5} = 24 \text{ m}$$

2. Multiply the average width by the length to get the area of the field, as:

$$\text{Area} = 24 \times 50 = 1200 \text{ m}^2$$

3. Convert this area into ‘ares’/ ‘nalis’, as:

$$\text{Area} = \frac{1200}{100} = 12 \text{ ‘ares’}$$

$$\text{Area} = \frac{1200}{200} = 6 \text{ nalis}$$

BOX 13-2

SOWING SEEDS

When the seeds of a wild plant are ripe they fall to the ground. There a few germinate and grow into new plants. These take the place of the old ones which die after dropping their seeds. However, most of the seeds die or are eaten by insects, birds and rats, and do not produce new plants. In growing crops in our fields, however, we want all the seed we sow to become new plants, or at least most of them. In a forest perhaps one out of 100 seeds that fall to the ground survives and become a new plant. In our crop fields we want at least 80 or 90 seeds out of 100 to live and grow into new plants. Therefore, we need to know why seeds die and are eaten so that we can protect them.

If the soil surface is smooth, then a seed in contact with it absorbs moisture and germinates. If the surface continuous to be moist by rain or irrigation, the seed will send down roots and grow. (The sub-surface soil dries more slowly then the surface, and so remains moist and gives water to the new plant.) If the soil surface dries out after the seed germinates, the new plant may dry up and die.

When a seed falls on the soil surface, and it is visible, it may be carried away by ants and rats to be stored as winter food, or eaten on the spot by birds.

To protect the seeds we sow they must be kept moist and hidden. There are two ways in which this can be done. If the seeds are placed on the soil surface, and there is no rain the field must be irrigated regularly. They must also be covered with a layer of compost or residues from the previous crop. In this way they will be hidden, and will also not dry out so fast if there is no rain or irrigation. In Uttarakhand many fields cannot be irrigated and so surface sowing, especially in the dry season is not successful.

The other way to protect our seeds and ensure that they do not dry out is to place them in the soil.

When our ancestors first cleared the forest to grow crops, they cut the trees, bushes and other vegetation, allowed the cut vegetation to dry, and then burned it. After burning, the soil was soft. They made holes in it with a pointed stick, dropped a seed in it and filled the hole with loose soil. The seed was protected and in contact with moist soil. This was a very successful method of sowing, but was slow and it took a long time to sow large fields.

In the first few years after sowing, the roots of the original trees, and other forest plants decayed or were removed. It was then possible to spread the seeds on the soil and to mix them with a *pawdha*. Later, when ploughs had been invented, the seeds were mixed in the soil by ploughing the field. Still later, it was found that seeds could be dropped in the furrow made by a plough and then covered as the adjacent furrow is made. Finally mechanical seed sowers were invented which make furrows, drop the seeds into them and then close them. In this way the crop plants grow in lines and this makes it easier to weed the field.

There is, however, a serious problem with digging and ploughing a field in order to sow seeds. The soil surface is directly exposed to rain, sun and wind. The result is that soil is carried away by water and wind erosion. To prevent this soil loss, some farmers are now experimenting with methods of sowing that do not stir the soil or uncover the soil surface.

One of the methods is to sow the seeds on the surface of the field after cutting the previous crop and cover them with fine compost and/or a layer of crop residues. Another method is to make furrows in the field without ploughing. The residues of the previous crops are left in the field as mulch. In this way not all the soil is stirred and so is not so easily eroded. If a mulch of compost is spread on the field after sowing, fewer weeds will grow. And if the weeds that do grow are pulled up or cut and then left laying in the field as a mulch, they further reduce soil erosion.

If fields are not ploughed at all before sowing, not only is the soil protected, but much labour is also saved. Bullocks will not be needed (except maybe for carting). If fewer or no bullocks are kept, there will be more fodder to feed cows and buffaloes – and hence more milk!

BOX 13-3

SOME PROBLEMS FOR PRACTICE

In this box you will find some problems to solve. These will give you needed practice. Also, if you are able to solve them, you will know that you have learned what is in the exercises and boxes studied so far this year.

The members of each team will work together to solve these problems. You can then compare your answers with the answers of other teams. Be certain that every member of your team can solve all the problems by herself/himself. This is not an examination. Keep your workbooks with you and consult them if necessary. Do all calculations neatly on the blank pages provided.

PROBLEMS

1. 1,000 seeds of particular type of tree weigh 100 g. We want to sow seed in 200 seedling bags. We sow one seed in each bag. What weight of seeds are sown? If we sow two seeds in each bag, then what weight of seeds is sown?

   Answer ....

2. We have to make a plan to plant trees in one part of the bare land of our village. This area is 150 'ares'. If we plant the seedlings at a spacing of 1 m x 1 m, how many seedlings do we need? If we plant at a spacing of 2 m x 2 m, then how many seedlings do we need?

   Answer ....

3. The germination percentage of a particular lot of tree seeds is 60. We plant one seed in each of 150 seedlings bags. In how many bags do we expect to find no seedling appearing?

   Answer ....

4. The length of an irregularly-shaped field is 80 m. It's width when measured at five different points is 19 m, 17 m, 14 m, 14 m and 12 m. What is its area?

   Answer ....

Date: ....

Code : Crop 4
Month : May

EXERCISE 14

TOOLS, IMPLEMENTS AND MACHINES USED IN OUR STUDY VILLAGE

INTRODUCTION

We use several tools, implements and machines in out farm work. In this exercise we will learn about the tools, implements and machines being used in our study village.

PROCEDURE

1. Visit your assigned household and collect the following information.

   a. Visit your household assigned to you in exercise 7 last year. Ask them to show you all the tools, implements and machines they use in growing crops, managing trees, including fruit trees, and managing their animals, and to explain the use of each one.

      Record this information in Table 14-1. Make a diagram of each tool and implement on the opposite blank page.

   b. Which implements and machines do the members of your assigned family use but which they do not own. How do they arrange for the use of these? Write this information in Table 14-2 .

   c. Of those tools and implement used by your assigned family which ones are available in the village itself and which ones must be brought from outside the village? Enter your information in Table 14.3.

2. In the classroom, exchange information among teams and so complete table 14-1, 14-2 and 14-3.

FOR THE TEACHER

Take up Box 14-1 before beginning this exercise. In this exercise the people of study village will be resource persons for the students. Each team should visit the household assigned to it in exercise 7 and request the members of the concerned families to show them their tools/implements/ machines and provide information about these.

Table 14.1. The tools, implements and machines with our assigned family

No.	Name of the tool, implement or machine	Its purpose and the way it is used

Table 14-2. Implements and machines used and how their use is arranged

No.	Name of the implements/ machines	What work was done with this implement/machine and what arrangements are made for its use

Table 14.3. Sources of various tools and implements

Made at home
Manufactured in the village
Obtained from outside the village

QUESTION

1. Of the tools, implements and machines mentioned in Box 14-1, which one did you not see in your study village? What do you think is the reason for their absence.

Teacher's signature:....................

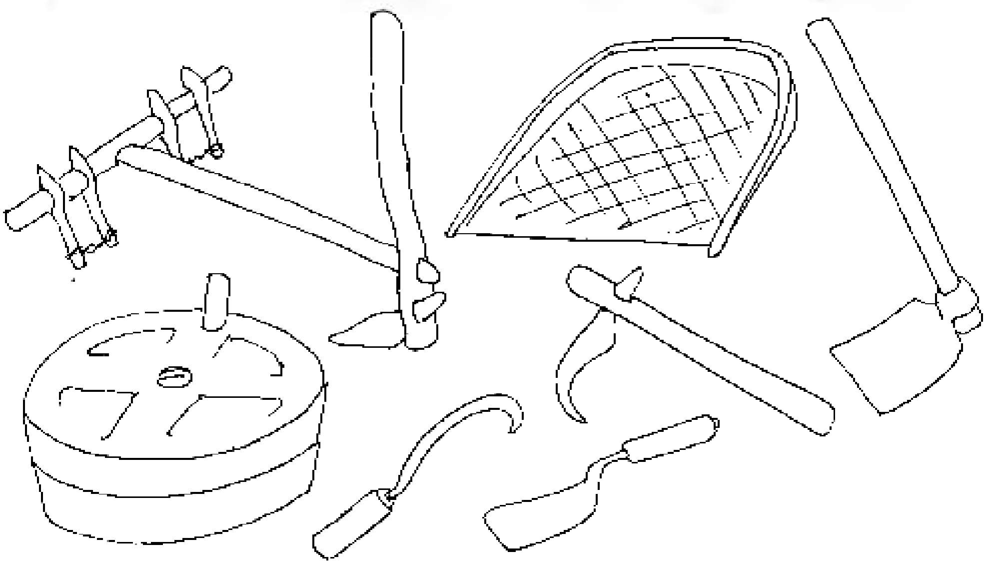
Date:....................

Box 14-1

TOOLS IMPLEMENTS AND MACHINES USED IN OUR STUDY VILLAGE

In managing our crops, trees, animals and water we use many tools, implements and machines. A tool is a small device held in the hand, like a sickle, a *khurpi* or *kutli,* and a *phawda.* An implement is a larger, more complicated device like a plough, a hand pump, a chaff cutter, a *chakki* and a cart. A machine is a complicated mechanical device like a thresher, an electric or diesel pump and a tractor. Some of these were invented long ago, and are still useful, while some have been invented more recently.

One of the first tools invented was the axe. It was needed for cutting and trimming trees. At first stone axes (Box 4-1) were used, and later they were made of iron. To grow and harvest crops, *kutlis, khurpis* (small digging tools), sickles and *phawdas* (a large didding tool) were invented later. When fields became more numerous and larger these simple tools were augmented by ploughs, harrows and planks for leveling the soil and breaking clods. These made the work of preparing fields for sowing easier and faster. They required bullock power in addition to human power. Then came chaff cutters and mangers for



feeding bullocks, cows and buffaloes, and bullock carts for transporting materials. When the practice of watering crops began, simple hand-powered and bullock-powered implements were invented to lift it from rivers and wells. Still later, electric, diesel motors were invented, and put to use to drive pumps, *chakkies*, chaff cutters, threshers and tractors.

We can say that long-ago all tools were human powered. Later-on, implements that were powered by bullocks were invented. Finally, bullock power is being replaced by electric, petrol and diesel power. These developments have made many operations easier for people, quicker and more effective.

When bullock power is used, the bullocks are fed on the produce of the village ecosystem. The energy for powering our implements thus comes from the village itself. When we use machines powered by electricity, petrol and diesel we are buying energy from outside the village.

In previous times all tools and implements were made in the village, though iron was brought from outside. The wooden parts were made in the household or by a village carpenters. The iron part was made by a blacksmith. Today the iron parts, and also some of the wooden part are made in factories in the city and bought by us from the market.

Date: ....

Code : Animal 1
Month : June

EXERCISE 15

OUR DOMESTIC ANIMALS

INTRODUCTION

Every family keeps a few domestic animals. In this exercise we will learn what types of animals are kept in your study village, why they are kept, and how they are cared for.

PROCEDURE

1. You will visit your assigned family and request the family members to answer the following questions. Write down their answers in Table 15.1
   a. What types of domestic animals do they keep? Be sure to include all types of animals.
   b. What is the use of each type of animal?

Table 15-1

Type of animal	Use

FOR THE TEACHER

Schedule a period in which you can take the class to your study village. Box 15-1 can be taken up after completing this exercise.

2. Also ask following questions, and any other question you may think of.

a. Are all the family's animals present at the house at the time of your visit? If not, why not? Where are they?

b. What are the different types of animals fed? How are they fed?

c. Which family member(s) feed the animals? Why?

d. Who milks the cows and buffaloes?

e. Who cleans the animals and picks up the dung and soiled bedding?

f. What is done with the dung and the soiled bedding?

g. Are any of the animals taken for grazing? If so, why? Where are they taken? Who takes them? What do they eat when they are grazing? (Note: In answering this question, consider all types of animals. For example, chickens as well as cows 'graze'.)

h. For ploughing two bullocks are needed. Does your assigned family have two bullocks? If not, how do they plough their fields?

i. Some families may not have any bullocks, but instead plough their land with tractor. Does your assigned family have a tractor? If not, and if they also do not have bullocks, how is their ploughing done?

j. Which family members do the ploughing?

k. How is a sick animal treated? Who treats it?

____

____

____

3. In the classroom, after the visit, make a list of all the types of animals found in your study village.

List of all the types of animals found in our study village

Sl.	**Type of animals**

Teacher's signature:....................

Date:....................

Box 15-1

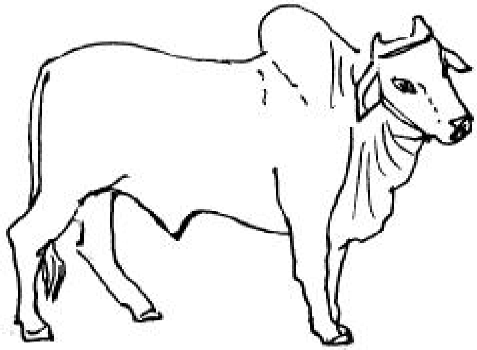
THE DOMESTICATION OF ANIMALS

Many types of animals live in our village eco-system. Some types are domesticated and others are not. The word 'domesticated' means that animals live under human control. We provide them food, shelter and protection. They, in turn, work for us in various ways like pulling a plough and guarding our homes, and they produce food for us in the form of milk, honey, eggs, and meat. They also provide us skins and wool. Those animals which are not domesticated are termed 'wild'. Both wild and domestic animals are necessary to make our village ecosystem healthy. We will learn about wild animals later. In this box we will consider domestic animals.

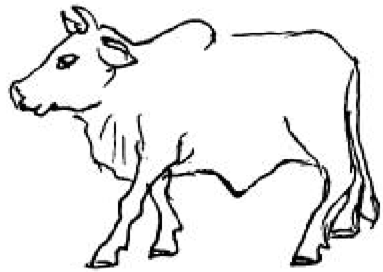
Very long ago, more than 10,000 years ago, our ancestors were hunters and gatherers. This means that they obtained their food and other requirements entirely by collecting it from wild plants and by killing wild animals. Then slowly some types of wild animals were domesticated. The first type of animal to be domesticated was probably the dog. We can imagine that people found the puppies of a wolf mother that had died. The puppies were kept at home and fed. Children played with them, so that when they grew up they preferred to stay with human beings to living wild in the forest. They helped people by guarding their homes.

Other animals that were domesticated were cattle, buffaloes, horses, sheep, goats, pigs, chickens and elephants. Not all types of animals can be domesticated; they never submit to human control even if reared by humans from birth. Also, those types which are hunters and eat meat are not so useful as those that are vegetarians and thus have not been domesticated. Examples are leopards, owls, pine martins (*chitrols*) and turtles.

After a particular type of animal was domesticated people selected among them the most suitable individuals for their needs. They selected the offspring of the largest (or smallest) parents, or those which produced the most milk or wool, or which were easiest to manage, or were healthiest or strongest. When this process is repeated over



Haryana bullock



Pahari bullock

many generations, a distinct 'breed' of the animal is created. Consider the case of cattle. Most breeds of cattle have been selected for the ability of bullocks to work. Examples are the mountain (*Pahari*) and Haryana breeds. In the mountains small, agile bullocks are needed to plough small fields and walk on steep mountain paths. In the plains, larger, longer-legged bullocks are needed to plough larger, flat fields and to pull bullock carts. Each major area of India has its own breed of cattle. Buffaloes for in India are kept for milk production, but in South-East Asia, for ploughing. In buffaloes too there are different breeds in different parts of the country.

In general, it is better to keep only those breeds of animals that have been selected for the area than to bring in types that have been selected for other areas. An example is the rearing of European type cattle, or those produced by mating European and local animals ('crossbreeds'). These animals were selected in their own areas for high milk yield. As a result, the bullocks are not good for draught. Moreover, the cows are delicate, and easily fall ill in our climate.

In managing our animals, we can continue to select the best offspring for further breeding, and so improve the breed still more.

Date: ....

Code : Trees 5
Month : July

EXERCISE 16

TRANSPLANTING TREE SEEDLINGS

INTRODUCTION

In this exercise you will learn how to transplant tree seedlings and to care for them. This exercise is a continuation of Exercise 10, and it will be continued next year in Exercise 29.

The seedlings of the seeds you planted in Exercise 10 may be ready to transplant at this time. If they are not ready, then your teacher will arrange some other seedlings for you.

REQUIREMENTS

1. *Phawda* – one for each team
2. *Khurpi* – one for each team
3. Tape measure, 1.5 m – one for each team
4. Basket for carrying seedlings – one
5. Tape measure, 15 m – one for the entire class

FOR THE TEACHER

Take up this exercise in the month of July. If you select an area for transplanting tree seedlings outside the school compound, then extra time will be needed for students to come and go to the planting site. This exercise may therefore have to be done outside school hours. The students will also have to visit their plantation site for observation and tree care at monthly intervals throughout the year.

Take up Box 16-1 before, and Boxes 16-2 and 16-3 after, this exercise.

PROCEDURE

1. Your teacher will select a site for the transplanting of your seedlings. This may be in your study village, in any nearby village where plantation work is in progress, or in your school compound. If possible, all teams should plant their seedlings at one site. The selected site must be protected from grazing animals.

2. Each team should plant about ten healthy seedlings.

3. Your teacher will tell you the spacing to be observed in transplanting your seedlings. The usual spacing is 2 m x 2 m; that is, 2 m between seedlings in lines 2 m apart. Write here the spacings to be followed.

   Distance between seedlings in lines ....m.

   Distance between lines ....m.

4. Using a tape measure, mark the place for each seedling with a stick or stone. Your teacher will assign ten sites to each team in a compact area. It is important to remember the location of your team's seedlings. During the next two years you must take care of these seedlings. Also you will have to make observations on their growth and survival.

5. Write the names of the types of seedlings that your team transplanted, and the numbers of each.

Type of trees	No. planted
....	....
....	....
....	....
....	....

6. After transplanting your seedlings check on them at least once a month during the school year. Be sure they are safe from grazing animals. Remove grass and weeds from the pits. Note in the space below your monthly observations; such as: has any seedling died? Which type? Which types are growing faster?

Teacher's signature:....................

Date:....................

BOX 16-1

METHOD OF TRANSPLANTING TREE SEEDLINGS

Seedlings are transplanted in July to give them the best chance of surviving. In the nursery, seedlings are watered regularly but after transplanting they usually cannot be watered. (There may not be sufficient water close by, nor do people have time to water many plants in big plantations.) The roots of the seedlings are small and do not go deep into the soil. If there is bright sun and no rain, seedlings can easily get dried out and die.

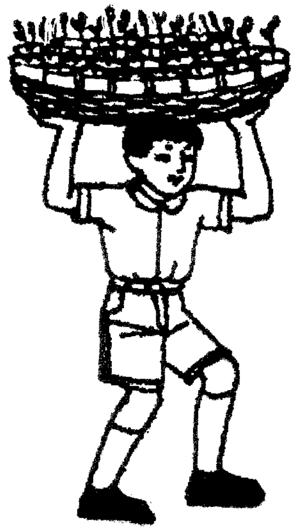
In the rainy season there is plenty of water in the soil for the plant to absorb. The weather is cloudy and hence the evaporation rate is lower than when the sun is shining. Because of these two conditions the seedlings are less likely to dry out and die. Tree seeds germinate naturally in the month of July when the rains have begun.

As far as possible, all seedlings should be transplanted in July. If transplanted in August, they get a shorter period of favourable monsoon weather to grow long roots and become strong enough to face the dry weather after the monsoon. Seedlings may, of course, be planted even in June if there are good pre-monsoon rains.

Deciduous tree species can also be transplanted in the winter when they are naturally leafless. Because they have no leaves at that time, they will not dry out. Winter rains also help them get established.

Pits must be dug to receive the seedlings. These should be approximately 30 cm square and 30 cm deep. In other words, they should be a cube 30 cm on each side. Remove the soil with a *phawda/ khurpi*, keeping the sides of the pit vertical. Pile up the excavated soil next to the pit. The top layer of dark, humus-containing soil (top soil), if any, should be piled separately from the lighter-coloured subsoil.

Now return all the soil to the pits. As you do so, remove all stones, grass and roots. Also, mix the top soil and subsoil. The pits are now ready to receive seedlings. If the land at your selected site is sloping it is a good idea to build up a bund on the lower edge of the pit. This will form a basin that will collect rain water. In a dry season, this extra water will soak in and keep the tree from dying.



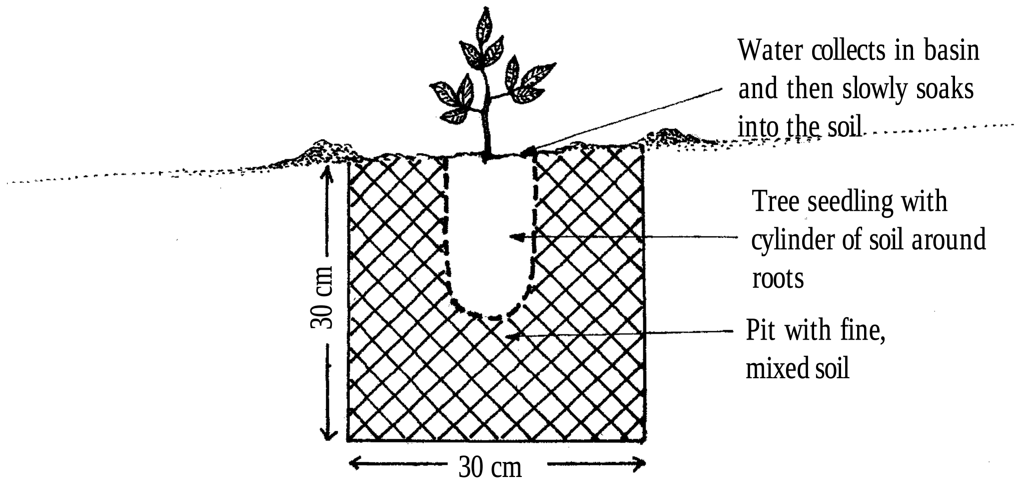
In the nursery, only strong seedlings with straight stems should be selected for transplanting. They are watered one day before taking them to the plantation site. Lift each bag and look at the bottom. If any root is found coming out of the bag, cut it off carefully with a razor blade. Pack the bags in an upright position into a wooden box or basket to carry them. Be careful not to drop them or shake them.

At the plantation site, carefully place one bag next to each pit. Be sure to make the bag stand upright. Do not lay it on its side.

Make a hole in the pit by hand, or with a *khurpi*, a little bigger than the bag. One person should hold the bag gently with two hands, while another person cuts the plastic bag with a razor blade. Do not use a sickle to cut the plastic. Gently remove the plastic leaving the cylinder of soil inside intact.

Place the cylinder of soil with the seedling in the prepared hole. The top of the cylinder should coincide with the level of soil in the pit. If it is lower, put a little more soil at the bottom of the hole. If it is higher, take out a little more soil from the hole. Holding the cylinder upright, replace soil in the hole. After putting each handful of soil. Press it down with your fingers. After the hole is completely filled press down all the soil in the pit around the seedling by walking on it.

The transplanted seedlings should look like this:



Be sure not to leave the empty seedling bags at the planting site. Collect and burn them.

After transplanting seedlings, keep the pits free from grass and weeds. Weeding should be done at least once a month during the monsoon. Weeds can be used as mulch; after decomposition they will nourish the seedling. Also, repair the bunds of the pits if the rain breaks them.

If you have transplanted the seedlings carefully and the winter and summer are not too dry, 70 or 80 percent of all transplanted seedlings should survive the first year. If you are careless, or if the weather is very dry, the survival percentage will be much lower.

If a seedling dies, you will have to put a new one in the empty pit the following year in July. This is called ‘gap filling’. With good care and weather, such gap filling should not amount to more than 20 to 30 percent of the seedlings originally planted.

Box 16-2

THE METHOD OF TRANSPLANTING FRUIT TREE SEEDLINGS

In Box 16-1 the general methods of transplanting tree seedlings has been explained. With fruit tree seedlings there are a few special features which will be explained in this box. Evergreen fruit trees, like all evergreen trees, are transplanted in the rainy season. Deciduous fruit trees are transplanted in the winter. Several types of evergreen fruit tree seedlings, such as loquat, orange, lemon and malta are however, also transplanted in the winter.

Before fruit tree seedlings are transplanted, the planting site should be dug or ploughed well and the soil surface leveled. One and a half or two months before transplanting pits should be dug. The dimensions of the pits depend upon the type of tree. For those types with deep and wide-spreading roots, large pits are required. For those with less deep and extensive roots, medium sized pits are needed, and for those with shallow and non-spreading roots only small pits need to be dug. In the following table the dimension of pits for various types of fruit trees are given.

Types of fruits	Dimension of pit
Large-rooted types	
(*Aam*, *Lichi*, *Kathal*, *Ber*, *Amla*, *Shehtut*, *Loquat*, *Akrot*)	1-1.2 m long; 1-1.2 m wide and 1-1.2 m deep
Types with medium-sized roots	
(*Amrood*, *Angeer*, *Kaku*, Pear, Sev, *Khumani*, *Nashpati*, *Cherry*, *Badam*, *Malta*, *Santara*, *Anar*)	80 cm long; 80 cm wide and 80 cm deep
Types with small roots	
(*Papita*, *Kela*, *Angoor*)	60 cm long; 60 cm wide and 60 cm deep

The distance between trees also depends upon the size of the tree. The distances between trees for various types are given below:

Type of tree	Distance between trees
Aam	10 x 10 m
Lichi	9 x 9 m
Amrood	8 x 8 m
Ber	7.5 x 7.5 m
Aru, Nashpati, Khubani	7 x 7 m
Nimbu, Santara, Malta, Sev	6 x 6 m
Papita	2 x 2 m

The soil from the pits should be mixed. Stones and plant roots should be removed. It should be left exposed to the sun for some days. Then well-decomposed compost should be thoroughly mixed with it before replacing it in the pit. The amount of compost to mix with the soil depends upon the fertility of the soil. In general for infertile soil (like sandy soil) the mixture should be 3/4ths compost and 1/4th soil. For soil of average fertility the ratio should be ½ compost and ½ soil. For clay soil, the ratio should be 1/3rd compost, 1/3rd sand and 1/3rd soil.

