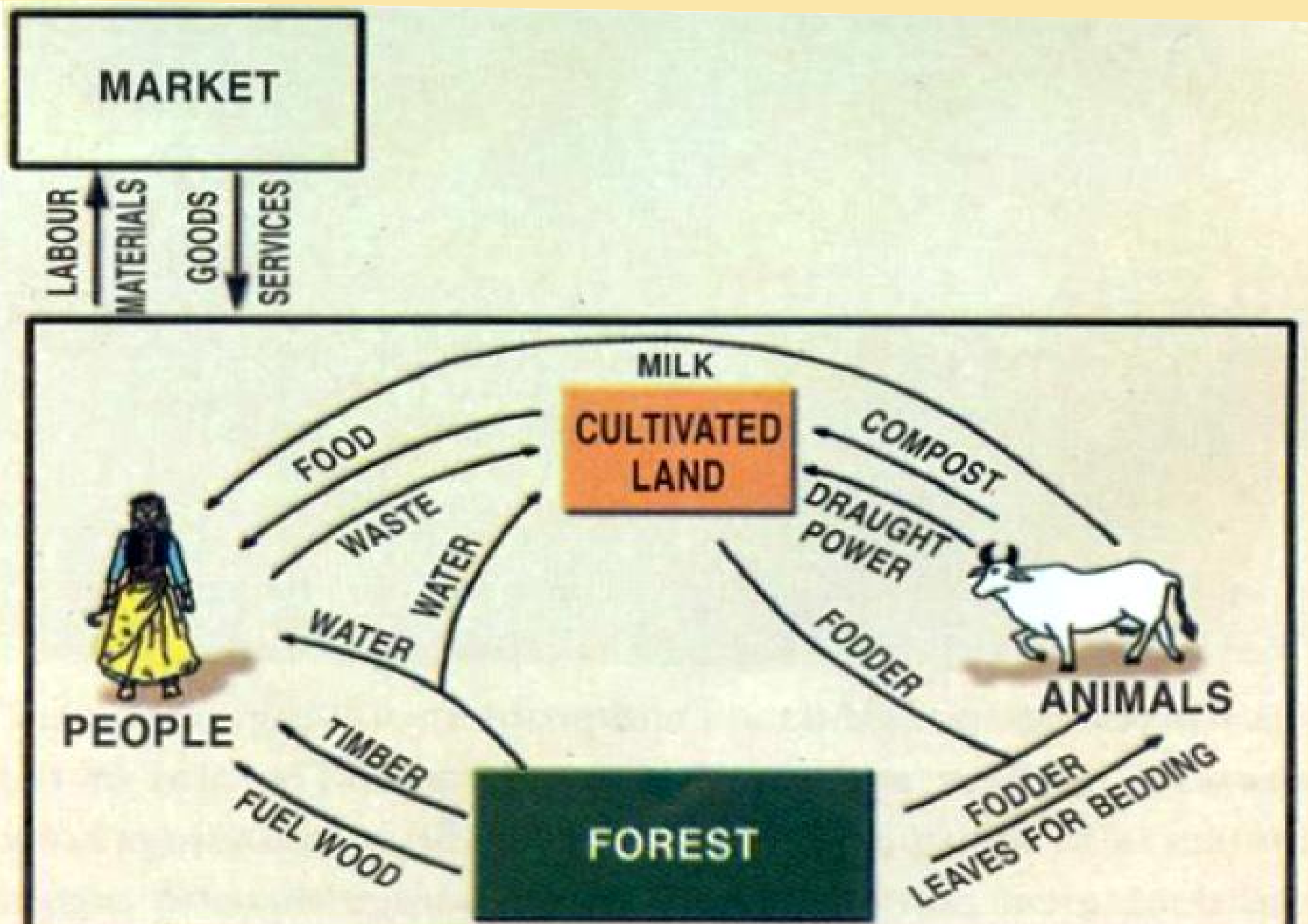
OUR LAND, OUR LIFE

Class 9



A VILLAGE ECO-SYSTEM

Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan

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 Nine

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

Conception	:	Sri Madhav Ashish Mirtola Ashram
Course design	:	M. G. Jackson
Workbook writing	:	M. G. Jackson, G. P. Pande, Suman Pande
Support	:	Lalit Pande, Krishan Singh Suyal, Deevan Nagarkoti, Anuradha Pande, Anjali Punera, Satish Datt Pande, Shri Kant Joshi, Naveen Chandra Kabadval; Mirtola Ashram, Gandhi Intermediate College and Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan
Illustrations	:	Chandra Shekhar Tiwari, Dhruv Joshi, Deepa Balsavar, Nita Gangopadhyaya, Deepa Pant, Kevin Maddison, Mohammad Salim, G.P. Pande
Additional Support	:	J.S. Gill, Sri Dev Ashish, Anil Bordia, J.C. Pant, G.K. Arora, Mahesh Chandra Pant
Administrative support	:	Education Department, Government of India and Education Departments, Uttar Pradesh and Uttarakhand
Financial support	:	Education Department, Government of India and Sir Dorabji Tata Trust, Mumbai
Thanks to	:	Officers of Education Departments, principals, teachers, students and guardians for valuable suggestions and support

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)

CONTENTS

Page No.

Page No.

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 nine, all exrcises except 37 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 : People 2
Month : April

EXERCISE 37

POPULATION STUDY PROBLEMS

INTRODUCTION

In our village ecosystem we see many types of plants, animals and decomposers. Everywhere we look we see populations of species either increasing or decreasing in size. Occasionally we see a population that seems to be constant in size. The human populations of most villages, for example, are increasing year by year, while the populations of trees in their village are decreasing. Is there a relation between these two tendencies? How can tree population be increased, and stabilised?

In this exercise we will study how populations increase and decrease, and what influence one population exerts on another.

REQUIREMENTS

1. Whole rice grains – a handful

PROCEDURE

1. Suppose there is a population of annual plants that doubles in size every year. In year one there is one plant. Calculate the population every year up to the 24^{th} year. Write the numbers in the appropriate space in Table 37-1
2. Now let each plant be represented by one grain of rice. Place the appropriate number of rice grains within each rectangle. The grains must be placed within the rectangles and must not be piled one on top of another. Begin with the rectangle for year one, and proceed to year two, three etc. In doing this what do you observe? What does this mean for a population of plants?

____

____

____

FOR THE TEACHER

Take up Box 37-1 after doing this exercise.