Fruit tree seedlings can be grown from seeds or cuttings at home, or can be purchased from a reliable nursery. The seedlings should be removed from the nursery with a ball of soil around the roots. Care should be taken not to break this ball during transplanting. For this, it should be wrapped with grass or straw. After taking out the seedlings they should be kept in the shade and sprinkled with water until they are transplanted.

Seedlings should be transplanted in the evening. The transplantation should be done as described in Box 16-1.

Seedlings should be placed in the soil at the same depth as they were in the nursery.

Fruit tree seedlings should be watered regularly after transplanting unless there is regular rainfall. Soil should be slightly raised around the stem for about 25 cm so that water will not collect on the surface near the stem. This way there is no danger that the seedling will rot.

In addition to regular watering and weeding, it may be necessary to protect transplanted seedling from cold by placing grass coverings over them.

BOX 16-3

TREES AND THEIR FOOD

Plants produce their own food

All living organisms need food to stay alive, to grow and reproduce themselves. Green plants make their own food. Animals can not make their own food; they eat plants, or other animals that have eaten plants.

Plants absorb water from the soil. Along with the water they also take in dissolved nitrogen and minerals like phosphorus, calcium and potassium. Leaves absorb carbon dioxide from the atmosphere and energy from sunlight.

Inside the leaves water, carbon dioxide and sun's energy combine to form glucose and oxygen. We can write this as:

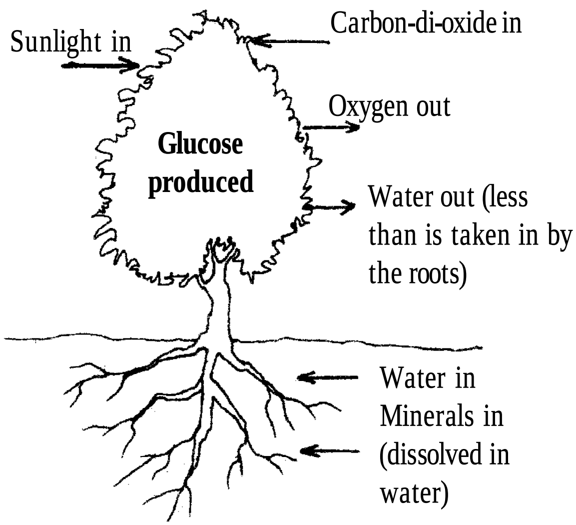
Water + carbon dioxide + sun's energy = glucose + oxygen

This process is termed 'photosynthesis'. The word 'synthesis' refers to the making of complex molecules (glucose) from simple ones (water and carbon dioxide). The word 'photo' tells us that sunlight is required.

Only green plants can make glucose in this way. In their leaves they contain a green substance called chlorophyll which is necessary for the process of photosynthesis.

Food and tree growth

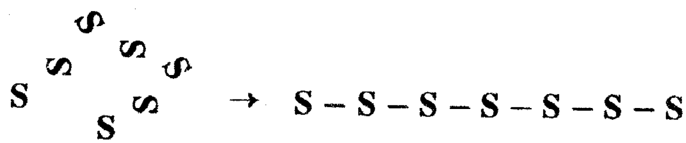
The basic food of the tree is thus glucose. It is made in the leaves where the green chlorophyll is. From there it travels, dissolved in water, to all parts of the tree. In the roots, stems and branches it is made into cellulose, a very large molecule that is the chief constituent of wood. In the seeds, glucose is made



into other large molecules – starch, fat and protein. (Protein molecules also contain nitrogen and phosphorus.) In the spring, when the tree makes new leaves, glucose stored in the stem and roots moves to the leaf buds. There it is made into protein which is used to make new leaves.

Trees normally use most of their food to make wood. Thus they grow bigger each year. Their stems and branches become longer and thicker. If we cut a tree's leaves for fodder, it increases in size slowly, or not at all. This is because the tree must grow new twigs and leaves to replace those we cut, leaving less food for the growth of stem and branches.

Food also supplies energy for growth. Cellulose and other large molecules are made from sugar molecules, as:



Glucose molecules   Cellulose molecule

Many molecules of glucose are joined together to from a chain. To make the connections between successive glucose molecules in the chain requires energy. This energy comes from a process called respiration. It occurs like this:

Glucose + oxygen = carbon dioxide + water + energy

You will see that this process of respiration is the opposite of photosynthesis. It occurs in the plant throughout the day and night.

A plant consumes carbon dioxide in photosynthesis, but produces it in respiration. However, it consumes more than it produces. In the case of oxygen, the plant produces more than it consumes. Hence we say that "plants consume carbon dioxide and produce oxygen".

Animal nutrition

Animals also need starch, proteins, fats and other complex molecules to sustain life. However, they cannot make these themselves. They must eat plants to get them, or eat animals that have eaten plants.

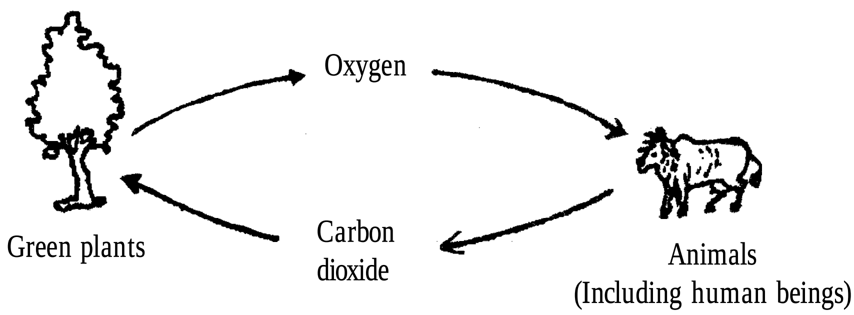
The plants eaten by animals are digested by them in the stomach and intestines. The undigested portion is excreted.

In the animal body some complex molecules are used to build up the body, to produce milk, for energy and for respiration. Energy is used to perform work like walking and pulling a plough. In animals only the process of respiration occurs, and not photosynthesis. Hence we say that animals consume oxygen and produce carbon dioxide.

Carbon dioxide and oxygen cycle

Since plants produce oxygen, while animals consume it, we see that plant and animal nutrition are complementary. It is obvious that animals could not live without plants, since plants are their food. However, plants could not survive for long without animals. They would use up all the carbon dioxide in the atmosphere. We can see that constant amounts of both carbon dioxide and oxygen in the atmosphere are maintained because of the interdependence of plant and animal nutrition.

Decomposers



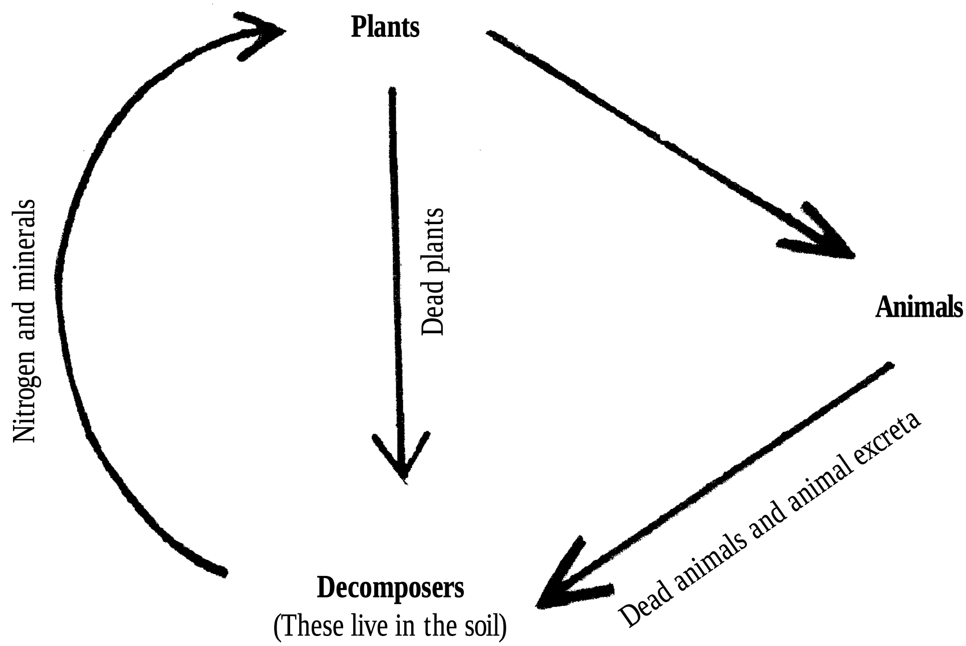
There are some organisms classed as plants that do not carry out photosynthesis. They are not green in colour. Examples of these are bacteria and fungi. They eat dead plants and animals. We see their activities when we make compost, and in the rotting of tree trunks and leaves in the forest. These organisms are termed decomposers.

Some animals are also classified as decomposers. This is because they live in the soil and eat dead plants, animals, and animal excreta.

Examples are termites and earthworms.

Nutrient cycles

As a result of the activities of these decomposers, nitrogen and minerals in dead plant and animal tissues are released into the soil. From there, they are absorbed by the roots of living plants. Nitrogen and minerals are called 'nutrients'.



If there were no decomposers the leaves that fall from trees every year would go on accumulating and trees would die because they would not get any nitrogen and minerals.

Date: ....

Code : Water 1
Month : July

EXERCISE 17

MEASURING RAINFALL

INTRODUCTION

Suppose we say, "There was more rain today than yesterday". How can we prove this? The only way is to measure exactly how much rain fell yesterday, and how much today. In this exercise we will learn how to measure rain fall.

REQUIREMENTS

Each team requires a vessel in which to collect rain water. Beakers of 100 ml, 200 ml, 500 ml and 1 litre capacity can be used. Also a canister open at the top. Any vessel, open at the top, can be used, provided it has a flat bottom and vertical sides, i.e., sides that are at right angles to the bottom. Each team should have a vessel of a different size.

PROCEDURE

1. On a rainy day in the morning, place your vessel in the open to catch the rain. The vessels of all teams should be set out at the same time.

FOR THE TEACHER

Take up this exercise when it rains. Take up Boxes 17-1, 17-2 and 17-3 after this exercise.

Be sure that every student can measure rainfall with a raingauge. For one year, beginning now, students will measure and record rainfall. You will assign definite times for each team to do this. Tell them that recording of rainfall has to be done every day at a definite time.

To record rainfall daily a small permanent school copy will be needed. This copy will be kept by you. From this copy students will note down data recorded by other teams.

At the beginning of the class eight the same students will analyse these annual rainfall data. Be sure that the work of recording rainfall continues during vacations, otherwise annual analysis will not be possible. When the academic session is over the work of measuring and recording rainfall during the summer will continue to be the work of these same students until the beginning of the next school session.

Put the vessels in an open place far from buildings and trees. In the evening, or when the rain stops, bring all the vessels to the classroom or laboratory at the same time. Try to choose a day for this experiment when there is heavy rain.

2. Measure the depth of the water in your vessel. Be sure to put your vessel on a table before making the measurement. Take a dry stick of wood, put it vertically into the water, touching the bottom of the vessel. Take it out and measure the length of the wet portion with your scale. Read the scale to the nearest millimetre. Write your reading here.

   Depth of water = ...mm

   This is the exact amount of rain that fell during the period you left your vessel in the open. If your reading is, say, 12 mm, we say "Rain fall during this period was 12 mm".

   Normally we measure rainfall during a period of 24-hours. There are special vessels to make this task easy (see Box 17-1). They are called 'rain gauges'. Many schools have these and rainfall is measured every day of the year. The amount of rainfall is written down in a copy every day. Thus the amounts of rainfall in one month can be calculated, and for a whole year.

3. Write your figure for rainfall in the appropriate space in Table 17-1. Exchange data with all the other teams to complete Table 17-1.

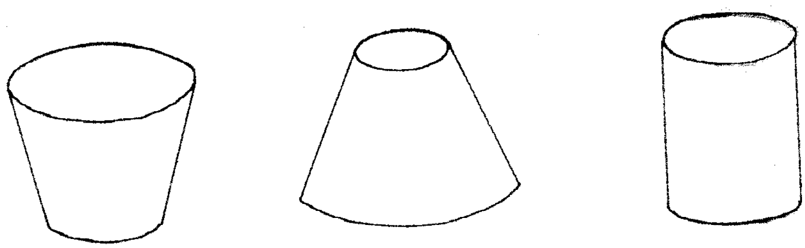
Table 17-1. Depth of water in rainfall-measuring vessels, mm.

Team number	Depth of water, millimetres
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

QUESTIONS

1. Compare the depth of water in the vessels of all ten teams (Table 17-1). Does depth of water depend upon the size of vessel? If not, why not?

2. The following three vessels were used to measure rainfall at the same place at the same time.



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Will they give the same reading? If not, why not? Which one will give the correct reading?

3. Let us suppose that one day you have measured rainfall on the school playground. The playground is a level field two 'ares' in area. The rainfall reading in the vessel used is 2 cm. Suppose the rain water that falls on the playground does not soak into the soil, or run away because there is a bund all four sides. Then you measure the depth of the collected water. Would it be the same depth every where in the field? How deep would it be?

____

____

____

____

____

____

Teacher's signature:....................

Date:....................

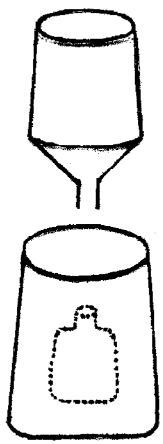
A task for the coming year

Rainfall is done with an apparatus called a 'raingauge'. This apparatus makes measurement easy and accurate. The measuring and recording of rainfall using a raingauge is the special task of seventh class students. Your class will do this from now onwards for one year. Your teacher will assign each team for a definite period of time to measure and record rainfall everyday. You will record the amount of rainfall in the school rainfall copy which is kept by your teacher.

BOX 17-1

HOW DOES A RAINGAUGE WORK?

Measuring rainfall with a canister or a beaker is not very accurate. It is difficult to measure the depth of small amounts of rain water. Also, if we do not measure the water immediately after it rains, some of it evaporates. A raingauge is an instrument designed to solve these problems. It looks like this:

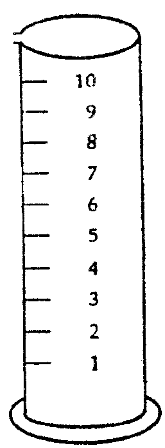


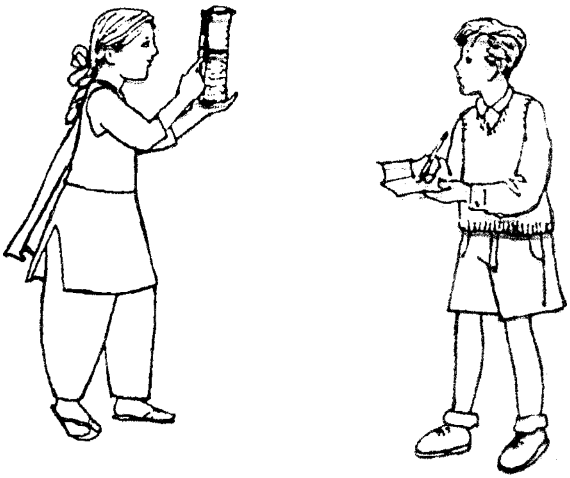
The top portion is like a large funnel. It screws into the bottom portion.

The bottom portion holds a large plastic or metal bottle. When the gauge is closed, the tip of the funnel fits into the bottle.

Once every day the rain gauge is opened up and the water in the bottle is transferred to a special type of measuring cylinder. The measuring cylinder looks like this:

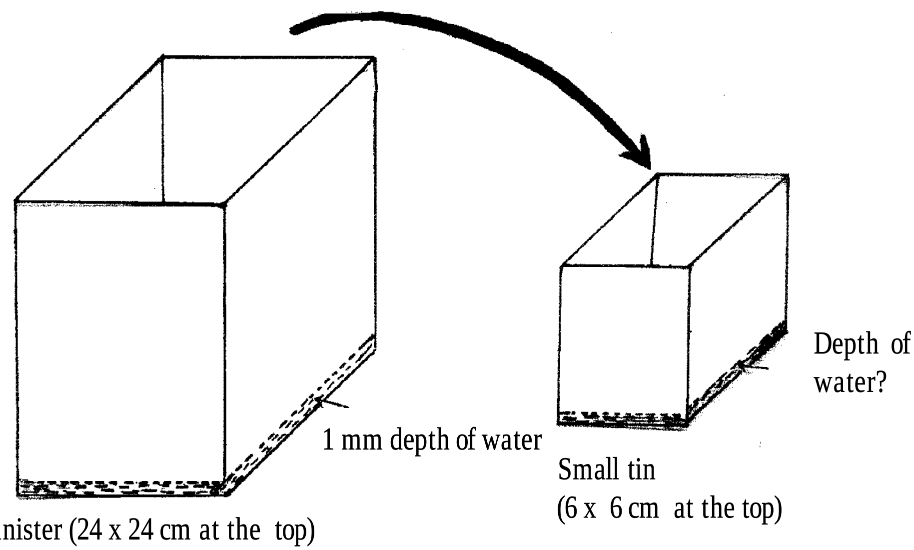
Water from the bottle is poured into this measuring cylinder. The level of water is compared to the scale on the side of the cylinder. This scale tells you directly the depth of rain water that has fallen. For example, if the level of water in the cylinder is equal to the line marked '6', it means that 6 mm of rain has fallen.



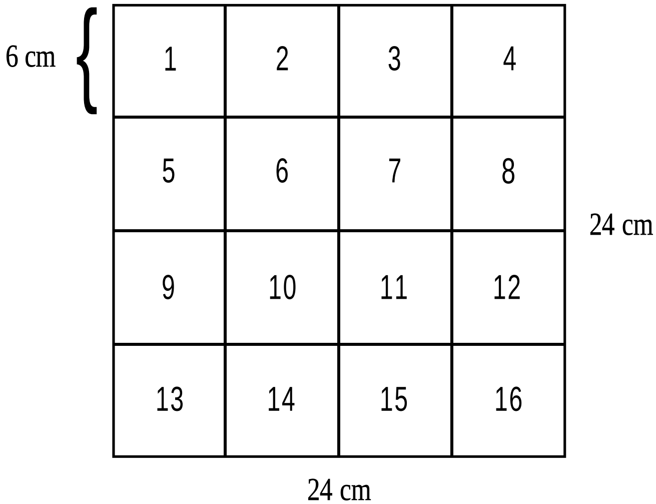


The number you read on the cylinder should then be written in the school rainfall copy in the space provided for the date of recording.

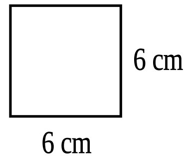
You may wonder how the measuring cylinder tells you directly the depth of water that fell into the funnel of the raingauge. To understand this we must know on what principle the rain gauge is constructed. Suppose we collect rain water in a canister, and suppose 1 mm rain falls. It is very difficult to measure 1 mm accurately, especially inside a canister. Let us therefore pour the water from the canister into a smaller tin which has a square top 6 cm x 6 cm. What will be the depth of water



in the small tin? To answer this, let us compare the areas of the tops of the canister and the small tin.



Top view of canister



Top view of small tin

Each side of the top of the canister is 24 cm long, which is four times the length of a side of the top of the small tin. We can see from this diagram that the area of the top of the canister is 16 times (16 small squares, each with a side of 6 cm) the area of the small tin. We can also calculate this number 16.

$$\frac{\text{Area of the top of the canister}}{\text{Area of the top of the small tin}} = \frac{24 \times 24}{6 \times 6} = \frac{576}{36}$$

Now we should be able to answer the question: how deep will the water be in the small tin if it was 1 mm deep in the canister? It will be 16 times deeper, or 16 mm deep. If we pour rain water from the canister into the small tin, and the depth of water in the small tin is 16 mm when we measure it, we know that rainfall was 1 mm. We can measure 16 mm more accurately than 1 mm.

$$\text{Depth of water in small tin} = \frac{576}{36} = 16 \text{ mm}$$

Now suppose we measure the depth of water in the small tin and find it is 32 mm. How much was the rainfall? The answer is:

$$\frac{32}{16} = 2 \text{ mm}$$

How deep will the water be in the small tin if rainfall was 10 mm?

16 x 10 = 160 mm

Now on the small tin we can put marks at heights of 16,32, etc. mm from the bottom and mark these '1 mm', '2 mm', etc. Then we can tell at a glance how much rain fell.

The relation to the area of the funnel of the raingauge to that of the top of the measuring cylinder is similar to the relation of the area of the canister to that of the small tin. By pouring the water from the bottle under the funnel into the measuring cylinder we magnify the depth of water for more accurate measurement. With the measuring cylinder we can also read the level of water from the outside.

Keep in mind that the measuring cylinder that is part of the raingauge is different from the measuring cylinder you used last year in Exercise 9. That one measured volume of water, while this one measures depth of water in the raingauge.

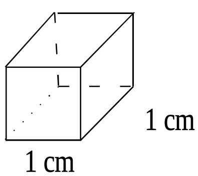
The measuring cylinder can measure up to 10 mm. If there is more than 10 mm of rain, we must first fill it to the 10 mm mark, then empty it and transfer more water. Let us say that we fill the measuring cylinder up to the mark twice, and on the third time we read '5 mm'. The rainfall that day was 25 mm.

BOX 17-2

VOLUME MEASUREMENT

We measure liquids like water and milk in terms of the amount of space they occupy.

A cube is a figure of three dimensions, having equal width, length and height. Each of its six faces is a true square. In a true square each side is same length and each of the four angles is of 90 degrees.



If each of these squares is 1 cm x 1 cm, the cube has a volume of 1 cm x 1 cm x 1 cm, or 1 cubic centimetre (cc).

This volume of 1 cc is very small, amounting to only about 20 drops of water. A larger standard volume is the 'litre'. This is equal to 1000 cc. The familiar litre measure is carefully made to contain exactly 1000 cc. When you buy kerosene it is measured with a one litre measure.

For measuring the amount of water used in irrigating our fields, an even bigger unit is used. This is 1000 litres or one kilolitre. A cube one metre on each side holds one kilolitre. We can thus also call this unit a cubic metre.

Here are two simple problems showing how volumes are calculated:

1. An ordinary canister is a square at the top, each side being 24 cm. It is 36 cm high. We multiply length x breadth x height to get the volume. Hence:

   Volume = 24 cm x 24 cm x 36 cm = 20,736 cc

   We can also express this volume in litres. To do this we divide the volume in cc by 1000. Thus:

$$\text{Volume} = \frac{20{,}736 \text{ cc}}{1000 \text{ cc}} = 20.736 \text{ litres}$$

2. A water tank is 2 m wide, 3 m long and 2 m deep. What is its volume? We multiply 2 m x 3 m x 2 m to get the answer 12 cubic metre.

Summary:

1 litre = 1000 mililitres = 1000 cubic centimetres

1 cubic metre = 1000 litres

Some problems for practice

Do all calculations neatly on the blank pages provided.

1. Imagine that the irregularly-shaped field you measured in Exercise 13 (see page 3) is to be irrigated. 5 cm of irrigation water is to be applied. (That is, water to a depth of 5 cm is to be applied.) How much water would be needed to irrigate this field? Give your answer in cubic metres.

   Answer : ....cubic metres

2. In Shantipuri village, 1,000 mm rain fell last year. 400 mm ran off, and 600 mm soaked into the soil. What is the percent run off?

   Answer ....

3. We dig pits 30 cm x 30 cm x 30 cm for transplanting trees . What is the volume of soil removed from each pit? Give your answer in litres.

   Answer ....

4. A roof is 8 m long and 6 m wide. All the rain water that falls on this roof is collected in a tank. Last year total rainfall was 100 cm. Calculate how much water was collected in the tank. Give your answer in cubic metres.

   Answer ....

5. A field 50 m long and 40 m wide is to be irrigated a depth of 5 cm. How much water will have to be applied? Give your answer in cubic metres.

   Answer ....

Box 17-3

CLIMATE, SEASON, WEATHER AND CROPS

In the Boxes 3-1, 3-2 and 7-1 we learned that the types of crops/trees that grow in a particular village vary with altitude. This is because the air temperature varies with altitude; the higher the altitude, the lower is the average air temperature throughout the year. In Uttarakhand we can divide the villages on the basis of average annual temperature into two main types: those below an altitude of about 1500 m, and those between 1500 m and about 4000 m. These two zones are termed 'sub-tropical' and 'tropical' respectively. Above an altitude of about 4000 m no trees can grow and no crops, only grass and lichens. This is called 'tundra' zone. Above about 5000 m, nothing grows because the average annual temperature is below zero degrees centigrade.

The average annual temperature of an area is the climate of that area. Thus in Uttarakhand there are four different climatic zones: subtropical, temperate, tundra and arctic. If we consider the whole of India, there are five zones, or five different climates: tropical, sub-tropical, temperate, tundra and arctic.

The average annual temperature of a village also depends on where in India it is located. Those villages in the southern states are in the tropical climatic zone. Those are in the northern states are in sub-tropical zone. Going farther north, villages in northern Asia (Northern Russia) are in the tundra and arctic zones. In a given state or country, the climate also changes with altitude, as we have seen for Uttarakhand.

'Tropical' means the climate that is found in the southern half of India at low altitudes. The average temperature does not go below about 15 degrees. There is no area of tropical climate in Uttarakhand. 'Temperate' means 'neither too hot, nor too cold'. Temperature goes from a minimum of near zero in winter to a maximum about 35 degrees. In the tundra, the ground below about 30 cm remains frozen all year, which is why trees and crops cannot grow. In the arctic, the ground is covered by snow all year round.

Whatever the climate of a village is, the air temperature, wind and rainfall vary from day to day. These variations are termed 'weather'. The general weather conditions vary throughout the year; at one time of the year, the temperature is always high compared to another time of year, or there is always more rain at one time of the year compared to other times. These different periods during the year are termed 'seasons'. In Uttarakhand we have four seasons: spring (February and March), summer (April to September), autumn (October to November) and winter (December to January). The weather in the summer is hot, in the winter it is cold and in the spring and the autumn it is cool. The summer season is divided into dry (April to May) and wet (June to September). The wet summer is the period of the monsoon rains.

What crops are grown in a particular village is determined by climate, weather and season. For example paddy can grow only in villages with a sub-tropical climate and only during the warm season. Even with in a given climate zone, a crop may grow only at lower or higher altitude. Sugarcane, for example is grown only in the Tarai and Bhabar, whereas, *sev* trees are grown only in the hills, usually above 1200 m.