Table 37-1. Numbers of plants in a population from year one to year 24

Year 1	Year 2
Year 3	Year 4
Year 5	Year 6
Year 7	Year 8
Year 9	Year 10
Year 11	Year 12
Year 13	Year 14
Year 15	Year 16
Year 17	Year 18
Year 19	Year 20
Year 21	Year 22
Year 23	Year 24

3. Here is a very old and famous puzzle. Imagine a pond, such as one finds in many villages. Further, imagine a single lotus leaf on the surface of the pond. Every day the number of leaves doubles. That is, on the first day there is one leaf. On the second day there are two leaves, on the third day four, and so on. If the leaves cover half the surface of the pond in 29 days, when will the entire surface be covered? Check your answer with your teacher.

   Answer: ....

4. Imagine a new village where no one lives. An old man and his wife settle there along with their two sons, two daughters-in-law and eight grandchildren. Assume that one generation is 20 years. All people marry, and each couple has four children, two boys and two girls. The girls marry and leave the village at age 20, and two girls come in marriage from other villages. Old people die at age 60. Calculate the increase in population and write the figures in Table 37-2.

Table 37-2. Number of people in the village from the present to year 100

Year	Children	Parents	Grand parents	Total
Today	8	4	2	14
20				
40				
60				
80				
100				

5. In the village of problem four, suppose that each person requires, on an average, 1000 kg or 10 quintals, of fuelwood per year. The tree population of the village can provide 1000 quintals of fuelwood per year without decreasing over time. How many people can the village support in terms of the number it can provide with fuelwood? Calculate the answer and enter it in the space below. This number is termed the 'carrying capacity' of the village ecosystem for people in terms of fuelwood.

   Answer: ....

Approximately how many years from now would the human population of the village exceed its carrying capacity for fuelwood? What do you think will happen after that?

6. Suppose that in problem 4 above the people in the village decide in year 40 that in future each couple would have only two children instead of four. Calculate the size of the population in the subsequent years.

Year	Children	Parents	Grand parents	Total
Today	8	4	2	14
20	16	8	4	28
40	32	16	8	56
60				
80				
100				

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

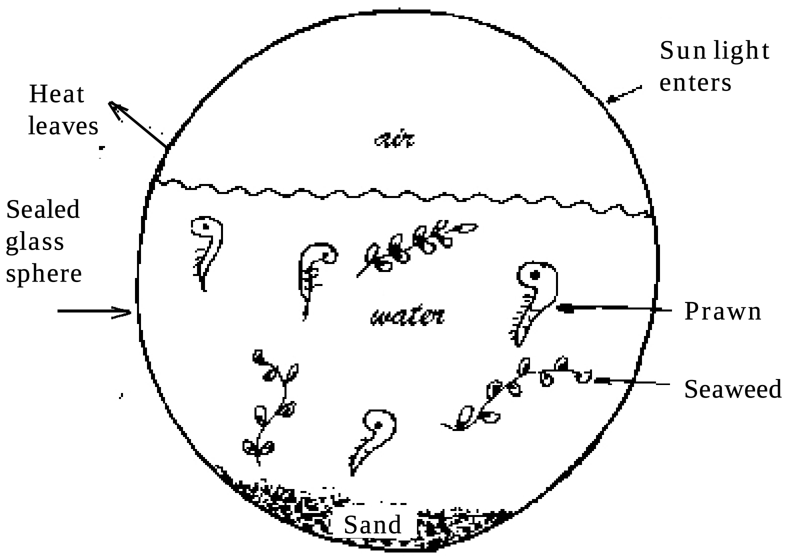
Date:...................

Box 37-1

ECOSYSTEM EARTH 1. A MODEL

A model is a man-made representation of a real entity designed to show its main features at a glance. It is an aid to understanding. A model may be physical, as the village map you made in Exercise 1 (Class VI), or graphic (drawn on paper) such as the diagram of ecosystem in Box 4-1.

A company in America makes a very instructive physical model of the global ecosystem. They begin with a clear glass sphere approximately 15 cm in diameter. It is hollow and there is a small hole at one point. A spoonful of sand is put inside the sphere and then it is filled 2/3rds full with salt water (to simulate ocean water). Eight or ten prawns (a small sea animal) are added and finally a few pieces of green seaweed. The sphere is then sealed by passing the flame of a glass-blower's torch once over the hole. The only thing that enters the sphere after that is sunlight and the only thing that leaves is heat. It must be exposed to the sun every day and also kept in darkness for 12 hours or so. It must be kept at a comfortable temperature and must not be shaken about. If all these things are done, the eco-sphere, as it is called, usually stays alive indefinitely, that is, the prawns and the seaweed reproduce continuously.



The eco-sphere is about the simplest physical model that can be made of an ecosystem in general. It contains all the essential elements of any ecosystem — sand (source of minerals), water, air, animals, plants and sunlight. It also contains decomposers — bacteria and fungi (introduced along with the added seaweed and prawns). As a general model it can represent any ecosystem on earth. However, it is most valuable as a model of the earth as a whole. The contents of the eco-sphere are completely isolated by its surrounding glass in the same way that the contents of ecosystem earth are isolated by the empty space that surrounds our globe.

The eco-sphere model helps us understand many aspects of ecosystem earth. For example, it helps really to understand that there is a limit to the number of people the earth can support and also what will happen if population exceeds that limit. In a newly-made eco-sphere the prawns and the seaweed multiply. But after some time, in a healthy eco-sphere, the populations of both stabilise and an equilibrium is reached. How is this stabilisation of populations achieved? How is the equilibrium maintained? Let us suppose that the population of prawns increases so much that there develops a shortage of food (seaweed). The prawns become malnourished. This causes a reduction in their fertility (i.e., delayed maturity, long reproductive cycles and, in some individuals, sterility). It also leads to the death of weaker individuals who are no longer able to resist various diseases. Maybe the stronger individuals prevent the weaker ones eating. In these ways the size of the prawn population is constrained by the supply of food. The average number of prawns, as determined over a fairly large number of generations when the ecosphere is an equilibrium, is the carrying capacity of the eco-sphere for prawns.

If the prawn population exceeds the carrying capacity both prawn and seaweed populations crash. They may recover and reach an equilibrium state. This is, however, not certain; some eco-spheres die when natural processes fail to maintain equilibrium.

We can be fairly certain that, if the human population exceeds the carrying capacity of the planet earth, people will die of starvation, disease and probably war. But human beings have the possibility of voluntarily limiting their numbers to keep population within the carrying capacity limit.