In a given village in a given season day-to-day variations in weather affects the yield of crops. Too much rain, or too little may reduce the yield of a crop, or even destroy it. Freezing weather (temperature zero degree) for even one night in February can kill the flowers of mango trees, in which case there will be no mangoes. Hail, which is frozen raindrops, falling on the ripe wheat crop can damage or even destroy it. High winds can cause the wheat crop to 'lodge', that is, to fall down and cause 'fruit drop', that is the falling of unripe fruit.

There are some things that can be done to prevent or lessen crop damage. Where hot summer winds ('*loo*') dry up summer or warm season crops, we can plant shrubs and trees on the western side of our fields. These act as a 'wind break'. On nights when freezing temperatures are expected, a smoking fire may be lighted near fruit trees, and in fields of crops susceptible to freezing weather like potatoes and tomatoes the fields may be irrigated in the evening.

Date: ....

Code : Land 4
Month : August

EXERCISE 18

SOIL EROSION

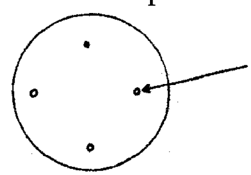
INTRODUCTION

Soil erosion is a process in which soil particles are dislodged and carried away by rain water. In this exercise we will see how this process occurs. We will also learn that soil erosion occurs more rapidly when the soil surface is not covered with vegetation.

REQUIREMENTS

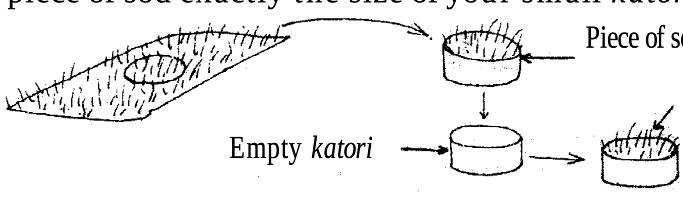
1. *Thali*, 25-30 cm in diameter and with a 2 cm vertical edge – one
2. *Katoris*, 8-10 cm in diameter and 3 cm deep – two
3. *Katoris*, 12-15 cm in diameter and about 8 cm deep – two
4. Tin 6-8 cm in diameter and about 8 cm deep, open at the top – one

   Make four holes in the bottom of the tin at the places indicated. Use a 2.5 cm nail and a hammer.



PROCEDURE

1. Find a place in the school compound or nearby village forest area where grazing has not occurred and the ground is covered with thick grass. With a *khupri* or the point of your sickle, cut out a circular piece of sod exactly the size of your small *katori*.



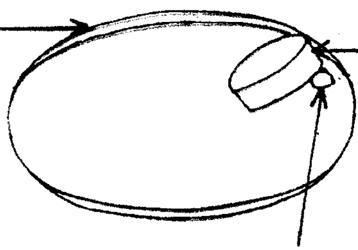
Fit this piece of sod snugly into your *katori*. The original ground level should coincide with the top edge of the *katori*.

FOR THE TEACHER

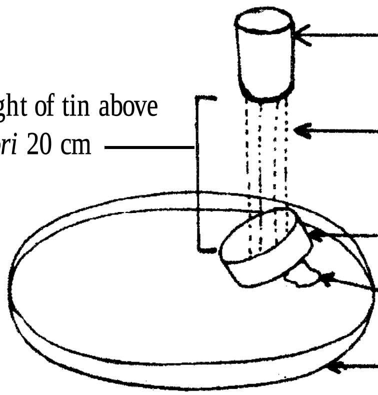
Take up Boxes 18-1 to 18-6 before beginning this exercise. This exercise will be done as a demonstration.

2. From the same place dig out another bigger piece of sod. Place it in your *thali* and break it into pieces. Remove all grass, stems and roots. Also all stones. Crumble the soil and put it into a small *katori*. Press it down slightly. The top of the soil should coincide with the top edge of the *katori*.

3. Place the *katori* of soil in the *thali* as shown.



Fill the tin from a bucket and quickly hold it over the *katori* as shown.

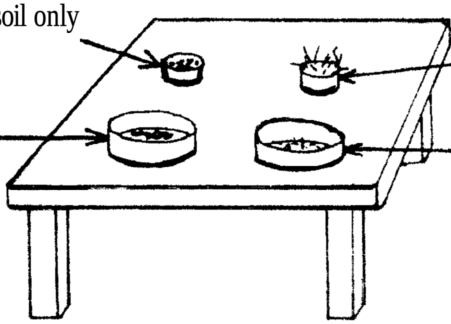


Move the tin from side to side slowly, so that the streams of water strike every part of the surface of the soil in the *katori*. Be careful that the streams of water do not fall outside the *katori*.

4. When the tin is empty, remove the *katori* and stone from the *thali*. Empty all the water and soil from the *thali* into a big *katori*. Keep both *katoris* for later observation.

5. Now place the sod-fitted *katori* in the *thali*, tilting it with the same stone. Run a tin-full of water over it as before. Transfer soil and water from the *thali* to the second large *katori*.

6. After completing, place all four *katories* on a table in pairs for observation as:



7. This display is best left undisturbed until the following day when the soil in the large *katoris* will have largely settled. To facilitate the comparison of the relative amounts of eroded soil in the two large *katoris*, tilt them uniformly at an angle of about 20 degrees with small stick or stones.

QUESTIONS

1. Look at the soil in the two big *katoris*. Which is more? Why is this?

____

____

____

____

____

2. Estimate, by looking at the two large *katoris*, how many times more soil one contains than the other, write your estimate here:

____

____

____

____

____

3. Now look at the surface of the soil in the small *katories*. Describe the differences you see. Here are a few hints: (1) Compare the levels of the soil in the two *katoris*, (2) Did the water wash out bigger or smaller soil particles?

4. On your way to school look for a place where the soil has eroded. Describe this place, and tell where it is. Why has the soil eroded from this place?

5. If soil erosion is occurring in your village, what can be done to reduce it? (see Box 18-1)

6. If possible, see some cultivated land on a day of heavy rainfall. Is water flowing across the surface? What is the colour of this flowing water?

7. How does soil erosion in the mountains affect villages in plains?

8. Is soil erosion from your village harmful?

Teacher’s signature:....................

Date:....................

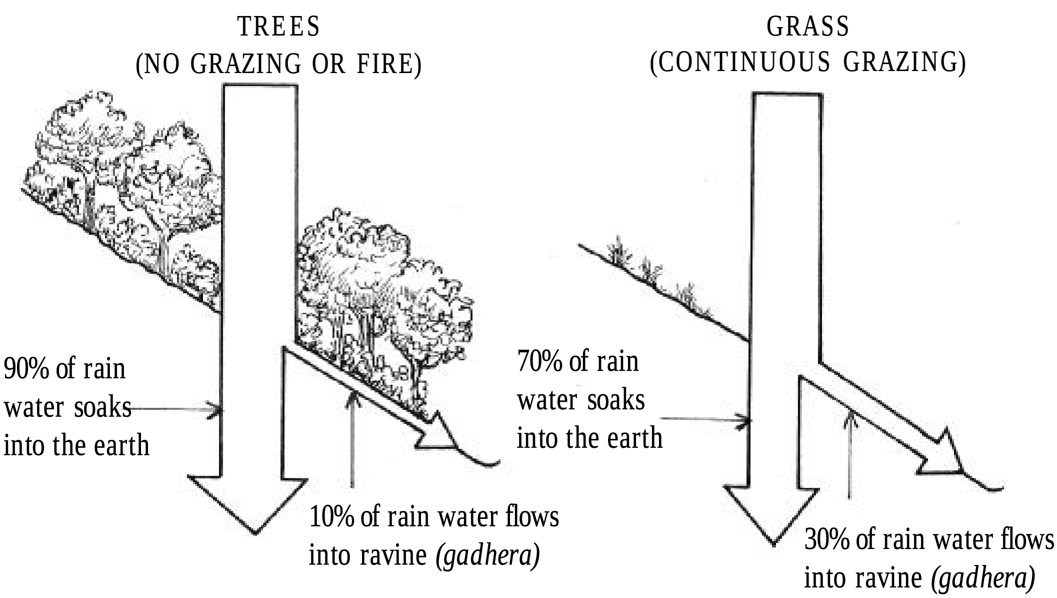
BOX 18-1

WHEN IT RAINS

When rain falls on our land it soaks into the soil. Last year in Exercise 9 we saw for ourselves how soil soaks up water. But where the land is sloping some of the rain water may run off the surface into drains and streams before it can be soaked up by the soil. In general, the steeper the slope, the greater the proportion of rainfall that runs off the surface.

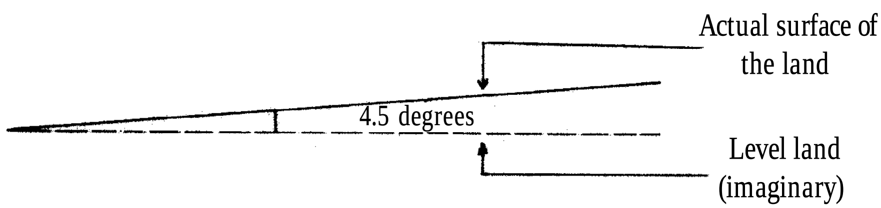
When there is heavy rainfall some water will run off even level land. If the soil surface is bare, then more water runs off than if it is covered with vegetation. In dense forest where the soil surface is covered with a mat of decaying leaves and many growing plants, there is no run-off of water even on very steep slopes, except perhaps when there is very, very heavy rainfall. Similarly if the soil surface is covered by thick grass.

On the other hand, if our support area does not have any trees, and if much of the soil surface is not covered by leaf litter or grass plants, the proportion of rain water running off may be 30 percent of the annual rainfall. Most of the water falling in heavy rains will run off.



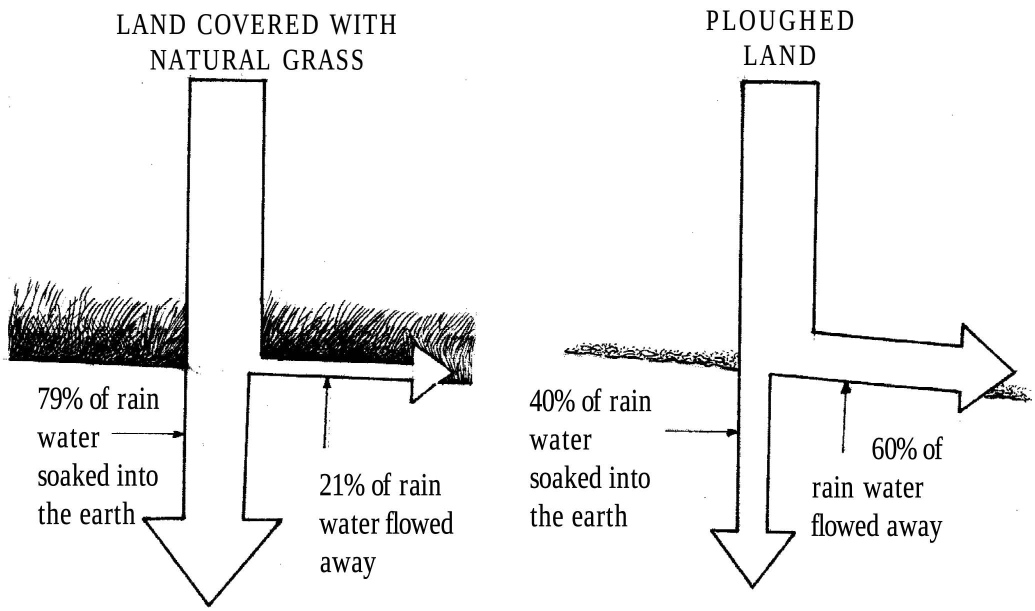
In cultivated land the soil surface is bare most of the year and water run-off is more than on uncultivated land which has a covering of vegetation. In organic farming (Box 11-1) we always keep the soil surface covered with mulch. This reduces rain water run-off, as in the case of the mat of decaying leaves in a thick, natural forest.

At the Central Soil And Water Conservation Research and Training Institute, Dehradun, the amount of rain water run-off from land with a 4.5 degree slope was measured as well as the amount of rainfall. Land with a 4.5 degree slope can be represented like this:



(You can verify the angle or slope of the land with your protractor.)

Part of this land was covered with natural grass and part of it was ploughed but not sown to any crop. On the grassed portion water equal to 21 percent of the total rainfall ran off (28 out off 133 cm). On the ploughed, bare portion water equal to 80 cm of rainfall or 60 percent of the total rainfall ran off.

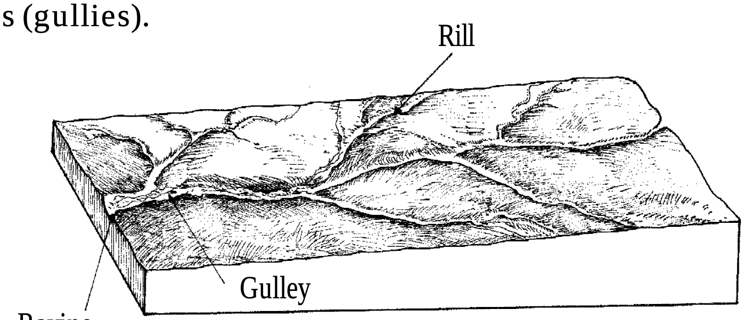


When rain falls on the bare surface of the land it dislodges and then carries away particles of soil with it. In the following diagram we see the first part of this process:

Rain drops hitting a bare slope dislodge many soil particles

If land is densely forested, the force of rain drops is broken when they strike the tree leaves. Water drips gently from the leaves to the ground. If there is leaf litter on the ground, this breaks the force of falling drops still more. Thick grass also breaks the force of falling raindrops.

On bare ground, rain water quickly flows down the slope, carrying the lighter soil particles that have been dislodged by the impact of falling drops. Since there are no plants or litter to impede the flow of water, it increases in speed as it moves down the slope. The water also tends to flow in small rivulets. In doing so, it dislodges still more soil particles, cutting small channels (rills) and at places even big channels (gullies).



The water running in these channels becomes brown in colour due to the soil particles suspended in it.

These processes by which soil particles are dislodged and carried away by rain water is called 'soil erosion'. The rate of soil erosion is more on steep slopes than on gentle ones because water runs faster down steep slopes carrying more soil particles with it.

The amount of soil eroded from an area of land can be measured. Here are the full results from an experiment done at Dehradun.

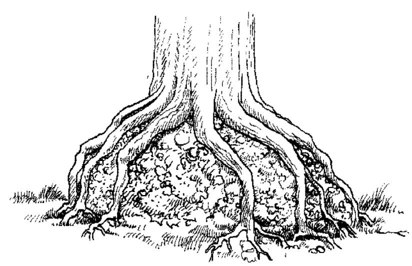
Cover of the land	Rainfall (cm) in the year	Percentage of water run off	Soil loss kg/'are'/year
Natural grass cover	125	21	10
Bare ploughed land	125	60	1500

From the results we see that there is some soil erosion even from land that is well covered with natural vegetation. This is called 'natural soil erosion'. There is some natural soil erosion also from natural forest, particularly in the Himalayas were all the land is sloping. Where the soil surface has been bared a greater rate of erosion occurs. We say that there is 'accelerated erosion'.

Since soil is the basis of our livelihood, we must carefully protect it from erosion. Whenever we plant trees in our village land and protect them from grazing and fire, we not only get more fodder and fuelwood, we protect the soil from soil erosion. And when accelerated soil erosion is prevented, the trees are healthier and yield more.

Is accelerated erosion occurring in your village land at present? How can you decide? Here are the sure indications of accelerated erosion.

1. If the soil surface is not completely covered with vegetation (living plants and decaying leaves on the surface), accelerated erosion must be occurring.
2. The presence of rills and gulleys.
3. The presence of pedestals under stones or trees as:



This pedestal is soil protected from falling rain drops. Its height above the soil surface indicates the thickness of the layer of soil eroded away at that spot.

BOX 18-2

MOUNTAINS AND PLAINS 1. WATER

Uttarakhand is composed of mountains and plains. Let us imagine that with a big knife we cut the state into two parts on a straight line between Roorkee and Kedarnath, or between Kichha and Nanda Devi, and look at the cut edges. This will help us understand the relationships between the plains and the mountains. We would get a view like this.

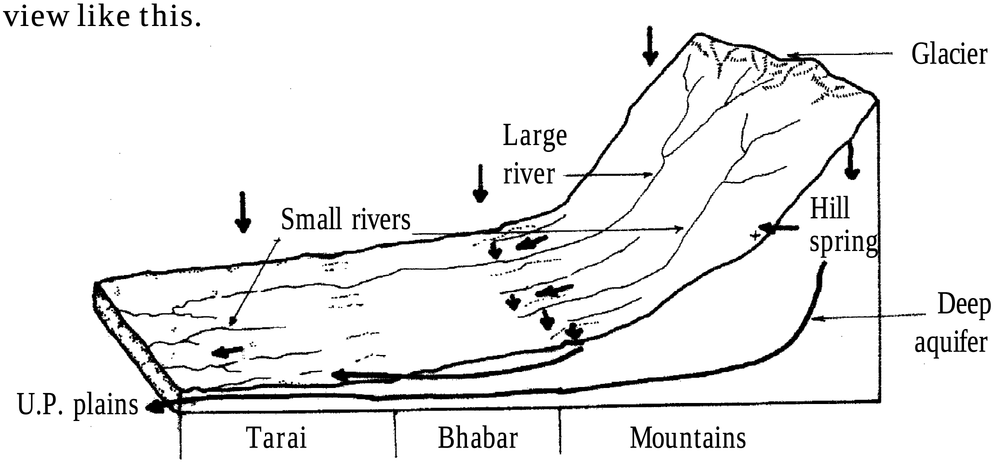


Figure 18-2-1

In this diagram the bold arrows show the flow of water. The rain that falls on the mountains flows down, by various routes, to the plains below. Let us follow each of these routes.

1. Large rivers

These are fed by glaciers on the highest mountains. One example you know of is Gomukh which is the source of the Ganga. As you know, at high altitudes, above about 5000 m, rain falls in the form of snow. When snow accumulates and becomes very deep, the bottom layer turns into solid ice. It become very heavy and begins to slide down the mountain side at various places. We can think of this sliding ice as 'frozen rivers'. These are glaciers. When the ice in a glacier reaches a lower altitude where it is warmer, it melts and becomes a river. Further down, these rivers also collect rain water that runs off the surface of the land, or which initially soaks into the earth and then comes out again as hill springs (see route 3 below).

Most of the water from these rivers flows to the plains beyond Uttarakhand and finally to the ocean. Some of the water in the large rivers, like the Ganga and the Ramganga, is diverted into canals and is used for irrigation, as in Haridwar District.

2. Small rivers

The small rivers flowing from the mountains to the plains are fed only by rain water and not by melting glaciers. They begin from altitudes below the snow line (about 5000 m). Thus their sources are two: direct surface run-off, and hill springs. Their flow is much less in the dry season when their only sources of water is springs. An example of this type of river is the Gola in Nainital and Udham Singh Nagar districts.

Many small rivers arise at the foot of the mountain from springs and, after traveling a short distance, disappear again in the *Bhabar*. That is all their water soaks into the earth. This water flows underground and then emerges at the surface again in the *Tarai* to form new rivers. These flow away to the plains beyond the *Tarai*. Some of them are damed and their water used for irrigation.

Of course, some of the water in the big rivers also soaks into the earth, but not all of it since the flow is very great.

We should note that the big rivers, because they are fed by glaciers, have a more even flow throughout the year than small rivers that are fed only by rain water.

3. Hill springs

Springs or seepages are places in the mountains where rain water that soaked into the earth comes out again. This water then flows away in small streams to feed the rivers. People living in the hills use some of this water for household purposes and, at some places, for irrigation. Why the water flows out of the earth at these places will be explained later in Box 21-2 where you will learn about the structure of the earth.

4. Deep aquifers

Some of the rain water that soaks into the earth in the mountains does not come out again in the hills, but goes very deep and flows underground to the plains. This is shown in Figure 18-2-1.

BOX 18-3

MOUNTAINS AND PLAINS 2. SOIL

The water that flows in streams and rivers from the mountains (Box 18-2) contains eroded soil. Moreover, the water flows very fast and carries even stones with it. When these streams emerge into the *Bhabar*, their rate of flow decreases. The stones and coarse soil particles they carry fall to the bottom and are left behind. Thus in the *Bhabar*, the soil is composed of this coarse material eroded from the mountains.

Further down, in the *Tarai*, the rate of flow of water in streams and rivers decreases still more since the slope of the land is less than in the *Bhabar*. Much of the fine soil also settles to the bottom and remains. Thus the soil in the *Tarai* has also come from the mountains. The diagram in Figure 18-3-1 shows how this process of soil erosion and deposition occurs. Some of the soil carried in the bigger rivers like the Ganga reaches far beyond the *Tarai*. In fact, the soil in the entire Ganga, Yumuna plain of UP, Bihar, West Bengal and Bangladesh has been formed from soil from the mountains of Uttarakhand, Himachal Pradesh, and Nepal.

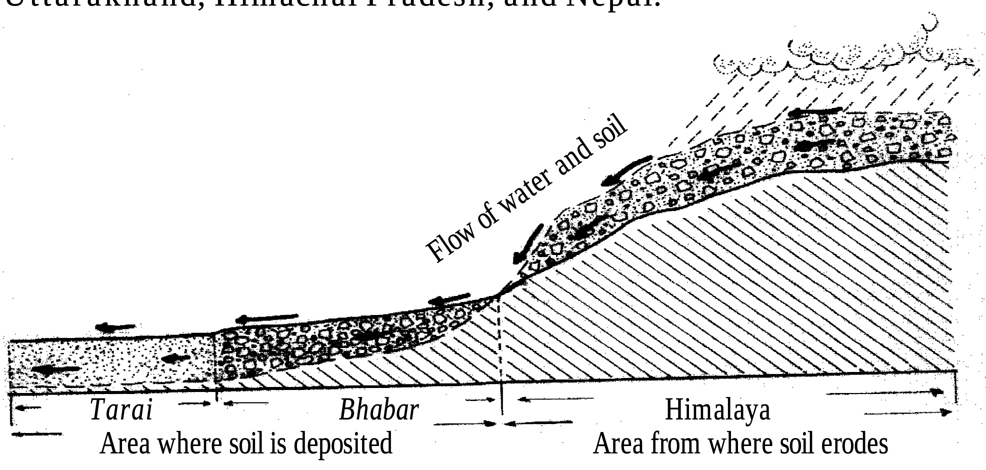


Figure 18-3-1. Erosion and deposition of soil in Uttarakhand

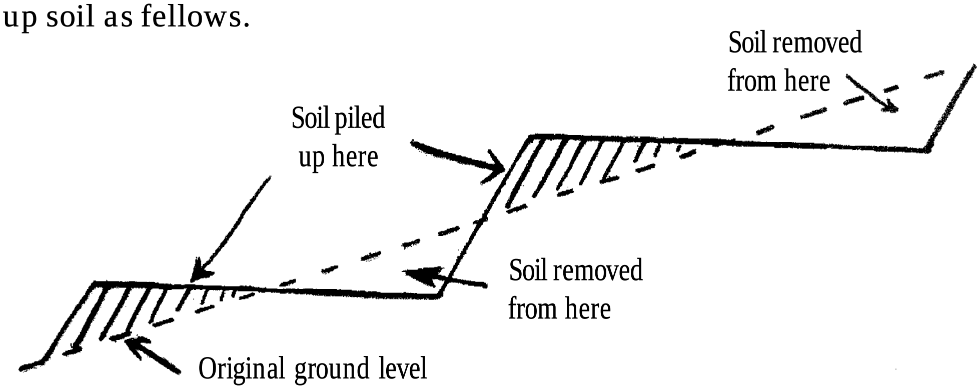
Some of the soil carried down from the mountains even reaches the ocean. There it settles to the bottom and after millions of years forms a very thick layer.

Box 18-4

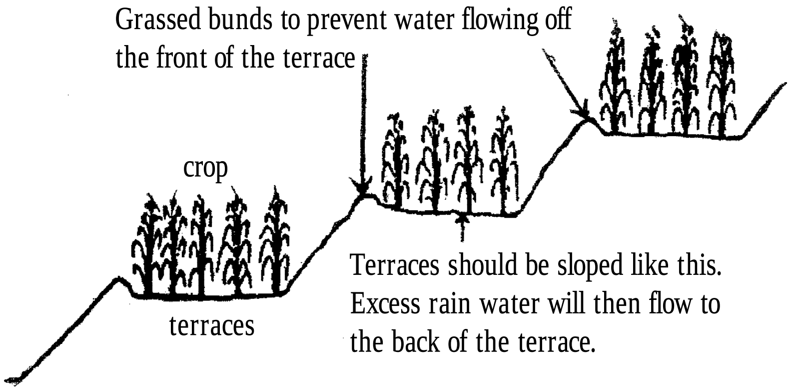
PROPER TERRACE DESIGN

To grow crops we remove all the trees and other vegetations from a part of the support area. Then we plough the soil in order to plant seeds. In doing this we bare the soil to falling rain and also make it loose. It thus becomes very succeptible to erosion. On sloping land all the soil can be washed away in a few years. If this happens, no further crops can be grown.

Most of the land in Uttarakhand is sloping. To prevent soil erosion terraces are made. These are big steps made by digging and piling up soil as fellows.



Properly-made terraces should slope slightly from front to back, and there should also be shoulder bunds as shown here.

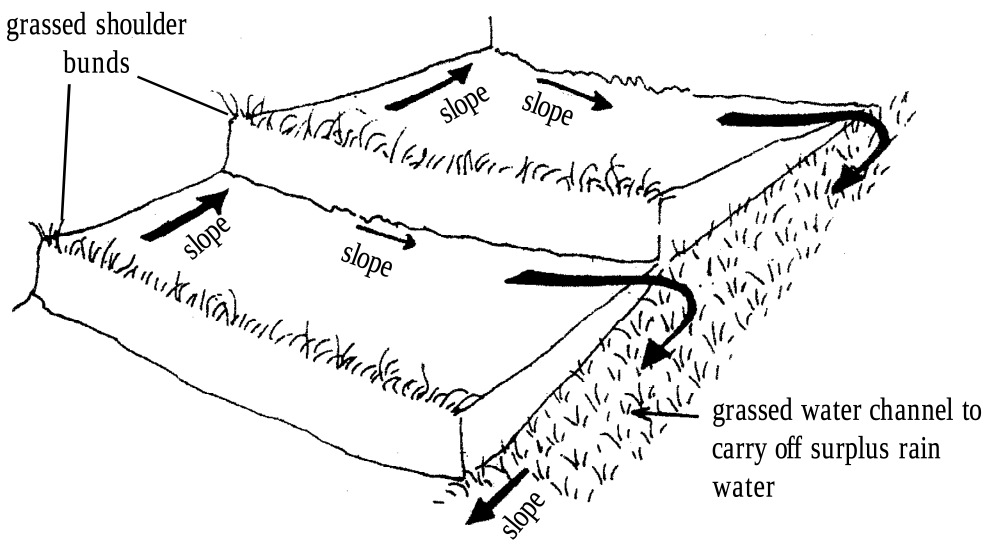


Rain water will not flow down the slope, but collect on the terraces and soak into the soil.

The Importance of properly-made terraces for reducing soil erosion is revealed by the measurements made in a village in Nepal

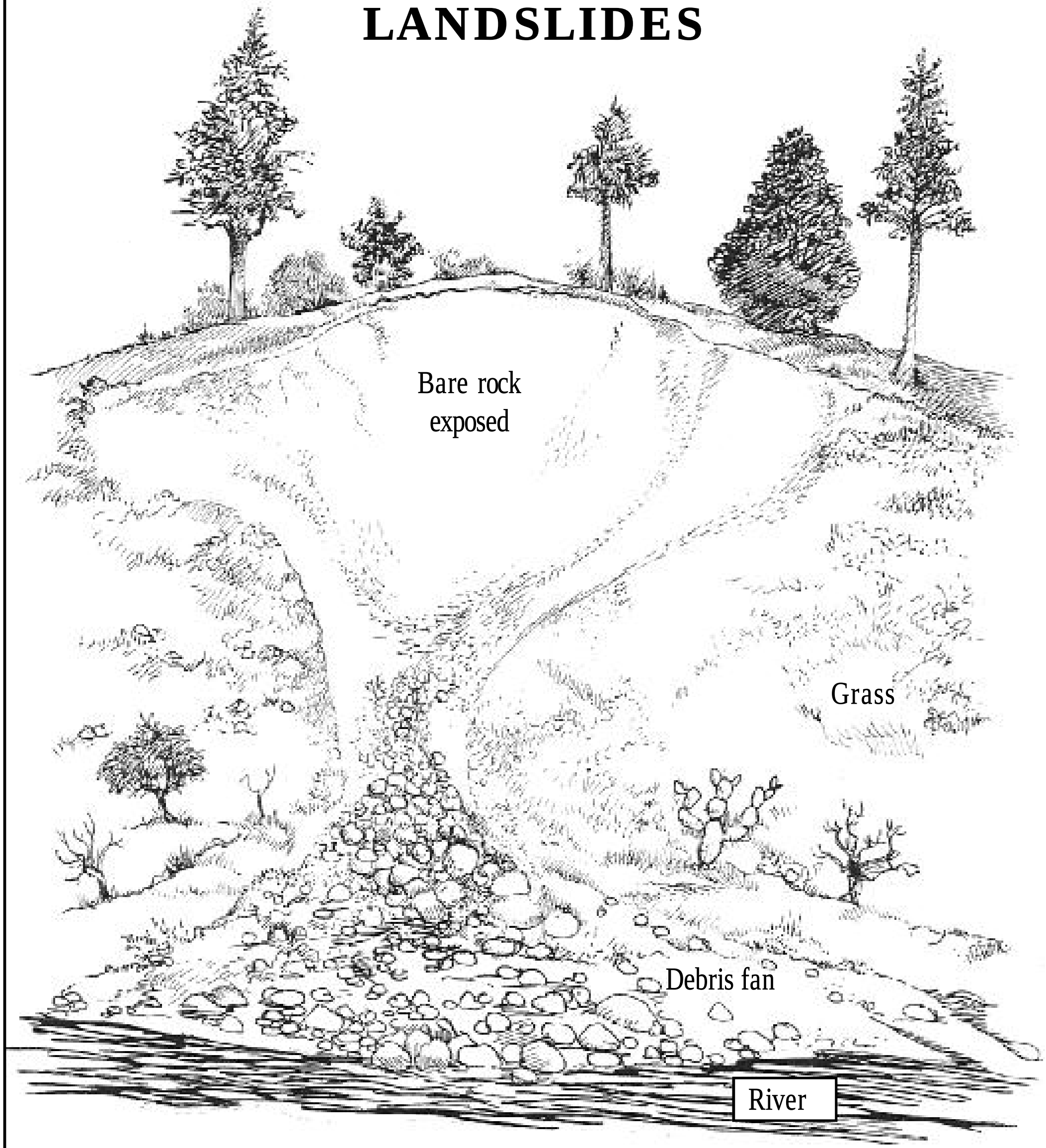
Type of terraces	**Soil lost by erosion kg/nali/year**
Inward-sloping with shoulder bund (as in diagram above)	40
Outward-sloping with no shoulder bund (as in common in Uttarakhand, Nepal and other hill area)	140

In making terraces for cultivation, we have said that they should slope from front to back to prevent erosion. At the same time, it is wise to slope the terraces slightly from one end to the other (see diagram below). In this way excess water during heavy rains can drain off. If too much rain water collects on the terraces, it may cause a landslide destroying the terrace. Animals must not be allowed to graze on these terraces as they will destroy the bunds at the fronts of the terraces. They will also overgraze the grassed channels at the ends of the terraces, turning them into eroding gullies.



Box 18-5

LANDSLIDES



Occasionally the entire soil layer on a slope will detach itself from the underlying rock and slide down. This phenomena is called a landslide. In the drawing above, the soil on a wide stretch of the mountain side has slid down the slope. At the top of the slope bare rock is exposed, while the gentler slope at bottom is buried by soil and rock debris.

Such landslides occur naturally on many slopes. Usually they are caused by heavy rains. The soil layer becomes saturated on many slopes. The water also encourages the soil layer to slip over the underlying rock. This is why landslides mostly occur during or just after the monsoon season.

After a few years, new vegetation begins to grow on the exposed rock face, and slowly a new layer of soil is formed. The debris fan at the bottom is quickly vegetated. In many villages such debris fans from old landslides have been turned into good fields.

While most landslides occur naturally, some are man made. Trees help hold the soil layer against sliding because their roots go deep into the rock layer. If the support area is mismanaged, so that trees disappear, the chances of landslides are increased.

If inward-sloping terraces are not also sloped from one end to the other, excess water may collect during heavy rain storms and cause a landslide (Box 18-4).

Landslides cause much damage to our land, and some times even to our houses. Some landslides cannot be prevented as they occur due to natural causes. Some can be prevented by careful management of our land. We can:

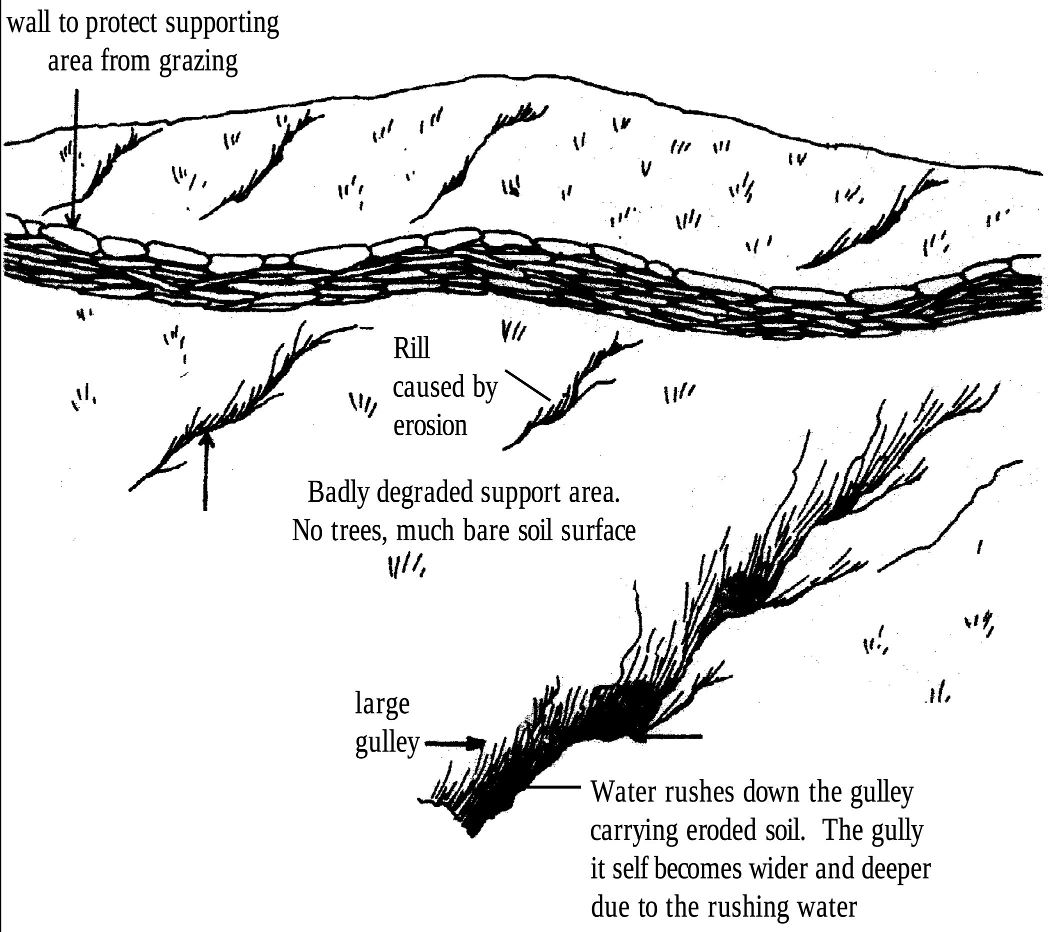
1. Be certain that our support area remains covered with healthy trees. We need to do this anyway to obtain the maximum production of fodder ad wood, and to minimise soil erosion. At the same time, the danger of landslides is reduced.

2. Construct our terraces with an inward slope, and a slight slope to one end to drain off excess rain water. Such terraces not only help prevent landslides of cultivated land, but reduce erosion (Box 18-2). We also get hand-cut fodder grass from the bunds and grassed channels.

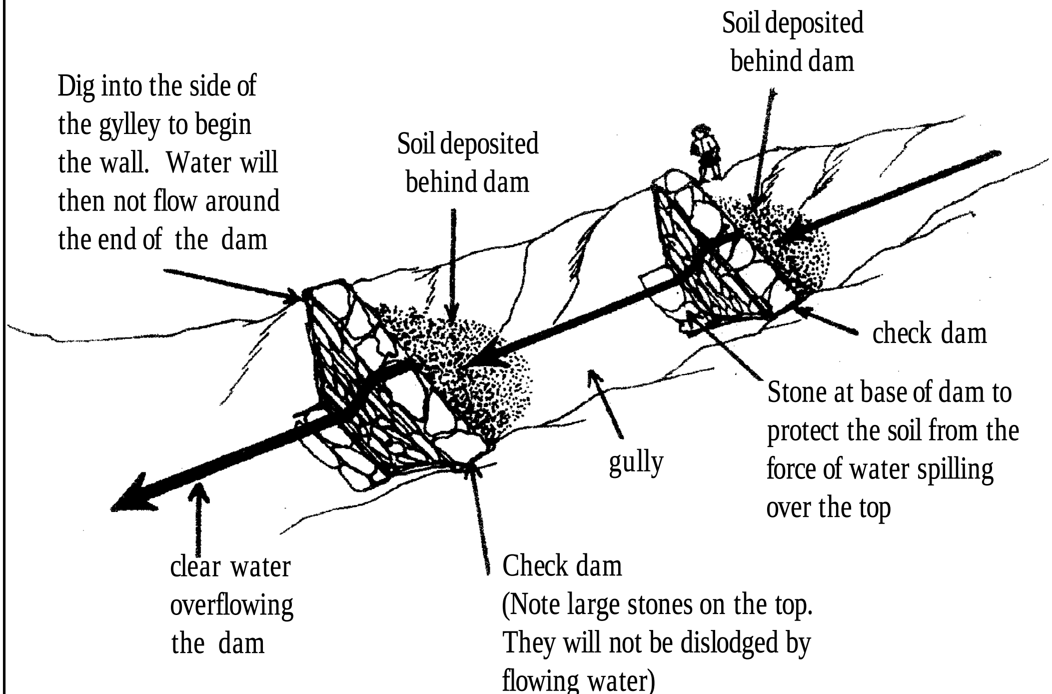
Box 18-6

CHECK DAMS

In many villages gullies have formed due to soil erosion. Many of these are very big, and with every hard rain they become deeper and wider. If such degraded support area is protected from grazing and fire, the soil surface will rapidly become covered with grass. This will reduce the rate of erosion very much. But even such protection may not stop the growth of gullies. We can visualise a gulley as wound in the land which must be healed. To heal it we must take additional measures.



Chek dams (also called 'gully plugs') are stone walls built across a gully at intervals. They check the speed of flowing water so that it cannot make the gully wider or deeper. The eroded soil carried by the water then settles on the upper sides of these plugs.



After 1-2 year when soil accumulates to the top of the dams, grass and trees are planted on the accumulated soil.

Date ....

Code : Crops 5
Month : September

Exercise 19

MY MEDICINAL HERB GARDEN

INTRODUCTION

In class 6, you have observed the medicinal plants of your study village in Exercise 3. In this exercise we will learn how to grow medicinal herbs in our garden.

PROCEDURE

1. You can do this exercise in the garden you prepared in exercise 11 'My Vegetable Garden' of class 6.
2. Read the Reference Box 19-1 for information on how to grow the medicinal herbs.
3. Record your observations in Table 19-1.
4. Preparation of the garden and compost application method will be the same as described in Exercise 11 "My Vegetable Garden" of class 6.
5. After sowing the seed, water your garden at regular intervals.
6. Ask your teacher whether there can be a "*Medicinal herb exhibition day*" for the class, for which you can bring medicinal herbs from your garden for exhibition.

FOR THE TEACHER

The information regarding growing of some important medicinal herbs of Uttarakhand is being presented in Reference Box 19-1. Ask students to use the information given in the Box for growing medicinal herbs in their garden.

If medicinal herbs are being grown in the school premises, allot space for each team.

Table 19-1

Name of medicinal herb	....
Date of seed sowing	....
Which part of the plant has medicinal use	....
Month of collection of the useful part of the plant	....

QUESTIONS

1. Write about your experiences of growing medicinal herbs.

2. What suggestions did you get from your parents and neighbours for growing medicinal herbs?

Teacher's signature:....................

Date:....................

Reference Box

Box 19-1

METHODS OF CULTIVATING SOME IMPORTANT MEDICINAL PLANTS OF UTTARAKHAND

In this Box, methods to grow some important medicinal plants of Uttarakhand are described. All these medicinal plants can be grown in areas up to 1500 m altitude. Some of them grow naturally, whereas some medicinal plants are under cultivation, for example *Haldi, Adrak, Ajwain, Saunf* etc. The bulbs or seeds of the naturally growing herbs can be obtained from the District Medicinal Plant Organisation (*Bheshaj Sangh*).

Adrak (*Zingibar officinale*)

Adrak is a annual herb plant. A temperate and humid climate is suitable for its commercial cultivation. In North India *adrak* is sown before the onset of monsoon. *Adrak* is cultivated from its bulbs (rhizomes). Bulbs should be 3.5 cm long and 15-20 g in weight. Bulbs are sown in fields in long rows. *Adrak* grows well in shade. If it is being cultivated in an open field then a row of maize should be sown along with it. For a better crop, mulching is essential, and weeding is necessary before second mulching. Its bulbs are used for medicinal purposes.

Crop matures 5-7 months after sowing when its leaves start yellowing. Its bulbs are dried in shade after washing.

Ajwain (*Trachyspermum copticum*)

Ajwain is an annual herb plant. Its plants attain a height of about 1.5 m. It is sown directly in fields or transplanted after being grown in a nursery. Seeds are sown in the month of October-November. Its seeds are used for medicinal purposes.

Arandi or Arand (*Ricinus communis*)

These trees grow naturally up to 1500 m altitude. It can be propagated from seeds or by grafting. Seedlings are transplanted in rainy season at a distance of 2 x 2 m after preparing them in a nursery. Pits of 60 x 60 x 60 cm dimensions are prepared in the fields before transplantation. Trees start flowering two years after transplantation. Fruits turn black on ripening, and are then plucked. Seeds from this fruit are used for medicine. A plant can give fruits for five years.

Arusa (*Adhatoda vasica*)

It is an evergreen shrub plant. It grows naturally throughout in India. It is propagated by seed or grafting. Sowing in the nursery is done in the month of May - June and after one and a half month, the seedlings are ready for transplantation. After one year the whole plant is dug up and all plant parts, flower, root and leaves are cleaned, dried and collected. Its root, flower and leaves are used in medicine.

Ashwgandha (*Withania somnifera*)

It is a shrub plant and grows up to 1500 m altitude. It is grown from seeds. Seeds are sown directly or transplanted after raising them in a nursery. Seeds are sown in the month of July in a nursery. Seedlings are ready for transplanting in the month of August-September. In fields, seedlings should be transplanted at a distance of 45 x 30 cm.

Direct showing in fields should be done in rows prepared at a distance of 40-60 cm. Its root is used for medicine.

Crop is ready after 5-6 months. Mature crop's root is harvested with 2 cm stem portion. Roots are cut in pieces 10 cm long after washing.

Awla (*Emblica officinalis*)

Awla is a medium height deciduous tree. It grows in dry and warm places. In Uttarakhand *awla* grows in valleys up to 1500 m altitude. It can be transplanted in any kind of land. It is grown from its seed. Its seedlings are ready for transplantation after 1.5 to 2 years. Generally transplantation is done during rainy season. But in irrigated land it is possible to transplant in summer and winters. Fruit collection time is varied from November to February according to altitude. Fruits are used for medicinal purpose.

Ghritkumari (*Aloe barbadensis)*

It is a stemless herb plant. Its leaves are fleshy. It is grown from its rhizomes. New rhizomes are separated from the old plant and transplanted in beds or seedling bags, so that a new plant is raised. Plants can be transplanted at any time in the rainy season. The most suitable time is in August - September after rainy season.

Distance between plant to plant is kept at 40 cm. It grows slowly. Therefore, it is likely to have more weeds in the first year of transplantation. Its leaves are used in medicine. At every three months keeping 3-4 leaves on the plant, rest of the leaves are plucked.

Haldi (*Curcuma domestica*)

Haldi is an annual herb plant. It prefers a climate similar to *adrak*. *Haldi* is grown with crops like sugarcane, chilli, onion, garlic, maize etc in crop cycle. *Haldi* is also grown in between the trees of mango, jackfruit and litchi. It is grown by its bulbs. It is sown between 15 May to 30 June. Bulbs are shown at a distance of 20 cm in rows at a distance of 30 cm. To maintain moisture in the field, bulbs are covered with leaves (mulching). Its bulbs are used in medicine.

Kala jeera (*Vicotica stiwartii*)

It is an annual herb plant. It is propagated by seed or root. Seeds are sown direct in field or transplanted after raising seedlings in nursery. Seeds are sown in the month of March-April in nursery. Seedlings are ready for transplantation in the month of July. For transplantation, the distance between rows should be 45 cm and plant to plant 45 cm.

Crop is harvested, dried and thrashed to collect seeds. Seeds are used in medicine.

Mandukparni

It is a herb plant. It is grown by grafting. It is grown in damp land after rainy season. Its leaves are used in medicine.

Pipali (*Piper longum*)

It is a ground spreading creeper. It is planted in the ground using pieces of vine having 3-4 nodes. These pieces are planted before the onset of rainy season. Pieces of vine are planted at 40 x 50 cm distance. It starts fruiting after 6-7 months of planting. A mature plant yields fruit for 15 years. Fully matured pods are harvested 3-4 times in a year. Crop is dried in shade after drying in the sun. Its pods are used for medicine.

Pudina (*Mentha sp*)

It is a herb plant. It's plants are grown by suckers. Suckers are directly planted at a distance of 60-70 cm. 15 January to 15 February is suitable time for planting. Crop is ready for harvesting after 120 days of planting. Second yield is harvested after 70-80 days of first harvesting. Its leaves are used in medicine.

Sarpgandha (*Rauvolfia serpentina*)

Sarpgandha is a perennial plant. It's height is about 80 cm. It's seedlings are raised from seeds in a nursery. Seeds are soaked in water for 24 hours; thereafter air dried for one hour before sowing. Sowing is done in the first week of May. Seeds are sown in nursery 1-2 cm deep at 8-10 cm distance in rows. Seedlings are ready for transplantation in fields in the month of July. In field, seedlings are planted in rows at a distance of 45 cm. Seeds are ready in the month of December. Roots are plucked in the month of January. It's roots are used for medicinal purpose.

Satwar (*Asparagus racemosus*)

It is a perennial vine occuring up to 1500 m altitude. It's vine is 1.5-2 m long. It is sown in a nursery in the month of May. When seedlings in nursery attain a height of 8-10 cm, these are transplanted in fields. Seedlings are planted in fields at a distance of 60 x 60 cm. After 12-18 months when transplanted plant starts yellowing, its fleshy roots are dug out. Dugout fleshy roots are dried in light sun, which are used in medicine.

Saunf (*Foeniculum vulgare*)

It is an annual herb plant. It's seedlings are raised from seeds in a nursery. Seed sowing time in nursery is around 15 June. Seedlings are transplanted in fields around 15 August. The distance between plants is kept 40 cm in a row, while rows are kept at a distance of 60 cm. Seeds are used in medicine.

Tulsi (*Ocimum basilicum*)

It is an annual herb plant. Tulsi is grown from seeds. Seedlings are raised in a nursery from seeds. Seeds are sown in April-May. After 30 days of sowing when plants attain a height of 12-20 cm it is transplanted in fields at a distance of 60 x 40 cm. It is harvested when leaves turn golden in colour. Its leaves and seeds are used in medicine.

Box 19-2

MEDICINAL PLANTS AND THEIR USES

You have probably been growing garlic, ginger, turmeric, coriander, caraway (*jeera*), mint, licorice (*saunf*), basil (*tulsi*), fenugreek, bishop's weed (*ajwain*) and mustard in your garden along with vegetables. These plants keep all our vegetables healthy and are also valuable for us directly because all of them have definite medicinal properties. They are our friends. We use them daily in our food. As spices they make our food tasty and at the same time they keep us healthy. This box describes the medicinal properties of these plants.

Added to our food, some of these plants make the food easier to digest. For example cauliflower tends to produce gas. To counteract this a small amount of ginger is cooked with the cauliflower. Other plants act like tonics. For example a small amount of turmeric added to our food when it is being cooked, tones up the functioning of the liver and eyes and improves complexion. Still others are used to cure specific ailments. An example here is basil leaves to treat fever.

If we know the medicinal properties of plants we can use them to treat common ailments and we do not have to go to the doctor.

Our ancestors identified the properties of these medicinal plants after long experimentation. You may have noticed that your grand-parents know many home remedies which they learned from their parents. The ingredients in home remedies are the medicinal plants which are available in our kitchens and our gardens. Home remedies for the most common ailments are described below.

Cough and cold

- One teaspoonful of the fresh juice of ginger with one or two teaspoons of honey should be taken three or four time in a day. It is especially effective if taken at night before going to bed. Ginger tea is another effective remedy for coughs and colds.

- Bishop's weed has a remarkable power to open up clogged and congested nasal passages. The fumes from a tablespoon of crushed seeds can be tied up in a cloth bundle and the fumes inhaled.
- Caraway water is an antiseptic beverage and very useful in treating common colds and fevers. To prepare caraway water, a teaspoon of caraway seeds is added to boiling water, which is allowed to simmer for a few second and set aside to cool. If the cold is associated with sore throat, a few small pieces of dry ginger should be added to the boiling water. It soothes throat irritation.
- Turmeric, with its antiseptic properties, is an effective remedy for chronic cough and throat irritations. Half a teaspoon of fresh turmeric powder is mixed in one cup of warm milk and boiled over a slow fire for about two minutes. Sugar can be added according to taste.

Common fever

- Lightly crush ten leaves of basil, four seeds of black pepper and a small piece of fresh ginger, boil all these in two glasses of water, and simmer until it becomes one glass of medicinal water. This should be taken, with sugar added, in three doses in a day.
- Tea made from fenugreek seeds is also very useful in reducing fever. It helps the body to perspire and it dissolves mucous. Take this tea three or four times daily.

Stomach ache

Indigestion and colic (gas in the stomach) are the main causes of stomach ache. There are many home remedies.

- A teaspoon of bishop's weed seeds with a little salt can be swallowed with luke-warm water. This remedy is very effective.
- Boil a teaspoon of licorice in a cup of water for about 20 minutes, cool and drink. This water relieves gas.
- A slice of ginger chewed with salt, can relieve stomach ache with nausea.

- Grind a mixture consisting of bishop's weed, dry ginger and black pepper in a ratio of 1:½:¼. A dose of about three grams can be swallowed with water. This remedy relieves in stomach ache.
- Crushed cloves of garlic may be infused in hot water or milk, cooled and taken for all digestive disorders.

Toothache

- Powdered asafoetida (*hing*) warmed on a *tawa* (an iron pan used for making *chapattis*) and put in the aching tooth reduces pain.
- A pinch of salt mixed with a teaspoon of mustard oil can be rubbed with a finger over the affected part. This is useful for many problems of aching teeth. It also makes the gums stronger.
- Chewing raw onion for three minutes is sufficient to kill all germs in the mouth.
- Basil is useful in tooth disorders. Its leaves, dried in the sun and powdered, can be used for brushing the teeth. It can also be mixed with mustard oil and the mixture used as a tooth paste. It can also be used for massaging the gums to treat pyorrhoea. It counteracts bad breath.

Conjunctivitis (infection of the eyes)

- A decoction prepared from freshly-dried coriander leaves is an excellent eye-wash in conjunctivitis. It relieves burning and reduces pain and swelling.