Date: ....

Code : Animal 2
Month : May

EXERCISE 38

DOMESTIC ANIMAL POPULATIONS OF OUR STUDY VILLAGE 1

INTRODUCTION

Cattle, buffaloes, bullocks and goats are the main animal populations in our village. In some villages chickens, pigs and horses are also found, but their numbers are small.

The purpose of this exercise is to estimate the populations of animals found in our study village.

Since animal population size varies from one time to another it will be necessary to repeat this exercise in the months of August and December (Exercise 43 and 47).

FOR THE TEACHER

Take up Box 38-1 and 38-2 after completing this exercise.

PROCEDURE

1. Visit your assigned household and request the members to tell you the numbers of different types of animals they have.

   Record the numbers in Table 38-1.

Table 38-1. Numbers of different types of animals in your assigned household on the day of your vosit

Type of Animals	**Number**
Cows	
Cow calves	
Bullocks	
Buffaloes	
Male buffaloes	
Buffalo calves	
Goats	
Sheep	
Pigs	
Chickens	
Horses	

Note: A cow is a female that has calved at least once. Similarly for a buffalo. A bullock is male that has begun to work.

Copy these data in Table 38-2 in the appropriate column and row. Exchange the data with other teams. Complete the Table 38-2 by calculating totals and averages.

Table 38-2. Average number of different types of animals per household on the day of your visit

Team No.	Number of animals										
	Cows	Bullocks	Cow calves	Buffaloes	Male buffaloes	Buffalo calves	Goats	Sheep	Pigs	Chickens	Horses
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Total											
Average											

QUESTIONS

Ask the members of your assigned household the following questions and record their answers below.

1. Do you have any cross bred cows? If yes, write their number and the number of *desi* (indigenous) cows in the spaces given below.

   Number of *desi* cows = ...

   Number of crossbred cows = ...

   Total number of cows = ...

   The total number of cows shown here should be the same as in procedure 1.

2. Are crossbred bullocks used for draught? After discussing the management and performance of crossbred cows and bullocks with the members of your assigned family, list the advantages and disadvantages of crossbreds in relation to *desi* cattle and buffaloes.

3. Do you have a tractor? If not, are you hiring a tractor for ploughing?

4. How is a tractor more useful than bullock? Do bullocks have any advantages over tractors?

5. Are there any cattle or buffallo bulls kept in your study village for breeding purposes? How many? Who keeps them? On what basis is breeding service available to other households?

6. Do you also keep chickens? How many? describe their feeding and management.

7. How do you treat sick animals?

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

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

BOX 38-1

THE ROLE OF DOMESTIC ANIMALS IN THE VILLAGE ECOSYSTEM

Domestic animals play an important role in keeping our village ecosystem healthy and productive. They produce vital foods for the human population of the village – milk, meat, eggs – and provide draught power for cultivating the land and transporting materials. To do this they eat crop residues, green tree fodders, and green grasses. Thus animals have definite functions in our village ecosystem and they have a unique food supply.

Also, there is not just one function and one food supply for all animals, but different functions and food supplies for different species. We can define 'place' in the ecosystem in terms of food supply and function. In each region of our country specific breeds of each species

of animal have evolved to fill the ‘places’ of the village ecosystems of that region. This species diversity and village adaptation is essential for ecosystem health.

Cattle, buffaloes and goats eat crop residues, green tree leaves and grass as fodder. They also eat fodder crops like *berseem*, sorghum, maize and cowpeas that we grow especially for them. However, these crops, particularly the legumes (e.g. *berseem*, cowpeas, *acacia, babul, subabool, basna*), are anyway needed to keep our ecosystem healthy because they give high quality compost and mulch to feed the soil. They contain more nitrogen and mineral nutrients than the residues from crops grown primarily for human consumption.

Now let us look at animal places in our village ecosystem in more detail.

First, in terms of food supply: The main catogories of foods and types of animals particularly suited to utilise them are as follows:

Crop residues	–	cattle and buffaloes
Green fodder crops, green grass and green tree leaves	–	goats and horses
Human food processing residues (wheat bran, oil cake, rice bran, husk of pulses), damaged food grains and kitchen waste	–	chickens and pigs
Water plants in village pond	–	fish

This is not a very strict classification. For example, cattle and buffaloes also eat green fodder, and indeed they must get some amount of these if they are to be healthy and productive. They are the only animals which eat a significant amount of crop residues. Again, the food of chickens and pigs can be fed to all the other animals, and indeed they are, but are not necessary for them; all the other animals are basically fodder eating animals, whereas pigs and chickens cannot digest fodders. The special place for chickens and pigs is that they can give us more food (in the form of meat and eggs) than cows and buffaloes and goats can give us (in the form of milk and meat) from one kg of chicken and pig food.

Second, in terms of services they perform in the ecosystem

Milk production	–	cows, buffaloes, goats
Draught power	–	bullocks, male buffaloes and horses
Meat	–	goats, chickens, pigs and fish
Eggs	–	chickens

To this list we can add ducks (meat, eggs), rabbits (meat, wool) and sheep (meat, wool).

Here we can also mention domestic bees, though they are insects and not animals. Their food is the pollen and nectar of flowers and their ecosystem function is to pollinate our crops. (See Box 20-1, 'Vegetable seed harvesting and storage').

It will seen that both cattle and buffaloes fill the same niche in our village ecosystem since both species provide milk and draught power. But the two species really differ from each other. Looking at all the buffalo and cattle breeds in the world, we find that no one breed can provide animals that are good at producing milk and providing draught power. They can do only one of these well. In India almost all breeds of cattle have been developed into good draught animals (e.g. Haryana). The cows of this breed do not produce much milk, though of course they do produce some. A few breeds, like Sahiwal and Sindhi, are good milk producers but the bullocks of these breeds are bulky and slow. European breeds like Jersey and Freisian are specialised milk producing breeds; again, their bullocks, or even the bullocks from crossing them with Indian breeds, are not good for draught. In addition to this, crossbred cows are not well adapted to our village ecosystem. They are more susceptible to diseases like foot and mouth disease than indigenous breeds. They require expensive medicines and some families even provide them fans to keep them cool. If they give more milk than buffaloes, they give extra expense also.

Thus in our country we keep cattle primarily for draught. The cows are kept primarily to produce bullocks. When we want good milk producing animals, we keep buffaloes. Indian buffalo breeds have been developed for this purpose. Buffalo bullocks are bulky and sluggish, not good for ploughing, though they are used to pull two-wheeled carts.