Cuts and wounds

- Good quality turmeric powder, dry or made into paste with a little water, applied on a wound, and covered with a clean cloth if necessary, stops bleeding quickly. It is also a powerful antiseptic, and helps the wound to heal quickly. A paste made from Bermuda grass *(Cynodon dactylon*) can also be applied with good effect.

Skin disorders

- Fresh garlic juice has been used successfully for a variety of skin disorders. Its juice is very strong and therefore it is best to dilute it before use.

To learn more about home remedies ask your parents, grandparents and neighbours.

Date: ....

Code : Crop 6
Month: September

EXERCISE 20

MAKING VEGETABLE SEEDS

INTRODUCTION

In this course the subject of organic farming is taken up in a series of three exercises, one each year (Exercises 11, 20 and 31). This exercise is the second in the series. In Exercise 11 you will have taken seeds from your parents or neighbour. Now it is time to make seeds of the vegetables that are growing in your plot for future use.

To grow vegetables in a natural way it is necessary to produce our own seeds. When we buy seeds from the market, we cannot be certain they will give healthy plants in our particular garden. Also, seeds purchased in the market are obtained from plants sprayed with chemicals, or chemicals are added to the seeds when they are packed. Of course, we can get seeds from our neighbours (if they do not use chemicals) and our class-mates. But if we get seeds from others, we need also sometimes give them seeds.

Begin from this year to produce your own seeds in your vegetable garden – if you are not already doing so. The techniques for growing the seeds of different vegetables are given in Boxes 20-1 and 20-2. Your parents and neighbours will also be able to guide you.

To keep a record of the seeds you produce, make a chart (see Table 20-1) in your vegetable garden diary and write in it the types of seeds produced and the dates when they are harvested.

Table 20-1. Information on seeds produced

FOR THE TEACHER

This exercise should be done in the same way as of Exercise 11 'My vegetable garden'. Take up Boxes 20-1 and 20-2 before begining this exercise.

Year…………..

Name of vegetable (1)	Original source of seed (2)	Date when seed made (3)	Comment (4)
Instructions			

Column 2: Write the original source of the seeds grown. If this variety has been grown in the village for many years, then write the name of your village.

Column 4: Note whether or not you think this variety is good for your village (e.g. health of plants, quality of vegetable produced)

Teacher's signature:....................

Date:....................

BOX 20-1

VEGETABLE SEED HARVESTING AND STORAGE

Last year you must have planted seeds you took from the house, or from your neighbours. This year you will have to produce seeds yourself for sowing next year. Or, you may have bought seeds or seedlings from the market. These may contain chemicals, and may not be well adapted to your village. So you cannot rely on the market for your seeds.

There is another reason also why you should produce your own seeds. In your vegetable show at school (Exercise 11), you may have seen vegetables which are better than yours. In that case you would naturally ask for a few seeds of that type to try in your garden next year. When someone asks for seeds, one cannot refuse. So, if you expect your class-mates to give you seeds sometimes, you must be prepared to give them some of your seeds if they ask. (For this reason always produces more seed than you will need for your own garden next year.)

To produce seeds from any vegetable, you should select one or a few plants in your plot. They should be those plants which are most healthy, and which have the best fruits or flowers. (With some vegetables, like beans and tomatoes, we eat the fruits, while we eat the flowers of cauliflower, and the leaves of fenugreek and cabbage.) Not all plants of one type of vegetable will be the same. By selecting the best plants for making seeds, many of those seeds will next year give plants like their parent. If you repeat this process every year, you will produce your own special variety of that vegetable. It will suit the climate and soil of your garden and your personal tastes. In this way the people of every village have produced varieties of vegetables, and crops too, which are distinctive. That is why in Exercise 11 last year you were advised to take seeds from your parents or neighbours. If you buy seeds or seedlings from the market, you may find that they do not thrive in your garden. Or you may not like the fruit.

There are two types of vegetables: self-pollinated and cross-pollinated. Pollination is the transfer of pollen, or male sex cells, from the male part of the flower to the female part. When this occurs the female part develops into a fruit. In self-pollinated vegetables, this happens automatically. In cross-pollinated vegetables this transfer of pollen does not occur by itself. However bees, when they visit the flowers to drink nectar, disturb the flowers and due to this disturbance pollen gets transferred. Some vegetables like pumpkin, cucumber, bottle gourd, and snake gourd even have separate male and female flowers, and bees must carry pollen from one to the other. Bees are therefore essential to vegetable production. We should not spray poisons on our vegetables because they will kill bees as well as other insects. (Spiders are another type of insect that are very necessary to vegetable production because they eat insects that eat plant leaves or suck their juice.)

Here are the main vegetables in these two groups.

Self-pollinated	**Cross-pollinated**
tomatoes (*tamatar*)	carrots (*gajar*)
brinjal (*bangan*)	radishes (*muli*)
chillis (*mirchi*)	turnips (shalgum)
peas (*muttar*)	onions (*pyaj*)
beans (*sem*)	cauliflower (*phool gobi*)
	cabbage (*band gobi*)
	kohlrabi (*ganth gobi*)
	muskmelon (*kharbooza*)
	watermelon (*tarbuza*)
	pumpkin (*kaddu*)
	bottle gourd (*lauki*)
	snake gourd (*ghia torai*)

When producing seed of cross-pollinated crops, remember that different varieties of the same crop grown near to each other will interbreed if they flower at the same time. This is because bees will carry the pollen from one variety to another. Also, cauliflower, cabbage, kohlrabi, radishes, turnips and mustard interbreed.

Therefore do not attempt to produce seeds of two different varieties of a cross- pollinated crop, or of two members of the group mentioned above next to each other at the same time. If you do, next year's plants will be of a mixed type. For example, do not try to produce both cauliflower and cabbage seed at the same time, unless you can manage for them to flower at different times. Another example: suppose you bring seeds of a new variety of radishes from outside the village. To produce pure seed of this variety, you should try to arrange that it flowers at a different time from the radishes in your neighbour's gardens as well as other radishes in your own garden.

Plants of different varieties of self-pollinated crop can interbreed if pollen from one is blown by the wind to the other. To guard against this, do not grow seed plants of different varieties near each other. The distance needed between plants to prevent crop pollination, called the 'isolation distance', varies from 50 to 250 m.

In Box 20-2 instructions are given for producing seeds of the most common vegetables.

Dry seeds in the shade in sunny weather. Put them in plastic bags labelled with the name of the vegetable, name of your village, your name, and the date of packing. Tie the top of the bag to make it air-tight. (Remember, the seeds of most vegetables do not remain alive for more than about two years.) If seeds are not kept absolutely dry, they will die much sooner.

Reference Box

BOX 20-2

INFORMATION ON MAKING SEEDS OF SOME COMMON VEGETABLES

Brinjal (*bangan*)

Pick selected fruits when they are fully ripe. Peel off the outer covering and cut the inner part into thin slices. Soak these slices in water overnight until the seeds get separated from the pulp. After separation put the seeds in clean water. Skim off the seeds that float and discard them. Dry the rest in the shade. The isolation distance is 50 m.

Cabbage (*band gobi*)

Seed production in cabbage is similar to that in cauliflower. When the head is mature, make a cut on the surface in the centre. This will allow the flower stalk to come out more quickly and easily. Check daily for cabbage worms.

Cauliflower (*phool gobi*)

Select one or more plants and leave them for seed. When their flowers are fully mature, remove the central portion. This will hasten the emergence of seed stalks from the remaining portions. Inspect the flower stalks carefully every morning and remove any worms you find. Harvest the seed pods when fully ripe. Dry the pods in the sun and thresh.

Carrots (*gajar*)

Leave selected plants to flower. Harvest the flowering heads when fully ripe and dry in the shade. Remove seeds by hand rubbing.

Fenugreek (*methi*)

After harvesting fenugreek twice for vegetable, leave the plants to flower and seed. When the pods are ripe (brown) cut the plants, sun dry and thresh.

Knolkhol or Kohlrabi (*ganth gobi*)

The method of seed production is similar to that in *cabbage*.

Ladies' fingers (*bhindi*)

Allow selected pods to ripen fully on the plants. Pick and sun dry. Remove seeds from the pods when dry.

Melons (*kharbuza, tarbuza*), Pumkin (*kaddu*), Bottle gourd (*lauki*), Sponge gourd (*torai*), Snake gourd (*ghia torai*)

Leave selected fruits on the vine until completely ripe. Cut open remove seeds and pulp. Crush by hand and soak in water for one to two days. Wash away the pulp. Dry the seeds in the shade.

Mustard (*sarson*)

Mustard is related to cauliflower, cabbage, raddish and turnip and can cross with them. Some leaves can be picked for vegetable when the plants are young, but be sure to leave enough leaves to feed the seed stalks which develop later. Seed production is as described for cauliflower.

Onion (*pyaj*)

Selected bulbs are left for seed production. The seed heads are picked when fully ripe dried in the sun and gently threshed.

Peas (*muttar*) and Beans (*sem*)

Allow healthy pods on selected plants to mature. Pick, sun dry and thresh.

Radish (*muli*)

Pull out the root of a healthy and mature plant. Cut off the leaves 4 cm above the root and cut off about half the root. Then plant the upper half of the root. After some time new leaves will come out followed by seed stalks. Harvest ripe pods, sun dry and thresh.

Red pepper (*mirchi*)

Pick selected fruits when fully ripe. Dry in the sun and store. The dry fruits are broken to get the seed for planting. The isolation distance for pepper is 250 m.

Tomato

Select one or more fruits from the healthiest plants in your garden and pick them when completely ripe. Cut them open and take out the seeds and pulp. Place these in a stainless steel or plastic sieve and wash them under running water whilst rubbing them gently with your fingers. Most of the pulp will be washed away. Spread the seeds and remaining pulp on a piece of paper. Dry in the shade. The seeds will stick to the paper. Remove them gently and store. The isolation distance for tomato is 50 m.

Turnip (*Shalgum*)

Seed production in turnip is the same as for raddish.

Weeds

Amaranth (*chaulai*) purslane (*kulfa*) and pigweed (*bathua*) are some of the 'weeds' that grow on their own in our gardens and fields which are very tasty and nutritious vegetables. They seed themselves, so be sure not to harvest all the plants for vegetable.

A general note on potatoes

Potatoes are grown from tubers and not seeds. However, the tuber used to grow a new crop are called 'seed potatoes'. At high altitudes it is possible to store seed potatoes until the next sowing season, but not in the plains. In the plains seed potatoes must be purchased from the market when needed.

Select healthy plants for seed and from these select only healthy, undamaged tubers. Store in a dark cool place and if they sprout before sowing time remove the sprouts.

Box 20-3

IMPORTANT VEGETABLE CROPS OF UTTARAKHAND

Vegetables are an important part of our diet. They make our diet tasty and nutritious, and at the same time bring variety to it. In Uttarakhand there is a great variety of vegetables owing to the varied climatic zones. Vegetables are a rich source of essential nutrients carbohydrates, fats, protein, edible fibre and large amounts of minerals and vitamins. In addition they contain substances which help our bodies resist many diseases.

In general vegetable crops are annuals. In some cases we harvest the fruits to eat, for example, tomato, brinjal, peas, ladies'fingers, french beans, tinda, bitter gourd, *lauki*, *kaddu*, *torai*, red peppers and green peppers. From others we harvest the stems and leaves as vegetable, for example, cabbage, *methi*, mustard, spinach, *chaulai*, and pigweed. From still others we harvest tubers, root or bulbs, such as potatoes, radishes, carrots, turnips, *gadheri/arbi*, onion and garlic. In the case of cauliflower it is the flower that is harvested.

Vegetables can be grown in small areas. They mature more quickly than grain crops, and for this reason, several crops can be taken in one year. These yield more than that of grain crops.

In the following table the sowing and harvesting times of vegetables are given according to altitude.

1500 m and above altitude

Name of Vegetable crop	Sowing time	Crop maturation period
1. Potato	February-March August	150 days 180 days
2. Onion	October	160-180 days
3. Tomato	January-February July	60-70 days

Name of Vegetable crop	Sowing time	Crop maturation period
4. Peas	August, November March	120-130 days
5. French bean (bush)	February-March	45-55 days
French bean (climbing)	February-March	65-75 days
6. Capsicum	January-February	80-110 days
7. Ladies' fingers	May-June	75-80 days
8. Garlic	February-March	90-110 days
9. Cabbage	April-May	75-80 days
10. *Lauki, karela kaddu, torai*	May-June	60-75 days
11. Radishes, carrot *methi, palak, lahi*	August-September	60-70 days

Up to 1500 m altitude

Name of Vegetable crop	Sowing time	Crop maturation period
1. Potato		
Early	20 September-10 October	80-90 days
Middle	15 October-25 October	95-115 days
Late	25 October-10 November	110-115 days
2. Cauliflower		
Early	15 May-30 June	60-75 days
Middle	July-August	65-80 days
Late	15 September-30 October	80-90 days
3. Lauki	February-March June-July	60-75 days
4. Ladies' fingers	February-March June-July	40-50 days 60-75 days
5. Onion	October-November	100 days

Date: ....

Code : Water 2
Month : October

EXERCISE 21

MEASURING DOMESTIC WATER CONSUMPTION - 1.

INTRODUCTION

How much water does a person use every day? How much water do animals drink? In every household some water is used for growing vegetables. How much? In this exercise we will try to estimate these quantities.

REQUIREMENTS

1. One litre measure - one for each team

PROCEDURE

1. Visit your assigned household and request the members to help you measure the amount of water they bring to their house every day.

2. Ask them to show you the container(s) they use to bring water. Measure with your litre measure the amount of water each contains. Write the amount here:

   Type of container .... Capacity .... litres

   Type of container .... Capacity .... litres

   Type of container .... Capacity .... litres

3. Next ask how many times during the day of your visit each type of container has been/will be used to bring water for household use, for animal watering and for watering vegetables. (Note that you should make those measurements even if the water source is a tap in the house.)

   Here is an example of how to record your information. Suppose you are told that 4 cannisters and 2 buckets have been /will be brought for household use (cooking, drinking, washing and bathing). You

---

FOR THE TEACHER

This exercise is to be taken up with the families assigned to the different teams in your class. Box 21-1 can be taken up after completing this exercise.

have already determined the capacities of the cannister and the bucket. They are 15 and 20 litres, respectively. Thus:

Type of Container	Capacity of container, l	Number of containers fetched	Amount of water fetched, l	Total water fatched, l
Cannister	15	4	60	100
Bucket	20	2	40	

Table 21-1 has been prepared to make recording of your data easy. Enter your data and complete your calculations.

6. Now transfer your results to table 21-2. Share your results with all other teams so as to complete the table. Total each column and calculate averages.

(6)

Table 21.1. Amounts of water fetched for different purposes in one day in one household in the month of October

Purpose	**Type of container**	**Capacity of container, l**	**Number of container fetched**	**Amount of water fetched (cols 3 x 4),**	**l Total water**
Vegetables	(1)	(2)	(3)	(4)	(5)
fetched, l					
Household					
use					
Animal					
watering					
Total	xxx	xxx			

Table 21.2. Average amount of water used for different purposes per household in one day in the month of October

Team number (1)	Name of head of assigned family (2)	Water fetched on day of visit, l			
		For household use (3)	For animal watering (4)	for vegitables (5)	Total (6)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total	x x x				
Average	x x x				

Table 21.3. Distance to water sources and time taken to fetch a container of water (see questions 2 and 3)

Team number (1)	Name of assigned household (2)	Distance to water source, m (3)	Time taken to fetch one container of water, min (4)	Number of containers of water fetched in one day (5)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total	x x x			

QUESTIONS

1. From where was the water used by this household fetched? Give the name of the water source.

2. How far is the water source from the house? (One kilometer equals about 2000 steps). How long does it take to fetch one container of water? (To answer these questions take one of the household containers and fetch water, noting the time and counting your steps.) Enter your results in Table 21-3 (columns 3 and 4).

3. How much time does it take a family every day, on an average, to fetch its requirement of water? To answer this transfer the total of column 4, Table 21-1 to the appropriate space in column 5 of Table 20-3. Total column 5, and calculate the average. Multiply the average value of column 4 by average value of column 5.

4. Where does the waste water from this house go? (Waste water means water after it is used for washing and bathing).

Teacher's signature:....................

Date:....................

Box 21-1

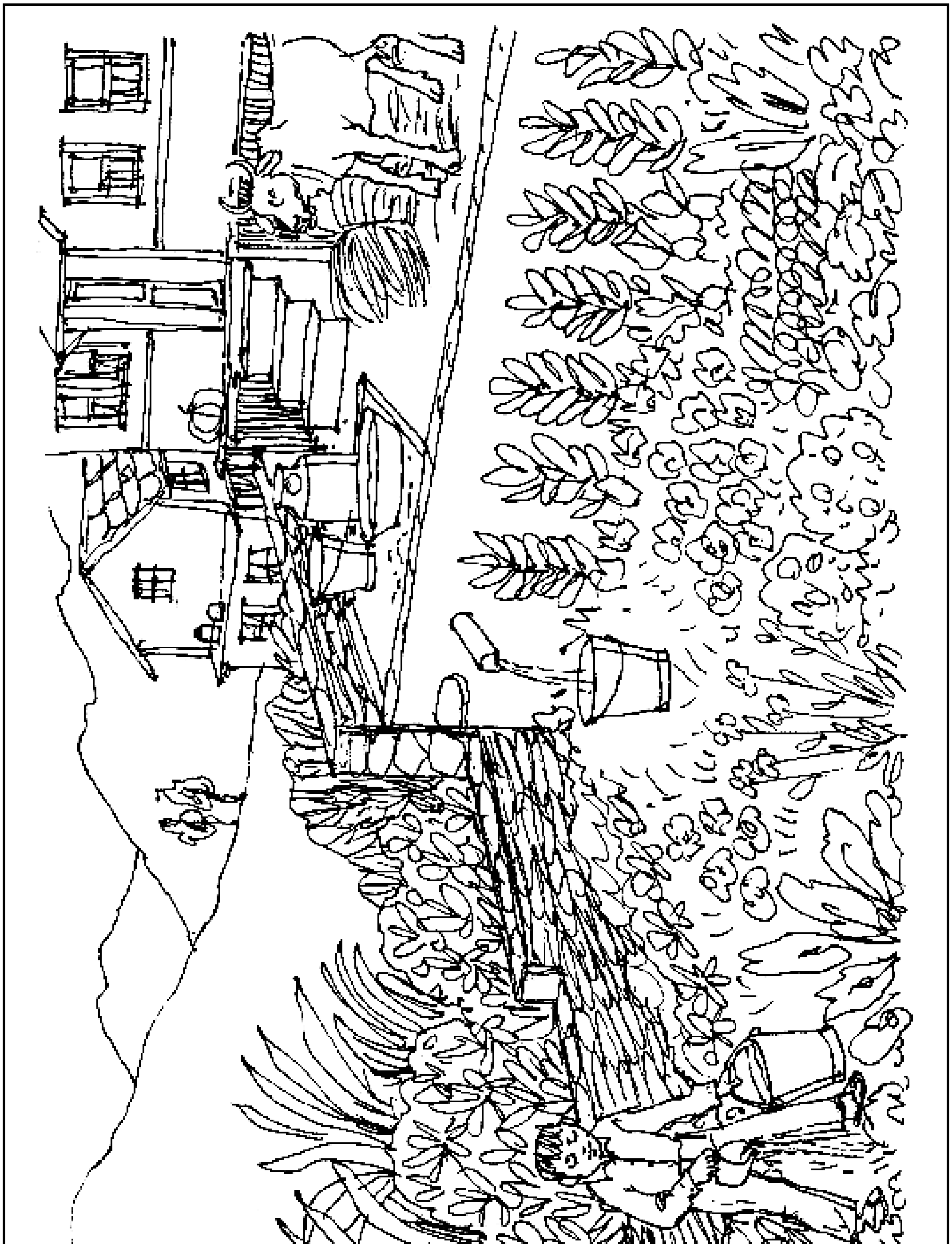
WASTE WATER FOR GROWING VEGETABLES

In most households in the hills of Uttarakhand water is scare. This may be because there is not enough water in village springs and seepages. This may be particularly true during the summer when spring flow is lowest. Water may also be scarce because springs and seepages are far from the house and carrying may take a lot of time.

Water used for washing and bathing can be collected afterwards in a cannister or bucket and used to water vegetables. One cannister of water is enough to water vegetables in about 10 square metres in the months of April and May or 20 square metres during the winter. From this much land we can produce about 20 kg of vegetables.

If we are carrying fresh water for vegetables at present, we can save time. Or we can grow more vegetables than at present with out carrying any more water.

To collect waste water effectively the washing/bathing place in the angan should be made *pucca*. Then the water will not soak into the earth through the cracks between *patals* (paving stones). It can be collected in a cannister or bucket as shown in the drawing on next page. The cannister/bucket used for collecting the water should be emptied and cleaned every 2-3 days otherwise it may give a bad smell and allow mosquitoes to breed.



Date: ....

Code : Water 3
Month : October

EXERCISE 22

STUDY OF VILLAGE WATER SOURCES

INTRODUCTION

The purpose of this exercise is to identify and describe all the water sources of our study village. We will also describe how the water from each source is used and what problems there may be in water utilisation.

PROCEDURE

Option - I (Where water sources are wells and canals)

1. Make a list of all the water sources in your study village. For this work your teacher will assign each team to a different part of the village. Each team will then go to its assigned area and note on the opposite page the names of all the water sources there. For wells, if they are privately owned, write the name of the owner. Be sure to include in your list wells of all types, canals, rivers and government water supply taps. Include any dry wells also. Make a copy of your study village map (from Exercise 1) on the opposite blank page before beginning this exercise and mark the position of each water source on it.
2. Assemble again with your teacher at a central place in the village. Make a single list for the whole village by combining the data of all teams. Make a final list in Table 22-1.

FOR THE TEACHER

Take up Boxes 22-1, 22-2 and 23-3 and review of Box 17-2 before beginning this exercise. Due to variation in the type of natural water sources in different places in Uttarakhand this Exercise has two options. Decide on the appropriate option according to the type of water sources in your study village.

Assign option I if the natural water sources in your study village are wells, artesian wells and canals (pages 97-106).

Assign option II if the natural water sources in your study village are springs (pages 107-111).

Table 22-1. List of all water sources of our study village

Serial No.	Type of the source	Name of the source

3. Your teacher will assign one or more water sources to each team. If there are less than ten water sources, then two or more teams will be assigned to one. Note your assignment in Table 21-2.

Table 22-2. List of water sources assigned to our team (No. ....)

Serial number	Type of the source	Name of the source

4. Go to the owner of your assigned well(s) and ask the following questions. Write these answers in the following blank page.
   a. When was the well first dug?
   b. How deep was it?
   c. What type of well is it?
   d. Was it subsequently made deeper? When?
   e. How deep it is now?
   f. How is the water lifted?
   g. Does the owner use all the water himself, or does he share it with, or sell it to, other families?
   h. What is the water used for?
   i. Has the water flow from the well remained constant in recent years? If not, why not?
   j. If the water is used for irrigation, indicate approximately on your map the area irrigated.
   k. Is there any difference in the crops grown on irrigated land and unirrigated?
   l. Are there any waterlogged areas in the village? Where? What is grown there, if anything?
5. Ask the same questions from an older person of the village in the case of government tube wells, artesian wells and canals. Also ask how their water is shared and distributed among families.

6. Make neat notes of all the information you have collected for each water source in Table 22-3.

Table 22-3

Name of the source:
Name of the source:
Name of the source:
Name of the source:
Name of the source:

7. The remaining work of this exercise may be done in the classroom. Make a large village map on a chart paper and show all the water sources in the village. Also, show the irrigated areas of the village. If irrigation is being done from both wells and canal, use different colours to demarcate the two.
8. Through classroom discussion complete Table 22-4 as best you can on the basis of Table 22-3.

QUESTIONS

1. Have any wells in the village been re-dug? What does this tell you about the water balance of the village?

____
____
____
____
____

2. At what depth do you think the water table is in your study village today (approximately). Give your reasons.

____
____
____
____
____
____

3. Can you explain why water comes out from an artesian well without a pump? (Answer this only after you have studied Box 23-1.)

____
____
____
____
____
____

Table 22-4. Information on total village wells

Type of well	Number of wells				Number of wells re-dug				Number of wells whose flow is decreasing
	30 years ago	20 years ago	10 years ago	Today	30 years ago	20 years ago	10 years ago	Today	
Dug well									
Tube well									
Artesian well									

4. Is all the cultivated land in your study village irrigated? If not, why not?

____

____

____

____

5. When crops are irrigated in your study village, where does the water go that is applied to the land?

____

____

____

____

6. Is the flow of artesian wells of your study village going down? If yes, what is the reason? (Answer this only after you have studied Box 23-1.)

____

____

____

____

7. Are there any water-logged areas in your study village? Where? What do you think is the cause of these? (Hint: Have these water-logged areas developed recently? Say in the past 50 years?)

____

____

____

____

8. Is there a pond in your study village? What are the benefits to the village of this pond?

____

____

____

____

9. Do you think that the mulching of crops has any effect on the water table? How?

10. Where has the ground water in your study village come from?

11. Is there a river or stream in or near your study village? Where does it begin? Where does it end?

12. What role do you think this river/stream plays in the village water balance?

13. Does your study village receive water by canal? If so, what is the source of that water?

Teacher's signature:....................

Date:....................

Option –II (High altitude villages – where water sources are springs, seepages or streams)

INTRODUCTION

Every village has a number of water sources. From these we obtain water for domestic use and for irrigating our crops. In this exercise we will estimate how much water these water sources produce.

REQUIREMENT

1. One litre measure – one for each team

PROCEDURE

1. Make a fresh copy of the map of your assigned village on opposite page. (You have already made a map of the village in Exercise 1)
2. In this map, mark the positions of all water sources in the village. Write in also the names of each source. Water sources may be of several types, springs, seepages, government water pipe, a stream whose source lies outside the village boundaries, a river. The flow rate of a river cannot be measured, except with complicated equipment.
3. Now measure the rate of flow of water from each source. Your teacher will divide this work among the teams in your class. Be sure that every source (except river) in the village is measured, whether anyone is using the water or not.

   Now measure the rate of flow of water from each source.