BOX 38-2

GOBAR GAS PLANT

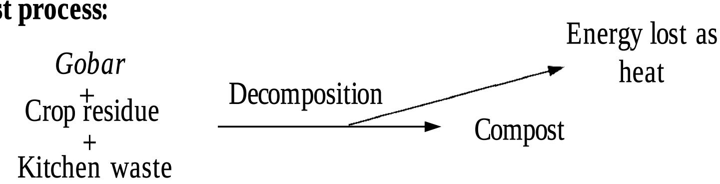
We have learned in Box 4-1, that when there are no trees in our village ecosystem we are forced to burn dried *gobar* (animal dung). Doing this reduces the amount of compost for our fields, and this means lower yields of crops. When we use chemical fertiliser in place of compost, problems have occurred. We decided that the only way to keep our soils healthy and productive is to grow trees for fuelwood, thus saving all *gobar* for compost making.

Of course, we can buy kerosene or gas to meet our fuel needs, but these cost a lot of money.

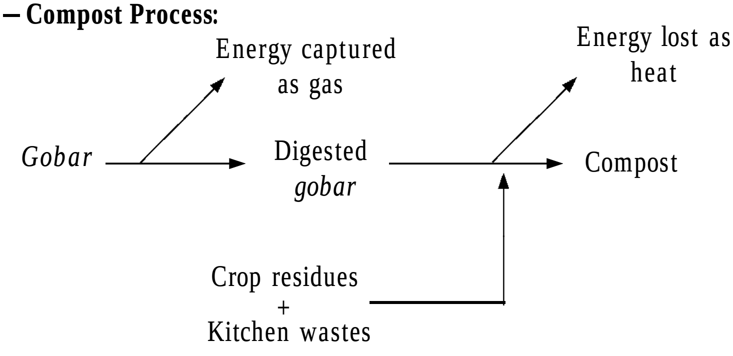
Actually there is another way to save *gobar*. If we put it in a *gobar* gas plant it will ferment to produce gas that can be used for cooking (and also for lighting). Afterwards the fermented *gobar* is put into a compost pile with crop and other wastes. Thus we can 'burn' the *gobar* and make compost out of it as well!

The following diagrams show how this is possible:

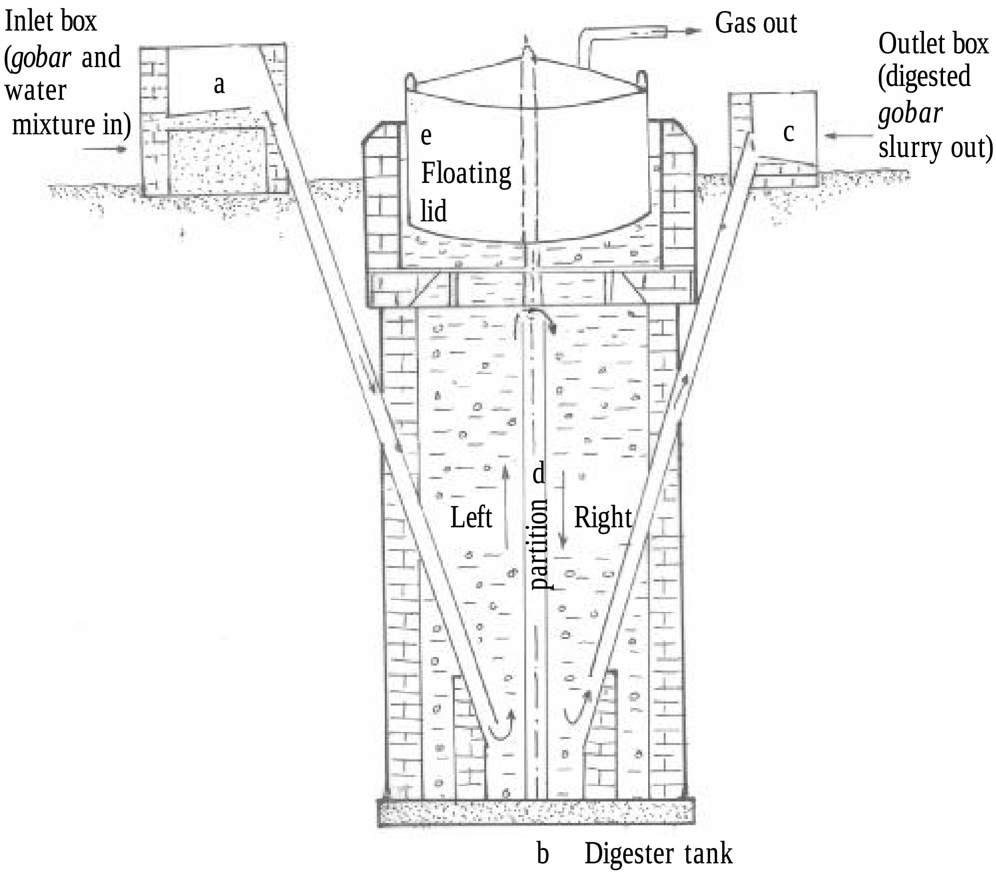
Usual compost process:



***Gobar* Gas – Compost Process:**



The next diagram shows how a *gobar* gas plant works:



Every day *gobar* is mixed with an equal volume of water and put into the inlet box (a). From there it goes to the left-hand side of the digester tank (b). This forces some of the mixture already in the tank to come out from the outlet box (c). The flow of the *gobar* plus water mixture is shown by the arrows. Fresh mixture cannot go directly to the outlet because of the partition wall (d) across the middle of the tank. It takes *gobar* + water mixture about 50 days to traverse the tank. During this period it is fermented by bacteria to give methane gas (CH_4) which collects under the floating lid (e). From the lid the gas is taken by a pipe to the kitchen where it is burned in a *gobar* gas *chulha* (stove). The gas can also be used in a mantle-type pressure lamp for lighting.

The size of the *gobar* gas plant is determined by the number of animals a household has. If a household of five to seven members has five to six animals (cattle and buffaloes of all ages) about 50 kg *gobar* per day will be produced. For this much *gobar* a biogas digester tank of two cubic metres capacity is needed. This will give enough gas for the family's cooking needs. A one-cubic-metre plant is needed if there are two to three animals; in this case the gas would not be enough and would have to be supplemented by fuelwood.

Gobar is fermented by bacteria within a definite temperature range (about 30-50 degree centigrade), and as a result, gas is produced. If the temperature is less than this the amount of gas produced per day will be less. In the summer, the maximum amount of gas is produced per day because bacteria are active at this time. In the winter gas production is very slow and may even stop.

The outlet from a sanitary latrine can also be connected to the *gobar* gas plant. Human waste can in this way be cleanly converted into gas and slurry for compost making.

If a *gobar* gas plant is constructed and operated properly there are no bad smells or flies.

Date: ....

Code : Fodder 2
Month : May

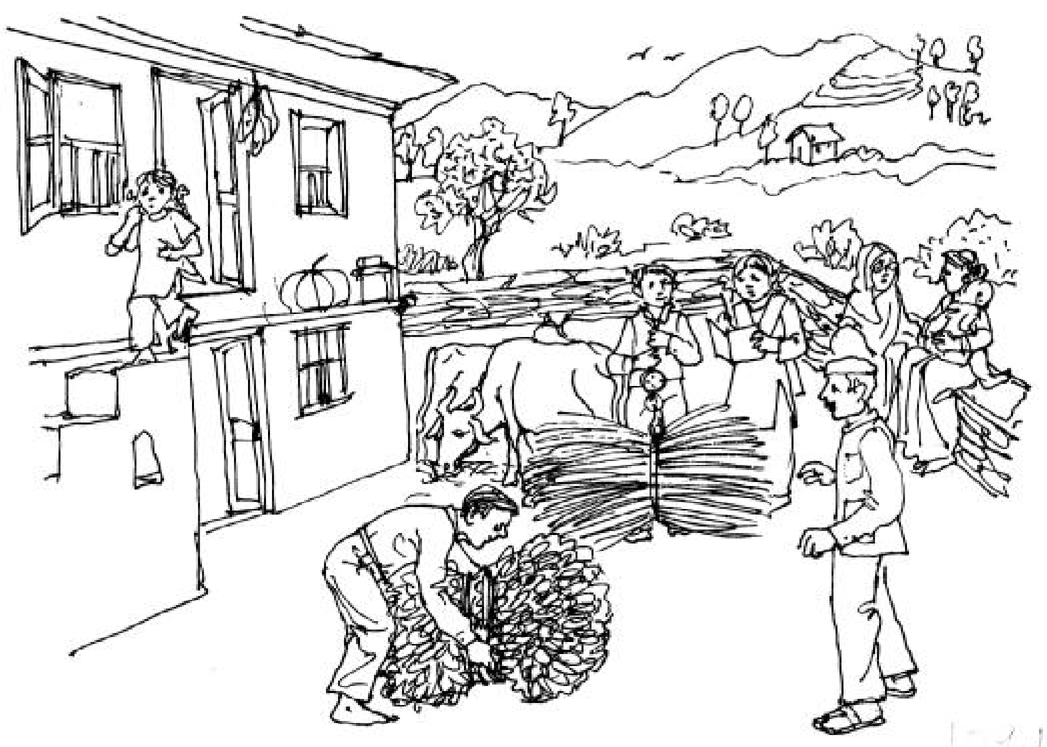
EXERCISE 39

ESTIMATING FODDER CONSUMPTION 1

INTRODUCTION

Fodder is food for our animals. When eaten and digested by them it provides the energy and nutrients to produce work, milk and meat. The undigested part of the fodder, dung and urine, is food for our soil, which enables it to produce food for us.

The purpose of this exercise and of Exercises 43 and 47, is to estimate the amounts of different types of fodder consumed by an average household



FOR THE TEACHER

Take up Box 39-1 and 39-2 before takingup the exercise.

of your village. You will weigh the amounts of fodder fed to animals in your alloted household on one day in each of three different seasons, as follows:

Summer (hot, dry season) (May)	-	Exercise 39 (this exercise)
Wet season (August)	-	Exercise 43
Winter (Cold, dry season) (December)	-	Exercise 47

Later, in Exercise 58, you will average the figures for these three days and assume that the average obtained represents the true average consumption of fodder for one day in the year by the animals of your assigned family. The figures from all ten teams will then be averaged to get the average consumption for one day all the households in the village.

REQUIREMENT

Spring balance, 50 kg - two to be shared among teams

PROCEDURE

1. Visit your team's assigned household and weigh all the fodder that is fed to their animals on that day. Not all the day's fodder will be fed during the period of your visit. Weigh whatever is offered to the animals at that time and ask the members of the household to indicate the amounts that were fed before you arrived, and that will be fed after you leave. Weigh/estimate these amounts also. Record these weights below.

   Green grass = ... Kg

   Dry grass and straw = ... Kg

   Green tree leaves = ... Kg

   Green fodder crops = ... Kg

   Notes

   1. Green grass is grass harvested while it is still growing.
   2. Dry grass is harvested when the grass has become mature and produced seeds. Straw is what is left after threshing grain (wheat, paddy, *maudua, madira* etc.) including the chaff.
   3. Green fodder crops are *berseem*, lucerne, cowpea, oats, maize, sorghum and sugarcane tops.

2. Transfer your data to the appropriate line of Table 39-1. Share your data with other teams and complete Table 39-1.

Table 39-1. Average amount of different fodders fed per household (May)

Team number	Green grass	Dry grass and straw	Green tree leaves	Green fodder crops
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				
Average				

QUESTIONS

Ask the members of your assigned household the following questions and record their answers in the spaces provided.

1. Which animals are fed entirely on cut grass or green fodder crops? How many are there of each?

Type of animal	Number
Cow, Dry	....
Cow, milking	....
Bullock	....
Cow calf	....
Buffalo, dry	....
Buffalo, milking	....
Buffalo calf	....
Goat	....
Sheep	....
Other (Specify)	....

2. How many of the animals of the household were sent for grazing on the day of your visit?

Type of animals	Number
Cow, dry	....
Cow, milking	....
Bullock	....
Cow calf	....
Buffalo calf	....
Chickens	....
Goat	....
Sheep	....
Horse	....

Note :

The total numbers of each types of animal in each category in questions 1 and 2 should be same as determined in Exercise 38. If they are not, why not?

3. Were any of the animals mentioned in the answer to question 2 also given fodder at stall? Which ones? Approximately how much was given?

4. Where do the animals of the village graze in this season?

5. Do they feed all their animals with the same proportions of fodders or do they give good quality fodder in relatively larger amounts to particular animals? Which fodder and which animals? Why and how much?

6. Aside from fodder, do they give mixed feed (*chata*) to their animals? Which animals, when and why?

7. What are the ingredients of the mixed feed? Which of these are purchased from the market and which are produced in the village ecosystem?