   Where the water is flowing from a spout, hold your litre measure under the spout and note the time taken to fill it. Say it gets filled in 15 seconds. The standard unit for measuring flow rate is 'litres per minute'. Hence we must convert your figure of 'one litre in 15 seconds' to litres/minute. This is done as follows

   $$\text{Water flow, litres/minute} = \frac{\text{60 seconds per minute}}{\text{measured flow rate, seconds to fill the one litre measure}}$$

   In the assumed case above the flow rate would be:

   $$\text{Water flow rate, litres/minute} = \frac{60}{15}$$

   $$\text{Water flow rate, litres/minute} = 4$$

If the water source does not have a spout, you may be able to make a small bund of soil, damming up the water and making it flow from a temporary spout. A temporary spout can readily be made from a tree leaf. If the outflow is large, it may be more convenient to fill a canister or bucket. A canister, we know, contains 20.7 litres when full (Box 17-2). If it takes say, 20 seconds to fill, the flow rate will be:

$$\text{Water flow rate, litres/minute} = \text{capacity of container, litres} \times \frac{\text{60 seconds/minute}}{\text{measured flow rate, seconds to fill container}}$$

$$,, = 20.7 \times \frac{60}{20}$$

$$,, = 62$$

If you use a bucket or container, first measure its capacity with your one-litre measure.

In the case of a government water pipe, only one measurement needs to be made — at the main distribution tank for the village. It is unnecessary, and also inaccurate, to measure the flow rate from individual stand-pipes. Be sure to measure the flow of water entering the main distribution tank. (You may have to open the lid and reach inside to do this.) *Naulas* (seepages) do not overflow. To measure water production from these make a mark on the side wall. Note the time. Remove several buckets of known capacity. Note the time when the water level returns to the mark. Say for example, you remove 4 buckets of water, each of 15 litres, or 60 l of water in all, and that the water level returned to the mark after 30 minutes. The flow rate is:

$$\text{Flow rate of naula litres/minute} = \frac{\text{60 l}}{\text{30 min}} = 2$$

4. Enquire how many families fetch their water from your source at present. In the case of a government distribution tank, count the total number of families that take water from all stand-pipes supplied by it. Be sure to count families that may live in other villages, but take water from your assigned water source. Write your answer here:

   Answer .... families

5. Enter your data in table 22-1 in the appropriate column and line. Exchange data with other teams so as to complete the table. Calculate the totals of columns 3 and 4.

Table 22-1. Flow rates of all water sources in the study village in the month of October

Team number (1)	Name of water source (2)	Flow rate litres/minute (3)	Number of families using (4)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Note : If there are more than 10 water sources in the village, extend this table by pasting in an extra page.

CALCULATIONS

1. Calculate the total amount of water produced by your water source in one day.

   Here is an example to show how to do this calculation. Suppose the flow rate for your water source is 4 litres per minute. Then:

water produced in one day, litres	=	4 litres per minute	x	60 minutes per hour	x	24 hour per day
,,	=	4	x	60	x	24
,,	=	5760				

   Now calculate the daily production of water for your own water source. Show calculations on opposite page, and write your answer here:

   Answer = ... litres per day

2. Let us suppose that the flow rate of your water source remains the same for the whole month of October. How many litres of water would it produce in this month? Multiply the figure for water produced in one day (problem 1 above) by 31, since there are 31 days in October.

   Answer .... litres in the month of October

3. The answer you found in 2 above may be a very large number. Convert it to cubic meters. Remember, there are 1000 litres in one cubic metre.

   Answer : .... cubic metres in the month of October

4. Repeat the above calculations (1, 2 and 3), taking the total amount of water produced by all water sources in the village

   Answer: .... litres per day

   .... litres for the whole month of October

   .... cubic metres for the whole month of October

Teacher's signature:....................

Date:...................

BOX 22-1

THE WATER CYCLE IN THE VILLAGE ECOSYSTEM - 1. PLAINS

In Exercise 5 ‘Our Village Ecosystem’ we saw that water is an important feature of our village. We need water to drink and for household use, for our animals, our vegetable garden and if possible to irrigate our crops. We must realise that to meet these needs we interfere with the delicate water balance in our ecosystem, and that if we are not careful we can upset it and cause many serious problems for ourselves. This may make our village ecosystem sick and reduce its productivity.

In this box we will learn what problems come from the mis-management of water, why they come, and how we can prevent them.

Our wells are going dry

In Box 5-1 Sukhbir Singh said that in his village wells are drying up. This is happening to old open wells and also to tube-wells. There is less water than before and crop yields are going down. When tube wells dry up people make them deeper. But after a few years they again go dry. Drilling deeper and deeper costs a lot of money. Not all families can afford to do it.

Why do wells go dry? To answer this we have to understand how our activities in our village ecosystem disturb this water cycle. Figure 22-1-1 can help us in this.

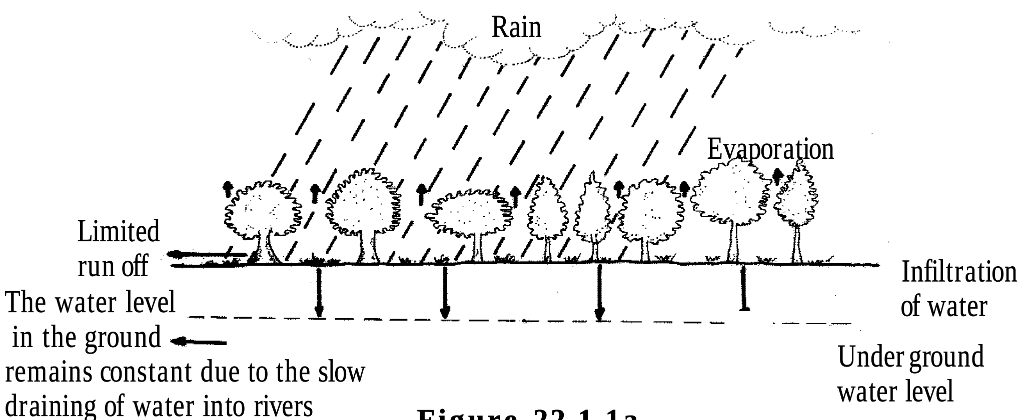


Figure 22-1-1a

In Figure 22-1-1a we see an ecosystem before a village was established. In this ecosystem water inflow and outflow are balanced, and so the water level in the ground remains constant, not too near the surface, but also not too, deep.

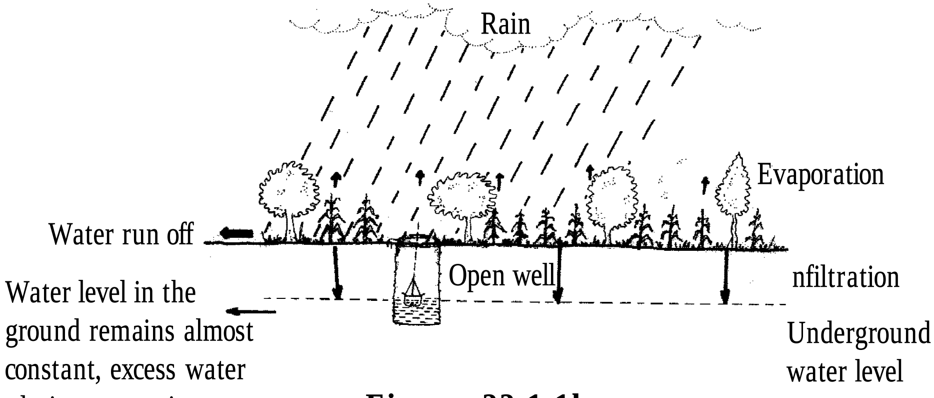


Figure 22-1-1b

Figure 22-1-1b shows the same ecosystem after a village was established. People made wells and removed water by hand or with the help of animals (*rahat* or Persian wheel). This water was used for drinking, household purposes, animals and watering vegetables. Large-scale irrigation of crops was not possible. Also, note that the rate of rain water run off was greater than before because the land is now ploughed and crops are weeded. Still, all this did not much effect the level of water in the ground; the natural water cycle was not much disturbed. Farming was carried on for many centuries with no water problems, except for drought years when rainfall was very little.

Now when electric or diesel pumps came to our villages – when your parents were your age – people began drilling tube wells. These can be much deeper than open wells and irrigation on a large scale was possible.

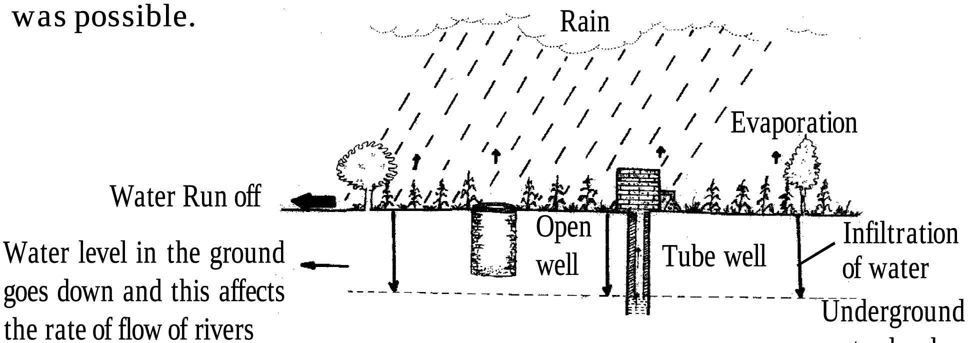


Figure 22-1-1c

In Figure 22-1-1C we see what happens when there are many tube wells in a village; the water level goes down because much water is pumped to the surface and only little of it percolates down again to the ground water level. Much of it evaporates. Open wells 'dry up'; that is, the ground water level falls below the bottoms of the wells. Further, the outflow of water from the village decreases because the water table falls below the level of the drainage ways, i.e., below the level of the streams. The streams 'go dry', at least in the dry season.

If many tube wells are made and they pump a lot of water, the ground water level falls still more and soon even the tube wells go dry. Those that can afford to drill their tube wells deeper do so, but after some more time, they again go dry as the water level continues to fall. This is what Sukhbir Singh meant when he said that the wells in his village are going dry.

The problem of artesian wells

The water in deep aquifers does not naturally enter into our village water cycle, and we have not mentioned it up to now in this box. Where artesian wells have been made, however, this water also enters our village water cycle. This does not create any serious problem. However, in recent years many of these artesian wells have started going dry. This is because too many artesian wells have been dug; this reduces the pressure of the water in the aquifer and the water stops flowing or at least there is a reduced flow in all the artesian wells. The meaning of the word 'aquifer' and the reason why the water they contain will be explained in Box 23-1.

The problem caused by canal water

Some villages in the *Bhabar* and *Tarai* regions of Uttarakhand also receive water from canals. This water comes from the big rivers like the Ganga and the Ramganga. It is not a natural water source of the village ecosystem and therefore we have not so far mentioned it in describing our village water cycle. Canal water, like tube well water, has made it possible to grow more and better crops. However, in some villages it has created a problem of water-logging, that is, it has caused the underground water level to rise to the surface. Except for paddy, crops can then not be grown. Also, in some villages where the underground water level has risen to the surface or near the surface the soil has become salty and no crops can be grown.

How to maintain water balance in the village ecosystem

In villages where the water table is falling due to excessive pumping of water, we must reduce the rate of pumping. When tube wells came to our villages, we started growing paddy and sugarcane in place of sorghum, millets, wheat, oilseeds and pulses. Paddy and sugarcane require lots of water, whereas sorghum, millets do not need irrigation and wheat grows very well with only moderate irrigation. Oilseeds like groundnut and mustard and pulses like gram, peas, black gram and green gram need little or no irrigation. Moreover, sugarcane, being a crop that grows all year round, need lots of irrigation water during the hot summer months.

To restore the ground water level to its natural position we must reduce the area of paddy and sugarcane and grow our traditional crops. This will reduce the amount of water we need to pump. If we wish to continue to grow paddy, we should grow some of the older varieties that our ancestors grew; recall that in Box 5-1, Sukhbir Singh is trying to get seeds of such variety. They grow well with much less water than the new dwarf types. Moreover, they produce more straw which will increase our supply of compost (Box 4-1).

Where artesian wells are drying up, the remedy is the same. Only a limited number of artesian wells in an area can give a good flow of water.

If our soil has become saline due to excessive irrigation with canal water, we need to reduce the amount of water we use by changing our crops. We must grow less sugarcane and more of our traditional crops which need less water.

With unlined irrigation canals, much water seeps into the ground thus contributing to the rise of the water level of all the villages along its course. This problem can only be solved by the government as they have made the canals and maintain them. Canals must be given a *pucca* (waterproof) lining to reduce seepage. Also, the permanent field distribution channels on our land should be *pucca* for the same reason. Making them *pucca* is our responsibility.

Box 22-2

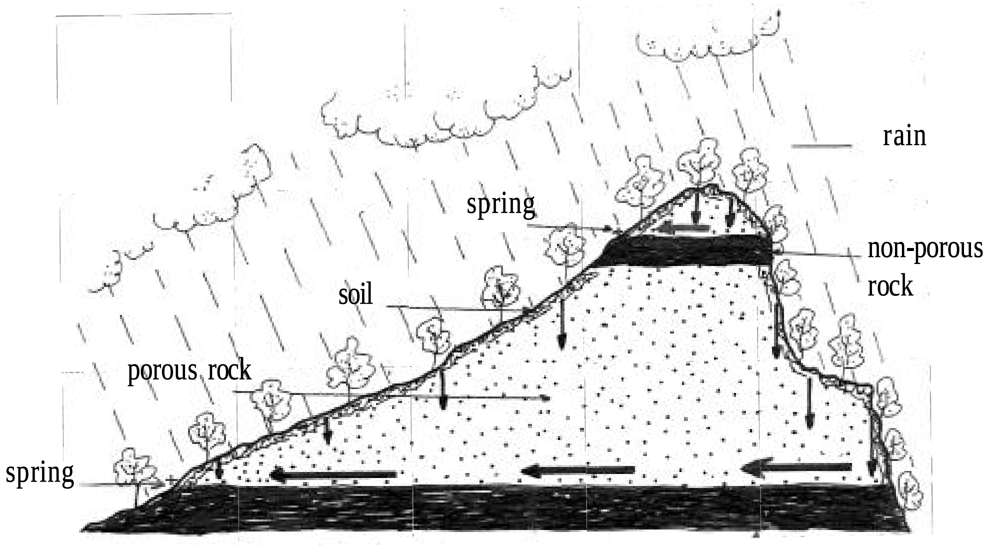
THE WATER CYCLE IN THE VILLAGE ECOSYSTEM-2. HILLS

In hill villages, most of our water comes from springs (and seepages). In many villages, the older residents tell us that the amount of water production by springs is becoming less and less. Why is this happening? The answer is that here too the natural water cycle is being disturbed due to poor management. To understand this we must first understand what a spring is and what part it plays in the village water cycle.

What is a spring?

We all know that a spring is a place where water flows out of earth. But there are other questions about springs that you may not have the answers for. Why does water come out of the earth just where it does, and not at another place? Why do some springs give more water than others? Why do some springs dry up in the summer and others not? Finally, why do many springs that previously flowed year round now go dry in the summer?

In this diagram below a hill is sliced open to reveal the structure of the rock beneath the surface. Two springs are depicted. Rain-water



soaks into the soil surface, and if there is enough rain, into the porous rock beneath the soil layer.

Some layers of rock are non-porous and do not soak up water. When downward-seeping water encounters such a layer it flows along it to the surface of the earth.

In the diagram the upper spring will produce less total water in a year than the lower one because the volume of the earth (soil + rock) in which water can be held is smaller. Also, the surface area through which rain-water can soak into the earth is less for the upper spring.

In a crude way we can say that the hill serves as a water storage tank. The bigger the tank, the greater the water flow from the spring.

Of course, other factors also determine the amount of water a spring will give. In year of low rainfall, less water will be stored in our 'tanks'. Even more important is how much of the rain water that falls soaks into the earth. In Box 18-1 we saw that if a mountain slope is covered with thick forest, a high percentage of the rain that falls soaks in. When the support area is grazed or burned, a smaller percentage of rain-water soaks in.

In many villages springs that used to flow year-round now go dry in summer. The main reason is that soil cover (live trees and dead tree leaves) has been destroyed by grazing and fire. Much of the rain-water falling on such support area runs off the surface into the nearby ravines. Thus the 'tanks' that supply the springs do not get filled up during the rainy season. They run dry in summer.

Remember, our support area produces fodder, wood and water. But it can produce these things in larger quantities only if it is covered with thick forest which is protected from grazing and fire.

Date: ....

Code : Soil 2
Month : December

EXERCISE 23

SOIL PROFILE

INTRODUCTION

To know our land thoroughly we must look below its surface. The productivity of the land depends upon how deep the soil is. In the hills the soil is only a thin layer and underneath it is solid rock. Where the soil layer is thin, productivity is poor. In the Tarai and Bhabar the soil is deep, and we do not find any underlying rock layer however deep we dig. However, there are at some places, particularly in the Bhabar, large stones which make the soil less productive and more difficult to plough. The soil there also has more sand particles (see Box 9-1) and less productive than soils with fewer sand particles. In the Tarai soils have fewer sand particles and more smaller particles and are thus more productive. Finally, dark-coloured soil is more productive than light-coloured soil.

In this exercise we will look beneath the surface of the soil in our locality.

Option A (Hills)

REQUIREMENT

For the class as a whole, the following equipment will be needed.

1. *Phawda*, one
2. *Kutli*, two
3. *Ganti*, one
4. Cloth tape measure (1.5 m), one

FOR THE TEACHER

The underlying structure and composition of the land in Uttarakhand varies from place to place, and also the means of studying it. If your school is in the hills, take up option A. If it is in the Tarai or Bhabar, take up option B. In the hills, it is convenient to look at a road cut, whereas in the Tarai and Bhabar a pit will usually have to be dug. It may also be necessary to dig a pit in the broad valleys like Bageshwar in the hills.

Before beginning this exercise, take up Boxes 23-1 to 23-5. The concepts in the boxes will help students to understand the exercise and their observations.

PROCEDURE

1. Select a road cut near the school as possible to save time. The cut should be deep one. So that a good depth of underlying rock is visible. However, a cut more than 2-3 m high is difficult to study. A new cut is preferable to an old one because the details we want to see will be clearer. Also, if the area above the cut is good forest, the soil portion of the cut (the soil profile) will be more complete. It will show all the layers – leaf litter, topsoil and subsoil. On eroded land there may be no leaf-litter and topsoil.

2. If the face of the road cut has a growth of moss, grass or shrubs, clear a strip of the face 20-30 cm wide from the top to the bottom of the cut. This will give a clear view of the soil profile.

3. Now draw neat sketch of he road cut on opposite page. You might like to make rough drawing first in rough copy, and then, after showing it to your teacher, make a corrected, fair copy in your workbook.

4. In your drawing, neatly label all the layers visible in the road cut.

5. Measure the thickness of each layer, and write this also in your diagram.

6. Try to find one sample of each of the three types of rock in this road cutting.

QUESTION

1. Do you see a layer of topsoil in the soil profile? If there is no topsoil or only a very thin layer, what could the reason be?

2. Why is the topsoil layer darker in colour than the subsoil layer?

3. Do you think that the soil you see has always been there?

4. Do you see long parallel dark lines in the underlying rock? Can you explain why the rock has these lines?

5. Do you see any cracks in the underlying rock? What is the significance of these cracks? You should be able to make at least two point here. (One hint: do you see tree roots growing into the cracks of the rock?)

6. What is the difference between sedimentary and igneous rock?

7. How is metamorphic rock formed?

Teacher's signature:....................

Date:....................

Note

Remember to return to question 3 and 6 in Exercise 22.

Option B (Tarai, Bhabar and broad valleys in the hills)

REQUIREMENTS

1. Tools for digging a pit (*gauthi, pauda, khurpi)* – one of each
2. Tape measure, 1.5 m – one for each team

PROCEDURE

1. Find a level place in your study village, if possible where there has been no disturbance by people or animals. Do not select an area that has been ploughed. Dig a pit one metre square and one metre deep. Pile up the soil at a little distance from the edges so that it will not fall back into the pit. Make the sides even and vertical. This will be a lot of work so all the teams should share it. Only one pit is to be dug. Do not destroy any tree or shrub. Where there is grass or herbs, put them with the soil separately from the rest of the soil you dig out.

2. Draw a map of the soil profile on the opposite blank page. Clearly mark the different layers you observe – if any. Label these layers 'A', 'B', 'C' and so on. beginning from the top. Also describe each layer in terms of the texture of the soil (coarse, smooth – i.e., large or small particles). Also note the dryness or wetness of the soil of each layer. Measure the thickness of each layer. Note particularly if you find a rock layer under the soil, and, if so, at what depth. (If you find a rock layer at less than one metre, do not dig deeper.) Are there stones mixed with the soil or lying on the surface? Clearly show these in your map at the levels where they occur. Finally show any plant roots you see in the soil profile.

3. Put all the soil back in the pit. Replacing the grass with soil at the top.

4. Ask your parents and grandparents how deep the wells (handpump, tube and artesian wells) in your village are. Also ask them if they found a rock layer when digging these wells. Record your information in the spaces provided below.

   Type of well ....

   Depth (approximately) ....m

   Was a hard rock layer found when digging? Yes/No

   If 'Yes', at what level was it found, approximately. ....m

QUESTIONS

1. Soil in the mountainous parts of Uttarakhand is usually very thin, sometimes less than 25 cm. Underlying this solid rock is found. Is the situation in your study village different? Describe the difference.

2. What do you think is the reason for this difference?

3. Do you find rocks and pebbles in the soil in your study village? Where do they come from?

4. From where does the soil of your study village come?

Teacher's signature:....................

Date:...................

BOX 23-1

THE ROCKS BENEATH US

In Box 18-1 and 18-3 you learned that the soil and much of the water that are vital to our lives in the *Bhabar* and *Tarai* areas of Uttarakhand come from the mountainous region of the state. You may be wondering: where does the soil in the mountainous regions came from? In this Box and the following two boxes we will try to answer this question.

In the *Bhabar* and *Tarai* regions of Uttrakhand the soil layer is thick since the soil is brought from the mountains and deposited here. We have to dig much deeper to find the underlying rock. In the Ganga plain beyond Uttarakhand the soil layer is very thick, more than 1000 metres. The following diagram shows this.

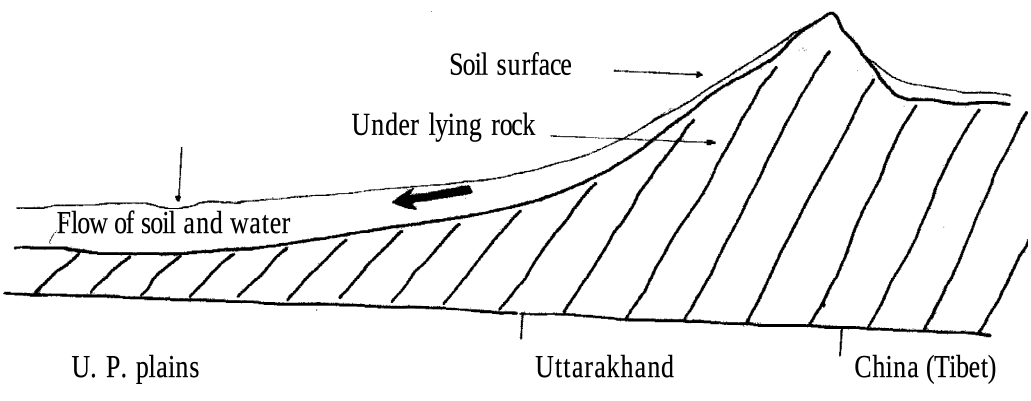


Figure 23-1-1

Looking at a road cut in the hills

When we look at the earth under our feet, we would say that it is made of soil. However, soil is only a thin layer covering the earth which is entirely made of rock. In the mountains it is easy to see the underlying rock, for example where the soil has been removed in making a road or building. Another example is village paths where all the soil may have been washed away at some places, leaving bare rock. Here is a drawing of a road cut where the road passes through a dense forest.

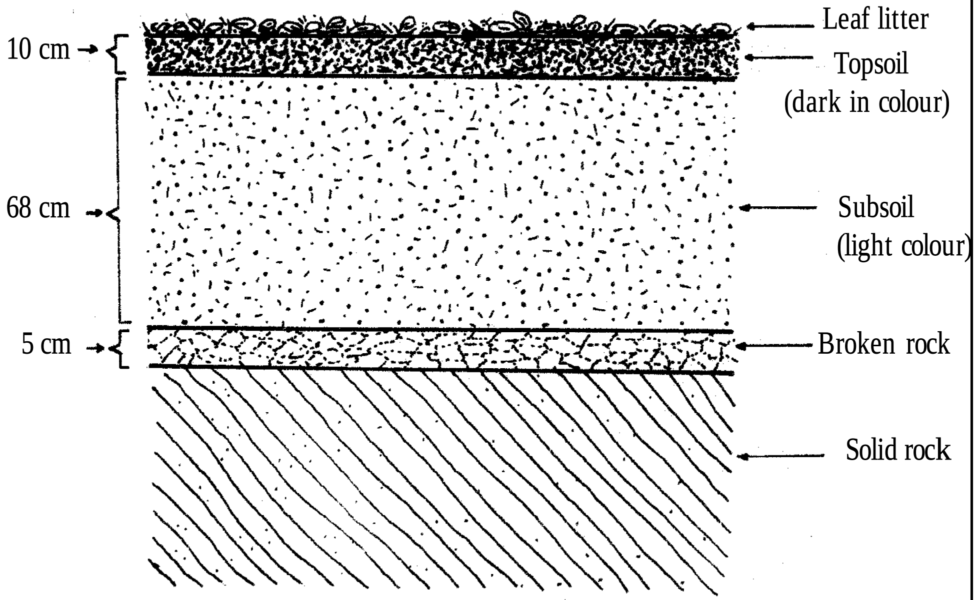


Figure 23-1-2

At the top of the cut we see in this figure a dark band of soil. This is called 'topsoil'. The humus from decayed leaves makes it dark. Below this we see a thicker layer of soil called 'subsoil' which does not contain any humus. (Do you remember what soil is? You can quickly read again Box 9-1 in last year's workbook.) Below the subsoil layer is a thinner layer of broken rock, and below this again is solid rock. Of course, the rock in most places is not completely solid or unbroken, but will have long, roughly parallel cracks in it. In Box 23-4 you will learn why these cracks occur.

Inside the earth

Below the layer of solid rock we see in a road cut, there is only more rock, right to the very centre of the earth. The earth is really a big rock, with only a thin skin of broken rock and soil on the surface.