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

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

BOX 39-1

LET US TALK ABOUT ANIMAL FODDER

Some fodders are better than others. In general we can classify them as fallows.

High-quality : *Berseem*, lucerne, cowpeas, hemp , oats , most tree leaves, and grazed green grass

Medium quality: Green sorghum, maize, green sugarcane leaves and some tree leaves like banj

Poor-quality : Wheat straw, paddy straw, sorghum/millet straw

Within each category, some fodders are better than others. For example, *berseem* is usually better than oats, *shahtut* leaves are better than those of *jamun*. Maize is usually better than sorghum fodder, wheat straw is better than paddy straw. Also, wheat straw from old, tall varieties of wheat is usually better than that from dwarf varieties.

What do we mean by 'good' and 'poor' quality in fodders?

First of all, a good quality fodder is one that contains a large amount of energy and all the nutrients animals need like protein (made from nitrogen and glucose), minerals and vitamins (Box 16-3, 'Trees and their food').

Second, whatever its nutrient content, if animals do not like it, then we cannot say that it is a good-quality fodder. For example, *neem* leaves, though of medium quality, and readily eaten by goats, are not much liked by cattle.

Third, a fodder may be nutritious and well liked by animals, but contain a toxic substance. *Subabool* is an example here. Its energy and nutrient contents are high and is relished by animals. If not more than 10 kg is fed daily to an adult cow, bullock or buffalo, it is a valuable fodder; if fed in larger amounts than this it will make animals sick.

Fourth no fodder, even the best, is good when given as the sole feed. Thus *berseem*, the best of all fodders, will upset a buffalo's or cow's stomach (loose motions) unless it is mixed with a small amount of medium or poor-quality fodder.

Finally, the energy and nutrient contents of green fodders is not constant througout the season or year. The first two or three cuttings of *berseem* are very nutritious, but later cuttings become hard and low in nutrients as the weather becomes warmer in the spring. Tree leaves are generally best in quality when they first appear, and then decline steadily until it is time for them to drop off the tree naturally.

The importance of green fodder

If animals are given only poor-quality fodder to eat, they will become weak and eventually die. These fodders do not give enough energy and nutrients to maintain life. If we give animals a small amount of good-quality fodder, like *berseem*, in addition to as much poor-quality fodder (say paddy straw) as they can eat, they can survive and remain reasonably healthy but cannot produce much milk or work. An example of this would be 10 kg *berseem* + paddy straw/or other dry crop residue for an adult buffalo/cow/bullock.

On a diet of medium-quality fodder, an adult animal can survive and be healthy and produce a little milk (two to four litres/day) or do a little work. (Not a full day's ploughing). When good quality fodders are the main feed, animals can produce four to eight litres milk per day and do nearly a full day's work without losing weight.

If we have buffaloes or cows able to give more than eight litres of milk per day, we must also give them some feeds like grains, oilcakes, wheat bran, rice bean, husk of pulses. A mixture of these with added salt at the rate of one percent of the weight of the mixture is very good (see Box 38-1). These feeds are concentrated sources of energy and nutrients.

If we do not have any green fodder (good or medium-quality) but only poor-quality dry fodder, we can give them concentrated feeds to keep them reasonably healthy. In the long-run, however, animals require at least a little green fodder to remain healthy and survive – say at least 5-10 kg/day for an adult cow/bullock/buffalo.

Young animals of cattle and buffaloes also need at least medium quality with some amount of high-quality fodder to grow up to become healthy, productive adults.

A family which grows two crops a year, one in *kharif* and one in *rabi*, generally has the following fodders available at different times of the year.

August to October	–	Green grass, sorghum fodder
November and December	–	Paddy straw, wheat straw, green sugarcane leaves
January to April	–	*Berseem*, green sugarcane leaves, paddy straw, wheat straw
May to July	–	Wheat straw, paddy straw

The nutrition of the animals of this family will be poor at two times of the year November and May-July. In these two periods there are no high-quality fodders. As a result, the milk yield of cows and buffaloes falls at these times.

Growing summer (March to June) fodder crops of maize, cowpeas or hemp can provide green fodder during the period May to July. For such crops there must, of course, be enough irrigation water. For the period November and December, fodder trees are the only satisfactory source of good-quality fodder. They are also a good source of high-quality fodder, often the only possible source of such fodder, during the summer (May to July). Here is another example of the complimentary roles of trees and crops in our village ecosystem.

BOX 39-2

MANGERS

In most households much fodder gets wasted because it is placed on the ground for animals to eat. While they eat they also trample some of the fodder under foot, soiling it.

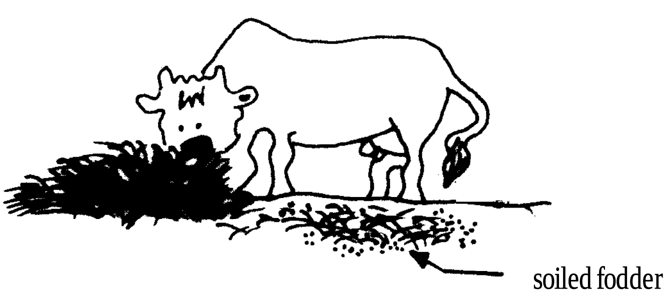
Of course, even soiled, uneaten fodder cannot be said to be entirely wasted. It goes into the compost pile. However, we get more benefit from fodder if it is first eaten to produce milk or draught power and then the residue — dung — goes into the compost pile.

A manger is a box into which an animal's fodder is placed. The fodder stays clean and the animal eats it all.

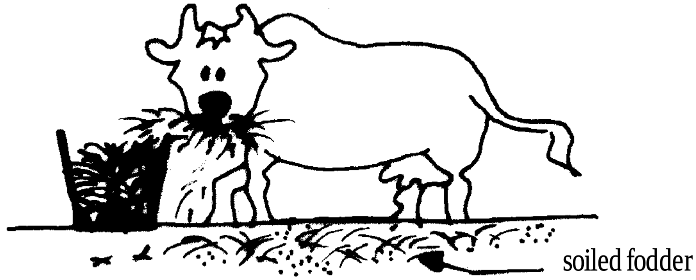
The simplest mangers are wooden packing cases or half oil drums. However, to prevent wastage with these mangers the fodder must be chaffed — for the reason we shall see in a moment. Chaff cutters are expensive to buy, and chaffing fodder is hard work. In this box a non-waste manger is described in which long fodder can be fed.