Figure 23-1-1 shows us that even through the soil layer in the Ganga plain is very thick, underneath it is solid rock.

Though the earth is made up of rock, we should not imagine it is like a bigger version of an ordinary rock we are familiar with. Inside the earth it is very hot. So hot, in fact, that the rock is not solid, but liquid. It is difficult to imagine that ordinary solid rock can be liquid. By heating a lump of *gur* (unrefined sugar) in a heavy iron pan it turns to a liquid; this melted *gur* may give you some idea what liquid rock is like.

If we could cut the earth in half like an apple and look inside, we would see something like this:

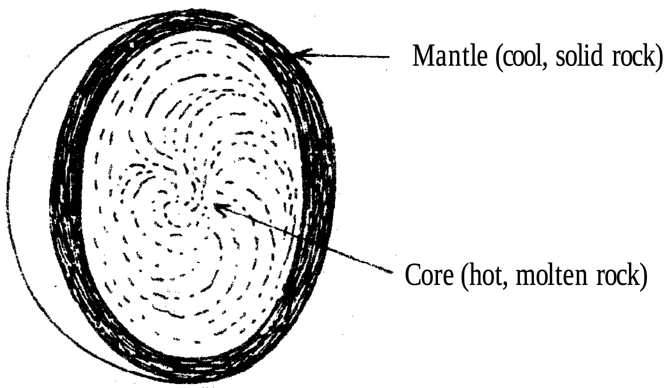


Figure 23-1-3

The cool, solid portion of the earth is about 40 km thick. Compared to the diameter of the earth (12,666 km), however, this layer is like the skin on an apple.

How do we know that the earth is hot inside? One way we know is from the existence of hot water springs, like the one at the Badrinath temple. Even in the middle of winter you can take a hot bath there. Some springs even give boiling water and steam.

But deep inside the earth the temperature is much more than that of boiling water. This we know because at some places on the earth's surface liquid rock sometimes squirts out. On coming out of the earth such liquid rock, called 'lava', quickly cools and condenses to solid rock. The openings in the earth's crust through which molten rock comes out are called 'volcanoes'. There are no volcanoes in Uttarakhand. Long ago there were numerous volcanoes in central and western India. The entire surface of the Deccan plateau is covered by a thick layer of solidified lava. Today the only volcanoes in India are under the sea near the Andaman Island. Countries like Japan and Italy have many presently-active volcanoes.

It is supposed that when the earth was very young, it was entirely a ball of molten rock. Slowly the surface layer cooled and solidified. This solidified rock is called 'igneous rock'. This rock is very hard and black or brown in colour. Solidified lava is also igneous rock.

The most common type of rock in the mountains of Uttarakhand is called 'sedimentary' rock. This is used to make house walls. This is much softer than igneous rock and usually has a grainy texture. It is grey and brown in colour. The harder types, taken out of the quarry as slabs, are used in house roofs and courtyards. The softer types are used for field walls.

A third type of rock found in Uttarakhand, in small amounts, is 'metamorphic' rock. Like igneous rock it is very hard. It has a glassy appearance and ranges in colour from white to pink.

Underground water flows

Some of the water that soaks into the earth in the mountains, reappears at the surface as hill springs, and some of it flows in deep aquifers down to the plains. Now that we have understood the structure of the rocks in the mountain. We can also understand how these underground water flows occur. In Figure 23-1-4 we again look at a mountain that has been sliced open in imagination.

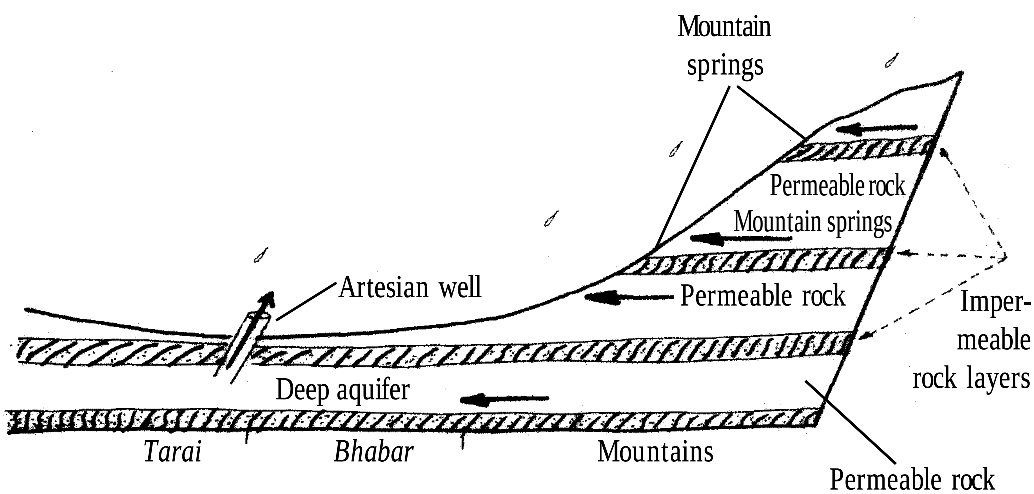


Figure 23-1-4

Some layers of rock readily soak up water (permeable rock) and some are impermeable to water (slates, or the slabs of stones for house roofs in the mountain are taken from layers of impermeable rock, whereas the stone used for walls is permeable.) Figure 23-1-4 shows how rain water soaks into the earth and accumulates in the permeable layers. Since it can not flow directly downwards because of the intervening impermeable rock layers, it flows along the upper boundaries of these layers and emerges as springs. A deep aquifer is a layer of permeable rock, filled with water, between two layers of impermeable rock. It is very deep and so the water does not emerge as a mountain springs, but flows under the plains. In the *Tarai*, some of these deep aquifers come quite close to the surface. People have tapped this water by drilling holes in the upper layer of impervious rock. The water then flows out by itself. These are known as artesian wells.

BOX 23-2

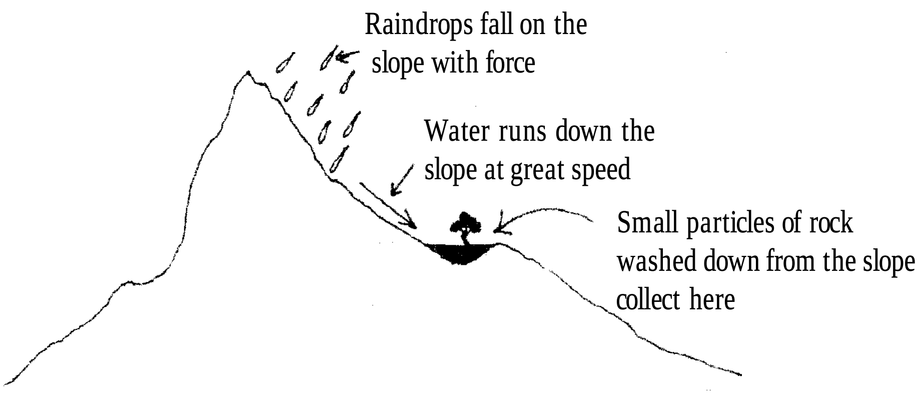
HOW IS SOIL MADE?

In Box 18-3 we learned that the soil of our study village came from the mountains. If the soil in the mountains is continually being eroded away to the plains, why has all the soil on the mountains not been washed away, leaving bare rock? Obviously new soil must be forming all the time to replace the soil that is eroded away. How is this new soil made? Look again at the figure of the soil profile in the mountain in Box 23-1. You will get a clue.

In that figure 23-1-2 we see that at the top of the soil profile there is a layer of humus-rich soil, called topsoil. Beneath that is a layer of subsoil which does not contain humus. Below this subsoil is a layer of broken or decayed rock and below this again solid rock. We infer from this that subsoil is formed by the breakdown of solid rock to small particles characteristic of soil. As topsoil is eroded away from the surface, new subsoil is formed from the underlying rock. Subsoil becomes topsoil when plant remains get mixed with it near the surface.

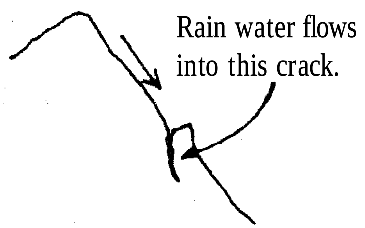
Now we want to enquire how solid rock is broken down into the small particles that characterise soil. Imagine a time very long ago when there was no soil at all, but only the rock crust formed by the cooling of the liquid rock comprising the earth. Here is a cross-sectional view of a bare rock mountain slope.

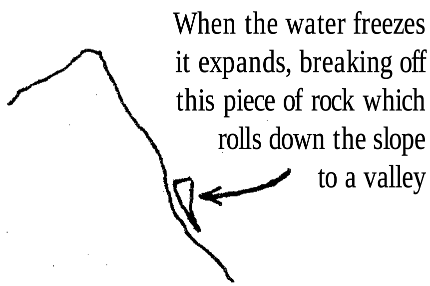
Rain drops beating on the rock slope very slowly break off pieces



which are carried down to lodge in a small pocket. This process may take thousands of years to form a handful of soil. A few plants may then begin to grow in this small pocket.

On the higher mountain slopes, where freezing weather occurs, water breaks down rock in another way also.





When a little soil forms here and there, plants begin to grow in it. Then the plants themselves begin to break down solid rock to form more soil. Their roots penetrate the underlying rock through the natural cracks in the rock. You can see this today in many road cuts in the mountains. As the roots grow, they split the rock into pieces. Also, the roots release carbon dioxide which combines with water to form carbonic acid. This acid dissolves the softer parts of the rock, releasing fine particles which add to the soil already present. Fungi, bacteria, insects and small animals that live in the soil (decomposers) produce carbon dioxide when they decompose dead plants and animals and animal excreta. These are the processes which create the layer of shattered or decayed rock just under the subsoil layer in the soil profile.

Soil formation proceeds very slowly. In an area of undisturbed forest, the rate of soil loss is, say, 35 kg/'are'/year. Let us say that the soil layer is 25 cm thick. In order for this 25 cm soil to have accumulated, the rate of formation of new soil must be at least a little faster than the rate of natural erosion. Probably this layer of soil has taken thousands of years to build up to it present thickness.

BOX 23-3

SEDIMENTARY ROCKS

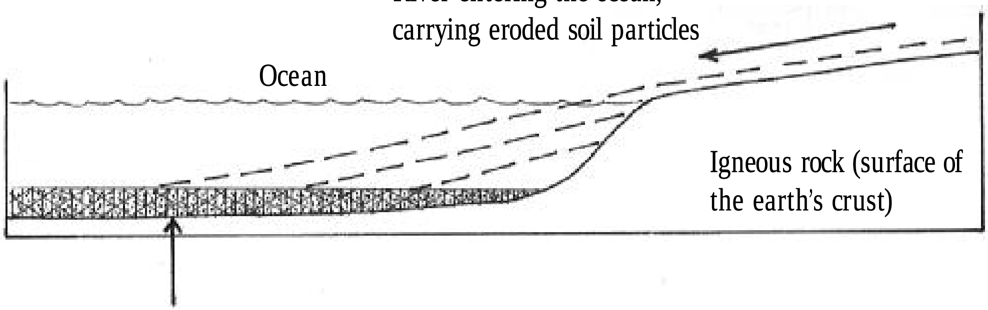
Most of the stone used to houses and field walls in the mountains of Uttarakhand is sedimentary rock. The name 'sedimentary' means that it is formed from sediments, or soil particles that settle at the bottoms of oceans. You may wonder how rock that was formed at the bottom of an ocean is found underlying villages which are so far from the ocean and at a much higher altitude. This box and Box 22-4 will give you the answer.

The following diagrams give a general picture of how sedimentary rock is formed.

Stage 1

River entering the ocean, carrying eroded soil particles

Ocean



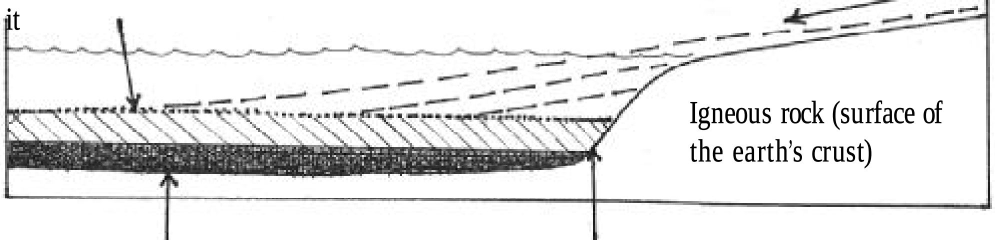
Igneous rock (surface of the earth's crust)

Eroded soil particles settle to the bottom of the ocean

Stage 2

Eroded soil particles settle to the bottom covering previous sediment and compressing it

River entering the ocean, carrying eroded soil particles



Igneous rock (surface of the earth's crust)

Older sediment becomes compressed to form sedimentary rock

Boundary line between older and newer layers of sediment

You will recall that the crust of the earth is made up of igneous rock. Soil was formed by the processes described in Box 23-2. Some of the soil particles were eroded by rain (Box 18-1) and carried down to the ocean by streams and rivers. This process continued for millions of years, resulting in the building up of sediment layers thousands of metres thick. You can imagine the great weight of this sediment, and why the bottom layers get compressed into rock.

Within sedimentary rock, distinct layers are visible, as shown in 'stage 2' in the preeceding diagram. These represent the sediments deposited in different periods of time, or from different sources. In removing sedimentary rock from a quarry, it breaks, or can be broken, or split, neatly along the lines between adjacent layers.

Sedimentary rock made of predominately large soil particles (i.e., sand particles) is termed 'sandstone'. That made from fine soil particles is termed 'shale'.

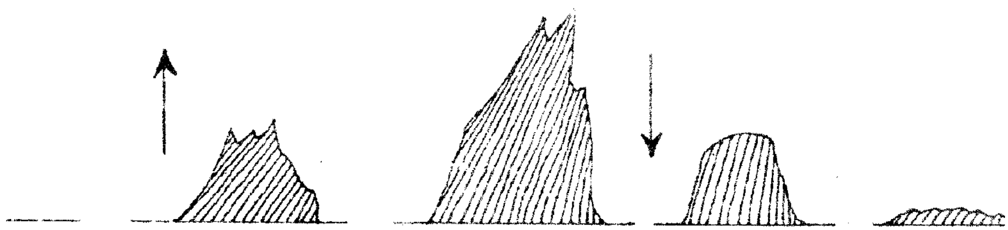
Igneous rock is called 'primary rock'. It provides the sediment which produces sedimentary rock, by the process we have just described. Sedimentary rock is therefore called 'secondary rock'. Today this rock itself is being turned into soil on our mountains, and some of the soil eroded away to provide sediment for yet more sedimentary rocks. The processes of soil formation, erosion and the formation of sedimentary rocks never stops. Today we can see that all rivers carry eroded soil particles, especially during the monsoon season. The Ganga river, for example, carries an average of 4 kg soil per cubic metre of water into the Bay of Bengal. Out of sight, thick layers of sedimentary rock are building up under the ocean.

But now you are impatient to know how rock formed at the bottom of the ocean can today be found in the mountains. Turn, therefore, to Box 23-4.

BOX 23-4

THE BIRTH AND GROWTH OF THE HIMALAYAS

One of the most astonishing things you will read in your geography textbook is that mountains are not permanent features of the earth's landscape. Rather, they are born, they grow, and finally they get smaller and disappear. This entire life history can be depicted as follows:



1 2 3 4 5

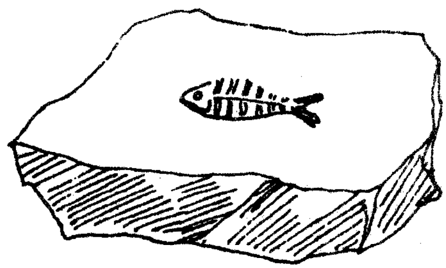
Level Surface rises Mountains grow Mountains stop Nearly
level surface to form mountains to full size growing and are
surface again worn
down

by erosion

Of course, you would have to live a very long time to witness this entire sequence of events – 300 or 400 million years in fact! And yet, even in one human lifetime we can witness the processes that are responsible for the growth and disappearance of mountains. Precise measurements of the altitudes of Himalayan peaks over the past 30 years or so show that these peaks are rising by an average of 5-6 mm per year. The rate of lowering of the mountains as a result of natural soil erosion and landsliding is estimated to be about 0.2 mm/year. (This is equal to a soil loss of 30 kg/'are'/year.) Due to our mismanagement of our land, the rate of lowering of the mountains today is several times greater than this figure. Even then, our mountains are rising faster at present than they are being worn down.

Still, you may wonder how we can know that the land in the mountains of Uttarakhand on once was at the bottom of an ocean, as our textbooks tell us. The really convincing piece of evidence for this is in the sedimentary rock we find in the mountains. Such rock, as we have seen (Box 22-3), is formed at the bottoms of oceans. Even more convincing is the fact that some times we find the fossils of sea animals in the sedimentary rock in our mountains. A fossil is the skeleton of a dead animal covered by sediments at the bottom of an ocean and preserved as the sediment is turned into rock. And now a days measurements can be done to determine the age of fossils, or in another words, how long ago the animal lived.

The fossil of a fish that lived in the ocean 25 million years ago found in a piece of sedimentary rock in the Himalaya today

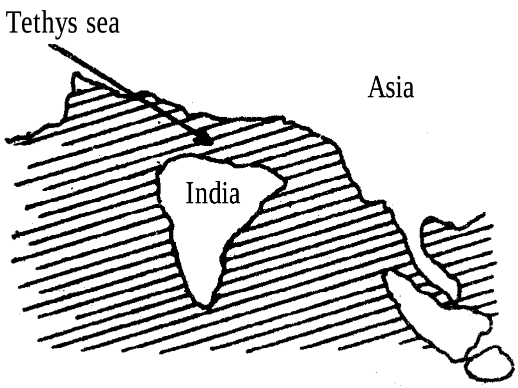


How does the level of the land rise from ocean bottom to mountain peak? How is it pushed up by many thousands of metres? Great force inside the earth is obviously at work. When you study geography in higher classes you will learn how these forces are thought to be caused.

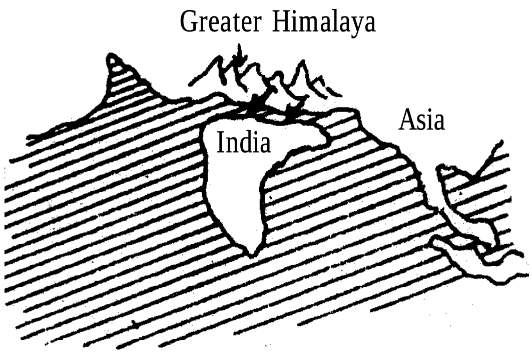
The Himalayas, the Alps, and some other mountains are called 'folded' mountains. That is the surface layers of the earth's crust get folded like a rug that gets pushed from two sides as:

Forces deep in the earth push a strip of the earth's crust from opposite sides causing it to buckle and rise.

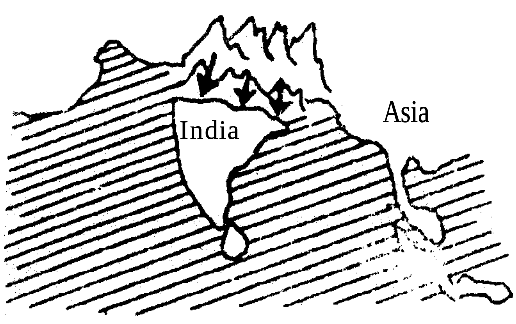
Here is a series of diagrams showing approximately how the Himalayas are thought to have been born and how they are continuing to grow even today.



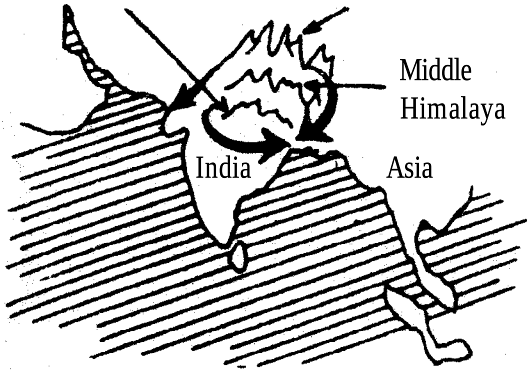
40 million years ago India and Asian continent were separated by an arm of the ocean called the Tethys sea.



38 million years ago the greater Himalaya range was uplifted. The Tethys sea became shallower and narrower as it filled with eroded soil from the mountain slopes (arrows). This soil formed sedimentary rocks.

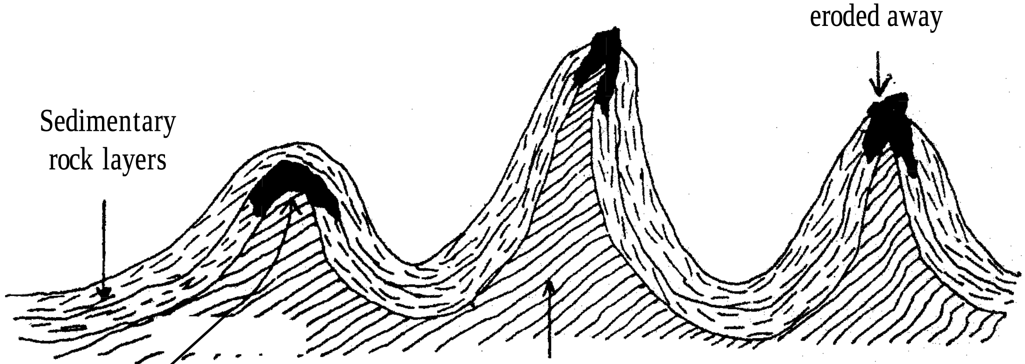


23 million years ago the greater Himalaya continued to rise. New mountains, the middle Himalaya, began to rise from the ocean. The layer of sedimentary rock formed on the ocean bottom was raised to form the mountain peaks. The middle Himalayan slopes in turn lost soil through erosion. The soil is washed into the ocean to form more sedimentary rock.



7 million years ago the greater Himalaya and middle Himalaya continued to rise. The lesser Himalaya was uplifted. India and Asia were now joined by land. The lesser Himalaya consist of sedimentary rock formed from soil eroded from the middle Himalaya. Erosion from the Himalaya continues, soil now flowing into the Indian Ocean in the Indus, Ganga and Brahmaputra rivers.

If we could slice open our mountains from top to bottom we would see why they are called folded mountains



The layers of sedimentary rock are folded like a rug. The lower layer of sedimentary rock near the peaks has been converted into metamorphic rock. This happens because the pressure is very high where the sedimentary rock layer is folded most sharply. The pressure increases the temperature, and together they change the relatively soft sedimentary to harder metamorphic rock.

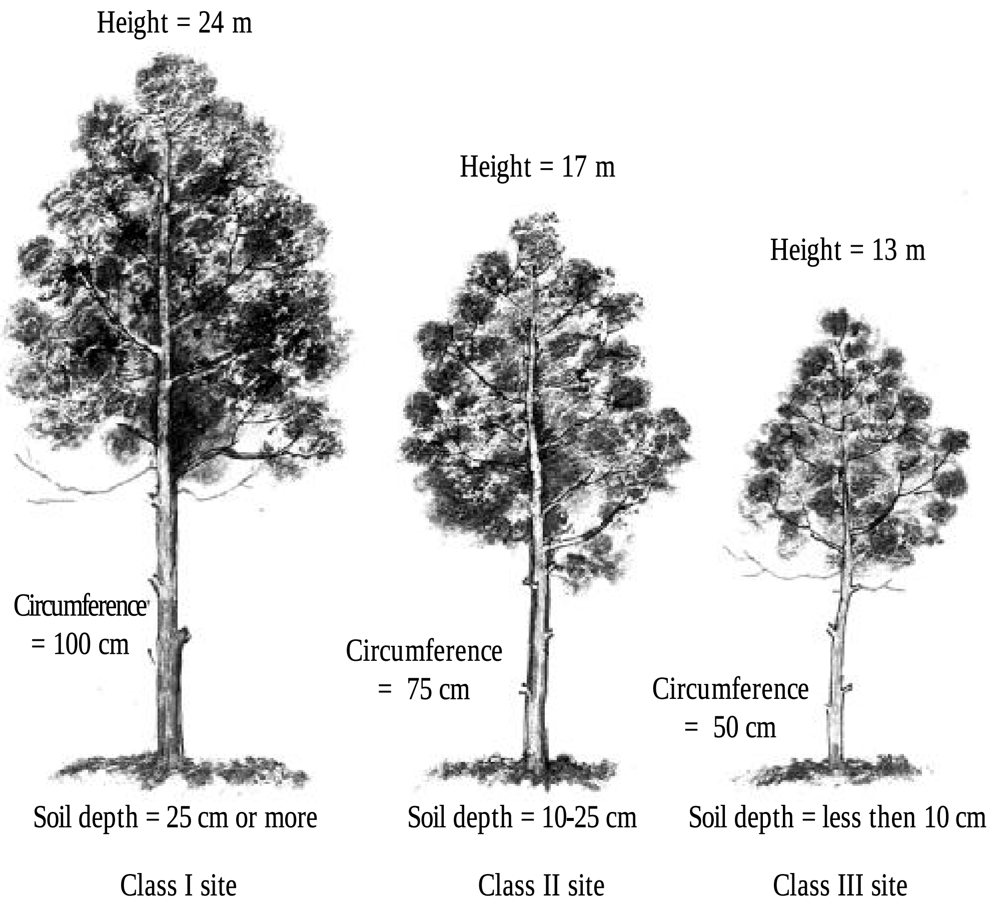
Sedimentary rocks is formed in layers (Box 22-3) and these layers are visiable in a road cut. When these layers were formed they lay horizontally on top of each other. In a road cut we usually find that they are not horizontal, but sloping. The reason for this is the uplifting of the earth to form mountains; this is shown in the diagram above.

Today the Himalayas are still being uplifted. This may stop after some millions of years. Then constant natural erosion will slowly wear them down again. The soil eroded from our mountains today might find its way into other mountains in the distant future. Such is the great cycle of mountain formation and destruction.

Box 23-5

SUPPORT–AREA LAND CLASSIFICATION

In high altitude villages there are some places in the village support area where trees grow faster and bigger than at other places. The main reason for this is the depth of soil. Where soil is deeper trees get more nutrients and water, and thus grow faster. In the following diagram the relation between soil depth and chir tree growth is shown.



All these trees are 50 years old. These facts tell us why the depth of soil in our support area is so important. On class I land chir trees will give us about three times more wood per nail in 50 years time than on class III land.

On steep slopes the depth of soil is usually less than on gentle slopes, even where both are covered by thick forest. This is because the natural rate of soil erosion (refer to Box 18-1) is more on steep slopes than on gentle ones. But there is very little class III area in undisturbed forest. Nearly all the class III land in our village support area today is a result of accelerated erosion – that is the speeded-up erosion due to our misuse of the land.

Class III land resulting from mismanagement (over-cutting, grazing and fire) cannot be brought back to class I status, whatever we do. It takes hundred of years to increase soil thickness by one centimeter. At most we can protect our class III land from further accelerated erosion by good management, that is, by protecting it from grazing and fire and by planting trees. We might say that our soil is a gift of nature given to us only once. If we squander it, we will not be given more. Let us at least take heed now.

Date: ....

Code : Land 5
Month : February

EXERCISE 24

PROJECT FOR RESTORING TREES TO OUR VILLAGE ECOSYSTEM 1. SITE ASSESSMENT

INTRODUCTION

This exercise is the first of seven Exercises (25, 26, 29, 34, 42, 47 and 58) in which you will learn how to make a plan for rehabilitating a portion of the uncultivated village common land. In this exercise you will assess the area selected by your teacher, calculate its area and the total number of tree seedlings to be planted.

REQUIREMENTS

1. Tape measure (15 m) – one
2. Tape measure (1.5 m) – ten

PROCEDURE

1. Your teacher will select a plot of 10-20 'ares' in area for this project. It must have a fence around it for protection from grazing animals.
2. Make a neat map of your selected plot on the opposite blank page.
3. Measure the plot, using the technique you learned in Exercise 13. Mark all dimensions in your map.

FOR THE TEACHER

Take up Boxes 24-1, 24-2 and 24 -3 before beginning this exercise.

For this project select village common land such as barren land or grazing land. An area of 10-20 'ares' will be needed. If village common land is not available, then this project can also be done in the school campus.

Some extra time will be needed for this exercise, which you will have to arrange with your principal.

4. Calculate the area of your plot.

   Area = ... 'ares'/nalis

5. Calculate the number of tree seedlings you will require to cover the plot. First decide the spacing of trees you intend to follow (Box 25-2).

6. In high altitude villages it will be necessary to check the soil depth in order to decide which types of trees should be planted (Box 22-5). Measure soil depth at different places as it may not be the same everywhere. Mark the areas of different soil depth in your map.

QUESTIONS

1. What approximately is the total area of common land in your study village in which trees could be planted?

   Answer = ... 'ares'/nalis

2. Assuming that one 'are' of such common land would produces 60 kg of fuelwood each year, how much fuelwood would each family in your study village get assuming that each family gets an equal share of the total.

   ____

   ____

   ____

   ____

   ____

3. What types of trees would you like to plant?

   ____

   ____

   ____

   ____

   ____

   ____

Teacher's signature:....................

Date:....................

BOX 24-1

WHERE CAN WE GROW TREES?

An important conclusion you have arrived at in Exercise 5, 'Our Village Ecosystem' is that trees are indispensable in our village ecosystem. Without enough trees we cannot produce healthy crops and animals and, indeed, we ourselves cannot be healthy. Sustained high yields of crops are only possible if there are enough trees in our village ecosystem.

Trees are necessary because we need wood for fuel. If we do not have fuelwood we must burn animal dung, depriving our fields of their food.

Trees also produce nutritious fodder for our animals – particularly at those times of the year when we do not have green fodder from our fields. They capture plant nutrients from deep in the soil where the roots of our crops do not reach. Finally, they are good companions for our crops. We will learn more about all these three roles of trees later in the course.

Now, most villages have very few trees left. Our village ecosystems are therefore sick. In many cases we have also used chemicals (fertilisers and pesticides) and this has made them still more sick. To make them healthy again we need more trees – and we must stop using chemicals.

There are two types of land in our village where we can plant trees.

1. Village common land

Village *charagah* (grazing land) and village *banjar bhoomi* (wasteland), were originally natural forest that was not cleared to make fields. Over the centuries, due to grazing and fire, trees disappeared from these areas. Since these are common village land, the work of planting trees in there areas, and of protecting them, will be the work of everyone in the village. The produce from these trees – wood and fodder – will be shared by everyone.

2. Private land

Even after doing this there will not, in most villages, be enough wood and fodder to meet every family's needs. This is because the area of common land is very little. Trees will therefore also have to be grown in and around our cultivated fields. Each family will have to plant trees according to its needs.

In Box 24-2, the method of reforesting our village common land is explained, while in Box 24-3 the method of planting trees in and around cultivated fields is explained. The management of trees for fuelwood, fodder and stemwood is described in Boxes 28-1, 28-2 and 28-3.

Many families now-a-days grow eucalyptus and poplar trees as a monocrop in their fields. The wood is sold. When grown in this way, these trees do not improve the health and productivity of the village ecosystem. They are like any other cash crop; they tend to draw nutrients away from the village ecosystem. They do not produce fodder, and very little fuelwood. Moreover, eucalyptus has very dense and wide-spreading roots. Thus when it is grown on field boundaries it suppresses the growth of crops for several metres on both sides.

Of course, if our village ecosystem produces enough fuelwood, fodder and compost, we would like to grow some cash crops in addition to food crops. Trees for stemwood may be one cash crop. In that case it is better to grow a native species like *shisham*. These should be sown on field boundaries, road sides, canal banks, and not as pure stands in crop fields.

BOX 24-2

RESTORING TREES ON VILLAGE COMMON LAND

Trees are the natural vegetation everywhere in Uttarakhand. Our entire village was originally covered by forest, as we learned in Box 4-1. Most of the trees were cut down to clear land for the cultivation of crops. Some areas were left as forest; animals were grazed there, and from them we cut tree leaves for fodder and trees for fuelwood and stemwood. Due to the grazing of our animals and fire these trees gradually disappeared. Now, our uncultivated, common village land is covered only with grass. Due to continuous grazing and periodic fires, coarse grass like *kans* (*Saccharum* sp.) and low-growing *doob* grass and also unpalatable annual plants are common in many villages. *Kans* grass is not useful as fodder, and *doob* grass gives very little fodder. Where grass has died out altogether leaving bare ground, there may be much soil erosion as well.

If such land could again be covered with trees, and if we managed them properly, we could get fuelwood, stemwood and fodder. How can this land be made into a forest again?

If such land is protected from fire and grazing, we will see that after a few years tree seedlings will appear in the midst of the grass. Year after year more tree seedlings will appear. They grow up and gradually replace the grass as the main type of vegetation. This process is much faster if there are a few trees remaining in the protected

area. They will drop seeds which give many new seedlings. After a very long time it will again become forest like it was in the past.

In most cases, however, trees will take a very long time to return because there are no seed trees left in our protected area. In such cases we can help nature by planting tree seedlings.

Also, if we depend entirely upon nature to plant trees for us, we may find some types of trees we do not need. If we plant trees, we can plant those which will be most useful to us. You have already, in Exercise 3, considered what types of trees are most useful to us.

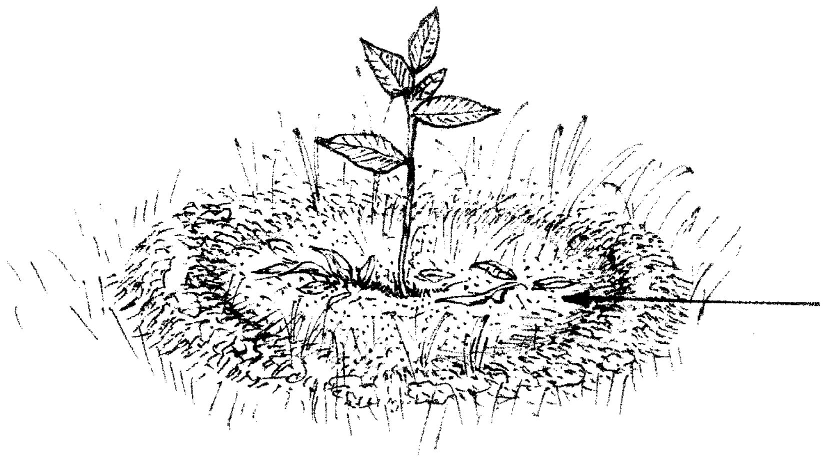
Let us consider how to establish a stand of trees for producing fuelwood. If the trees are managed by pollarding then 25 seedlings per 'are' (50 per nali) will be appropriate. Twenty five seedlings per 'are' means an average spacing of 2 m x 2 m. (Imagine that seedlings are planted 2 m apart in imaginary lines 2 m apart.) On steep slopes the spacing should be increased to 2.5 or 3 m. Of course, there may be some existing trees. Nevertheless, you should aim to plant 25 seedlings per 'are'. If some seedlings naturally establish themselves from the seed of nearby trees, and they are the type we prefer, they should be allowed to grow along with the planted seedlings.

At least five or six types of tree seedlings should be planted. Some additional types may establish themselves naturally. Thus you will have perhaps 10-15 useful types of fuelwood producing trees.

In planting seedlings, all the different types should be mixed. That is, do not plant all the seedlings of one type at one place, excluding all other types. The stand will thus imitate a natural forest where many types are mixed. Such mixing is likely to give healthier trees and higher production of fuelwood. After planting, the seedlings should be weeded regularly. Due to protection of this area from grazing, grass will grow vigorously. But while the seedlings are small, the area of the original pit must be kept free of grass and other plants. Every time weeding is done the weeds can be used as mulch.

When cutting the grass, care must be taken not to injure the young trees. Prevent fire in the plantation. One fire when the grass is dry can kill all the seedlings.

In the first year a few seedlings may die even with good care. Next



year, in July, the empty pits left by the dead seedlings must be filled with new seedlings. This is called gap filling.

When the saplings are well-established, in the third or fourth year, thinning may be necessary to bring the total number of saplings to about 25 per ‘are’. The weaker saplings may be removed. Also, those of types you think will not be useful, or that may even be harmful. Such weeding/ thinning will probably be necessary every year.

BOX 25-3

TREES IN AND AROUND OUR FIELDS

The first places to plant trees in our village ecosystem is in uncultivated common village land. However, in many villages there is very little such land left and therefore we need to plant trees in and around our fields as well.

The natural way of growing trees in cultivated land is as parts of our crop mixtures. They can be grown on the boundaries of our cultivated fields, on terrace risers, or in the fields themselves, either scattered or in lines. This practice is termed 'agro-forestry' a combination of agriculture and forestry in the same place at the same time. Of course, even now you will find trees growing like this in every village – only they are not enough to make our village ecosystem fully healthy and productive.

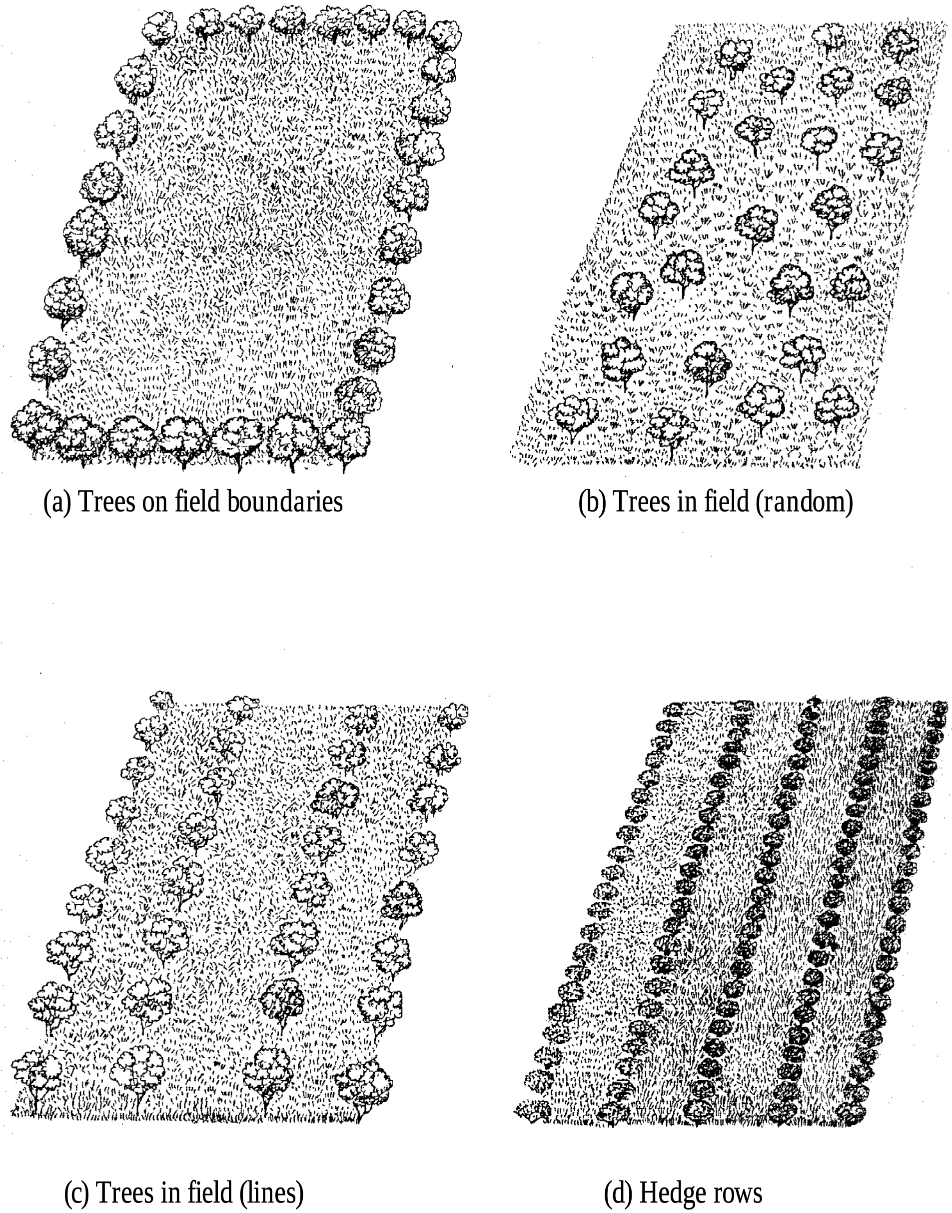
You might think that if we increase the area planted to trees crop production will decrease. But this will not happen; it will increase. Our crops will be healthier and yield more when grown mixed with trees. Also, trees will give us fuelwood, thus leaving all the animal dung for compost.

Let us consider the different ways of growing trees in cultivated land.

1. Trees on field boundaries (Figure 24-3-1a) : Tall growing trees for stemwood and fuelwood can be grown on field boundaries. One or two lines may be planted (with 2-3 metres between lines), and with trees 2-3 metres apart in the lines. The space under the trees should be allowed to fill up with naturally occurring shrubs, herbs and grasses and these should not be disturbed. In this way the field boundaries will become 'natural forests'. Here a variety of animals, birds and insects will find food and shelter. Most of these help to protect our crops.

2. Scattered trees in the field (Figure 24-3-1b and c) : Wood and fodder species may be planted randomly or in a regular pattern at the rate of one tree in 2-4 ares (25-50 trees per hectare). Annual or biennial crops are grown in the open spaces between the trees. Or the spaces may be planted with fruit trees. In the later case we should also plant stemwood trees on the field boundaries; these serve to break the force of hot and cold winds, thus protecting the fruit trees.

3. Hedges of small trees/shrubs across the field (Figure 25-3-1d) : Single or double lines of small trees or shrubs are planted at



(a) Trees on field boundaries

(b) Trees in field (random)

(c) Trees in field (lines)

(d) Hedge rows

Figure 24-3-1

4-6 m intervals across the field. Within lines the spacing is 0.25 – 0.5 m between plants, and for paired rows the distance between the rows is 0.5 – 1.0 m. When the saplings are about six months old they are cut down to a height of 0.5 – 0.75 m. New shoots will sprout and grow and these may be cut regularly two-three times per year at the sowing times of the crops sown between the lines of trees. Thus after sowing crop, the hedge may be trimmed and the cut branches and leaves spread haphazardly in the alleys as mulch. Or the trimmings may be done before sowing the crop and used for fodder and compost. These hedge strips should be allowed to fill up with naturally- occurring herbs and grasses, again making miniature 'natural forests'.

On sloping land, the hedge rows should be laid out at right angles to the slope; they can help reduce soil erosion. That is, the hedge rows trap any soil that may erode from the cropped alleys. Such erosion might happen during very heavy rain storms even when the alleys have been covered with mulch.

Subabool, dhancha, gliricidia and *cassia* (see Box 8-1) are especially suitable for planting as field hedges. You may also try any other, native shrubs of your locality. Figure 25-3-2 shows a mixed crop of subabool hedges, and wheat and mustard.

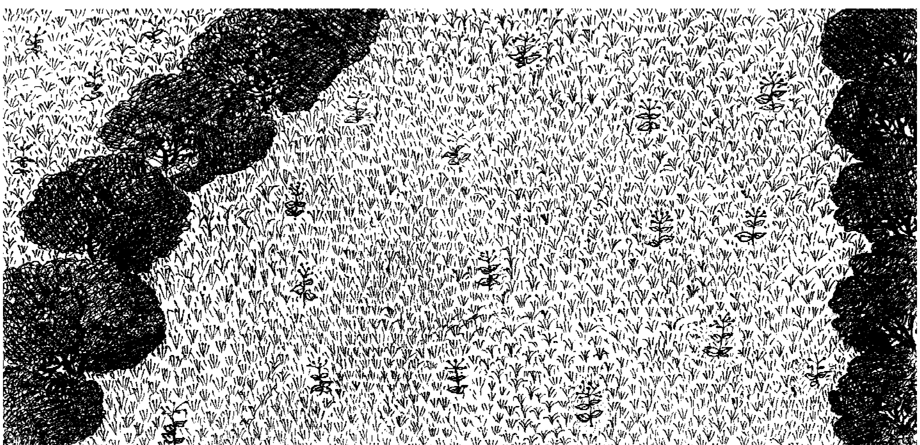


Figure 24-3-2. Wheat and mustard in alleys between hedge rows

4. Combinations of methods : The three methods given above can be combined depending on need and field conditions.

WHAT WE HAVE LEARNED THIS YEAR

Now that you have finished all the exercises in this year's workbook, it is time for review. Below are some questions that will help you to review what you have learned this year.

The members of each team should work together to answer each of these questions. When all the teams have prepared their answers, your teacher will ask two or three teams to read out their answers. The class then discuss and compare these. In this way everyone will come to know what points should be included in a complete and correct answer to each question. Each team can then revise its answer, if necessary.

Take help of your workbook in answering these questions. Remember, this is not a test.

Write your final answers in the spaces provided after each question.

QUESTIONS

1. What is the most interesting thing you have learned this year? (There is no 'correct' answer for this! Every student will have his/ her own choice.)

2. What is the correct method of transplanting tree seedlings?

3. What are 'decomposers'? What role do they play in the growth of trees?

4. Bhagwati's school has a tank to collect rain water. All the rain water that falls on the school roof flows into a gutter at the edge of the roof, and then through a pipe to the tank. The water is used to irrigate seedlings in the school nursery. The school roof is 4 m wide and 10 m long. The rainfall last year at the school was 120 cm. How much water flowed into the tank from the roof? Give your answer in cubic metres.

5. The barren land of a village received 120 cm rainfall last year. From each ‘are’ 60 cubic metres water ran off during the year. What does this tell you about the condition of this land?

6. What are the signs of soil erosion?

7. How can we reduce soil erosion from our village? Why is it important to reduce soil erosion?

8. How is soil formed?

9. How is sedimentary rock formed?

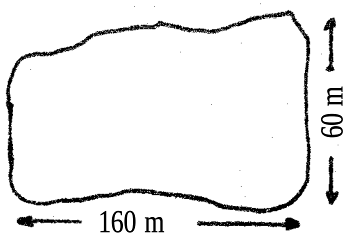
10. A spring produces water at the rate of 3 l per minute when measured on one day in the month of November. Assume this rate is constant during the entire month. How much water does the spring produce during the entire month of November? Give your answer in cubic metres.

11. What is a spring?

12. Why do we say that grazing is an ‘unsustainable’ method of managing our uncultivated land?

13. Village Ramgarh has the following area of uncultivated land, which the residents want to rehabilitate. They plan to plant fodder trees. How many tree seedlings are required?

Here is a map of the area



14. What is the reason for the lowering of the ground water level?

Teacher's signature:....................

Date:....................

WELCOME

WORK DISPLAY DAY

CLASS SEVEN

Now that you have completed this year's course, it is time to display your work for your parents and the residents of your study village. This display will be organised in the same way as last year. Here are the topics for the display.

1. **Rainfall:** Explain the concept of rainfall with charts and various utensils. Demonstrate how to measure rainfall with a rain gauge. What was the rainfall pattern at your school last year (chart). (Exercise 17 and Box 17-1).

2. **Soil erosion:** Demonstrate how soil erosion occurs. If possible show a site of natural erosion, i.e. make your display at a site of natural erosion in the school ground. Make charts explaining water runoff and absorption, how rain drops dislodge soil, and pedestals under stones and trees. Explain the difference between normal and accelerated erosion. (Exercise 18 and Boxes 18-1 to 18-6).

3. **Proper terrace design:** Models of wrongly constructed and properly constructed terraces. Explain reasons for inward slope, end-to end slope, grassed waterways and shoulder bunds. Soil erosion rates for wrongly-constructed and properly-constructed terraces (compare these rates with normal soil erosion rates). (Box 18-4)

4. **Water cycle in nature:** Display charts showing the water cycle in our village ecosystem. Make charts explaining the reasons for the lowering the water table and how the problem of water logging occurs. How can a change in cropping pattern help to balance the water cycle (Exercise 22and Box 22-1).

5. **What is a spring?** Explain with a chart, and also with tins of various sizes with different-sized holes in them. (The size, force and duration of slow depends on the size of tin, size of hole and depth to which it is filled with water -- these factors can be demonstrated.) Explain how flow rate is measured. Chart showing flow rates of springs in study village. (Relate different behaviour of study village springs to demonstration with tins.) (Exercise 22, Box 22-2)

6. **Soil formation:** Present charts to show how soil is made. Explain the action of rain, freezing water, growing roots and the acid produced by plants in the formation of soil particles. (Box 23-1, 23-2).

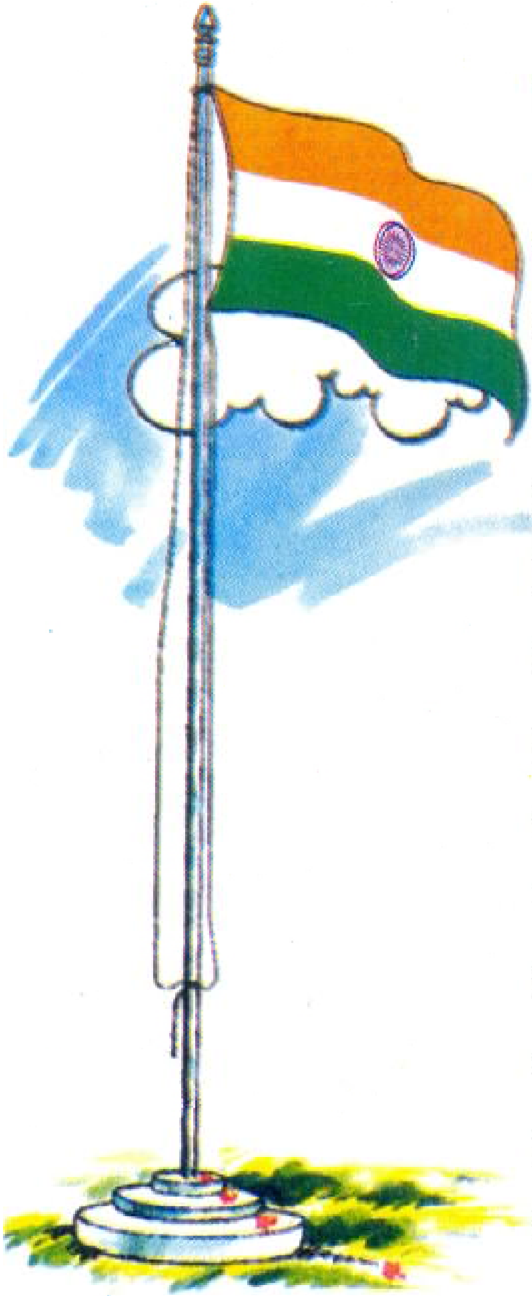
7. **Soil depth:** demonstrate how to measure (Make a pit at the site of your display). Charts to show effect of soil depth on tree growth. Relation of soil and soil depth. Accelerated soil erosion and the formation of class III land. (Exercise 23, Box 23-5)

8. **Relation between plains and hills:** Display charts and model explaining the relation between plains and hills in terms of water and soil. (Boxes 18-2 and 18-3).

9. **Growing trees:** Display charts or model showing the possibilities of restoring trees in the village ecosystem (Boxes 24-1, 24-2 and 24-3).

10. **Barren land rehabilitation:** This should be at the site of the area you selected for rehabilitations if it is in the school grounds. Otherwise make a map of the project area on the ground. Explain with charts the methods of rehabilitation. Natural and assisted regeneration. Explain the management plan for project area. List the types of trees to be planted. (Exercise 24).

11. **Organic farming:** Display charts explaining the benefits of making seeds of organically-grown vegetables and medicinal plants. Also explain the methods of making seeds and list the different types of medicinal plants (Exercise 20, Boxes 20-1, 20-2, 20-3, Exercise 11 and Boxes 11-1, 11-2 of class six).



राष्ट्रगान

जन–गण–मन–अधिनायक जय हे।
भारत भाग्य विधाता।।
पंजाब सिंधु गुजरात मराठा।
द्राविड़ उत्कल बंग।।
विंध्य हिमाचल यमुना–गंगा,
उच्छल जलधि तरंग।।
तव शुभ नामे जागे,
तव शुभ आशिष माँगे।।
गाहे तव जय गाथा।।
जन–गण–मंगलदायक जय हे,
भारत भाग्य विधाता।।
जय हे, जय हे, जय हे,
जय जय जय जय हे।।