Since the exact size and design of the non-waste feeding manger will be different for each house, no single plan can be given that will be suitable for everyone. Therefore the plan shown here is just an example. You will have to make your own plan. In order to do so, it is essential that you understand the principles involved. These are as follows:

1. When fed on the ground much of the fodder gets trampled under foot and mixed with dung and urine.

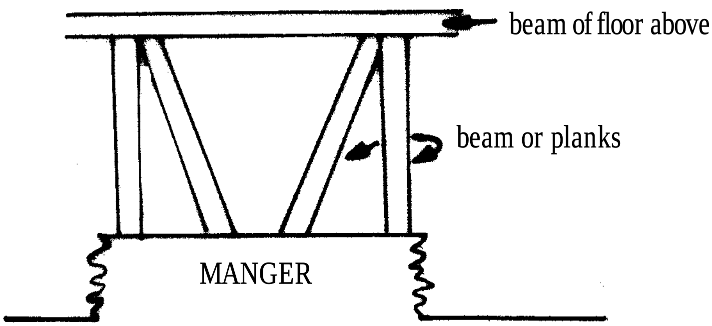


2. If fodder is fed in a packing box or a half oil drum, but without chaffing, then, too, much of it gets wasted.



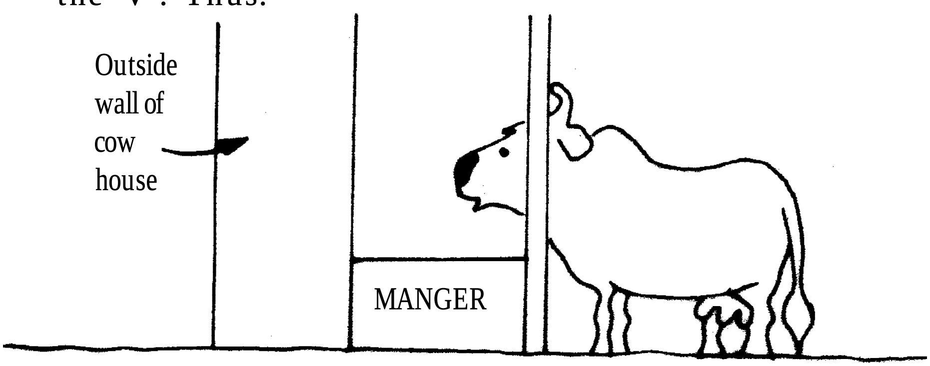
When the animal lifts her head and steps back some fodder, falls from her mouth to the ground and then gets soiled.

3. If we make a manger of this design in the cowshed, the animal cannot pull the fodder out and drop it on the floor.

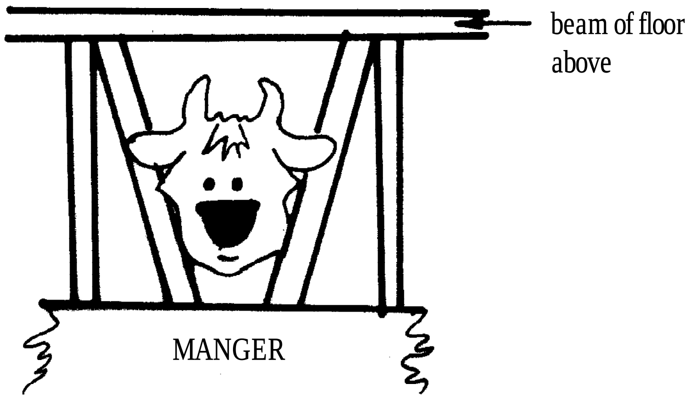


Front view of manger

To understand why an animal cannot spill fodder from this manger we will have to watch how she eats from it. You see that she must put her head into the manger through the 'V' shaped opening. But she can do so only at the upper part of the "V". Thus:

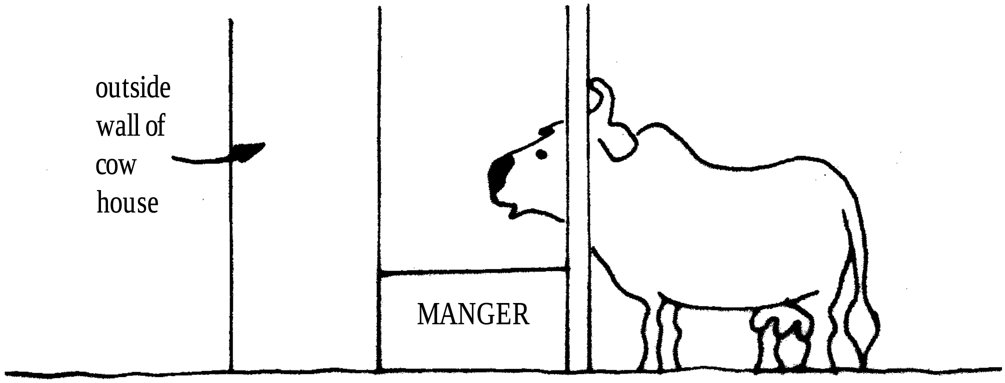


We can see this more clearly if we look at the manger facing the animal. We can see that her head cannot pass through the lower, narrower part of the 'V'. In fact, the bottom of the 'V' is wide enough only for the animals neck, which is much thinner than her head. So, only after putting her head through the upper, wider, part of the 'V', and then lowering it, can she reach her fodder and begin to eat.

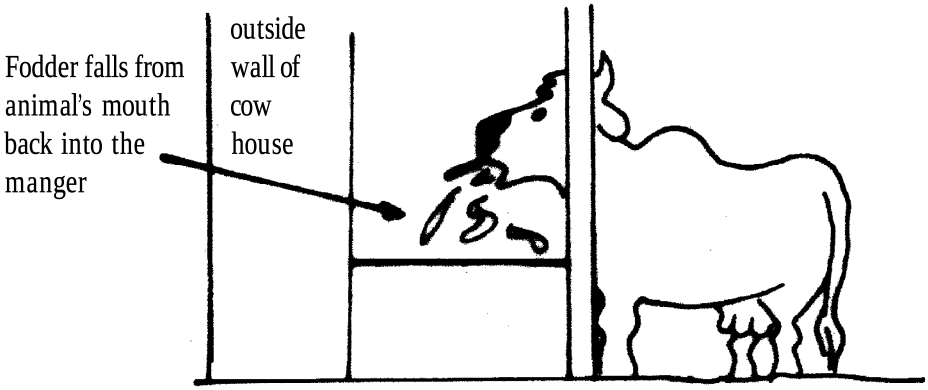


View facing the animal

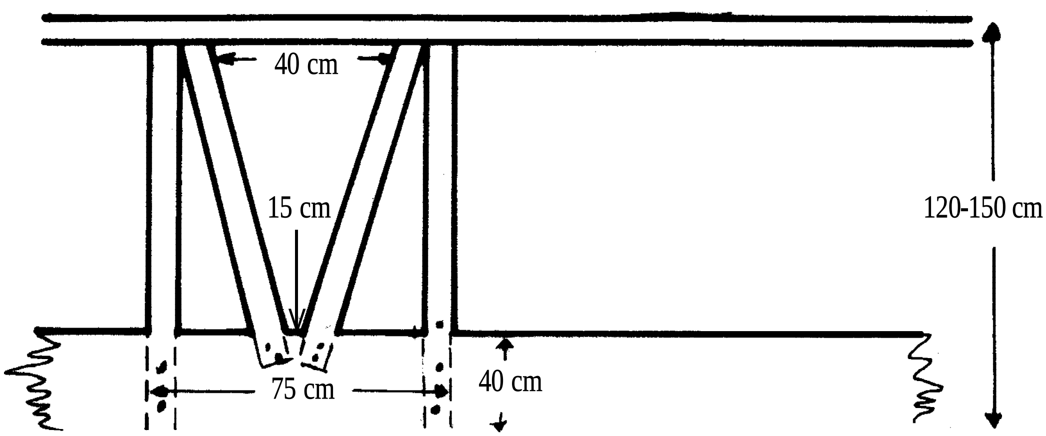
Here we see her eating her fodder.



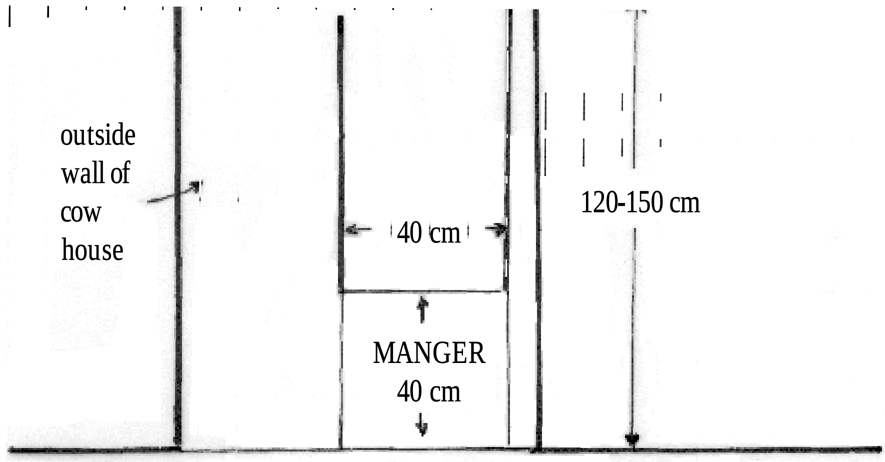
In order to take her head out of the manger the animal will have to lift it up again to the top of the 'V'. In doing so, she drops any fodder in her mouth back into the manger, thus:



Now we come to a sample design. All dimensions given are approximate. For example, a buffalo requires larger dimensions than a cow or a bullock.



a. Front view



b. Side view

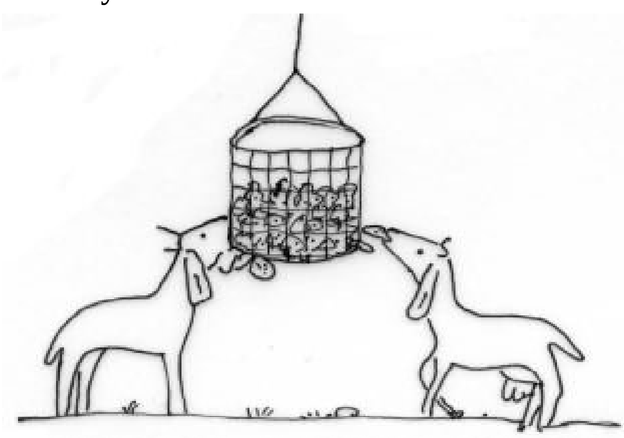
Do not worry too much about animals' horns; if they are too widespread, the animal will learn to twist its head while putting it into the manger.

Round poles can be used for construction if sawn ballis are not available. Also rough, used planks and ballis can be used.

It is suggested that, since there will be several places at the manger, the places at one end of the cow house be made bigger for bigger animals, and smaller at the other end for smaller animals.

The drawings have all shown the manger built in the cow house. However, a manger this type may also be built in the courtyard where the animals are tied during the day.

It may also be noted that in the stall feeding of goats a non-waste manger is also a must. A suitable manger may be made from basket canes woven so us to leave 5 cm x 5 cm openings, and suspended by rope from the ceiling, as:



Date: ....

Code : Trees 9
Month : July

EXERCISE 40

TREE CARE - 2

It is July again, the month for extra work in taking care of the tree seedlings you transplanted in Exercise 16. Fill any gaps that may have occurred due to the death of saplings during the year. Weed the trees and repair the bunds around them. Cut any bushes that may have grown since last year. If you continue to cut these bushes, they will get weak and die. Their places will be taken by grass and the trees you have transplanted. Check walls and gulley plugs, and repair them if necessary.

FOR THE TEACHER

Take up Boxes 40-1 and 40-2 either before or after the exercise.

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

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

BOX 40-1

SPECIES DIVERSITY

In this box we continue our study of the ecosystem. An important feature of any ecosystem is how many different species of living organisms it contains, and what effect this has on its biomass production.

An ecosystem contains three broad categories of living organisms, namely, plants, animals and decomposers. These three are interdependent, no one of them could survive without the other two. The ecosystem as an entity could not exist without all three.

Each of these categories of living organisms is made up of many communities. Thus within the plant category we find communities of trees, shrubs, grasses, ferns, herbs etc. Even within each of these communities there are numerous distinct types — that is species. Why do we find so many communities within each category? If we examine each community within the category of plants carefully we will find that it has a unique function. And so it is with species within communities also. Some examples will make this clear. Plants are the primary food producers in the ecosystem, manufacturing plant biomass from carbon dioxide in the air, and water, nitrogen and minerals from the soil, with the energy of the sun. But no one community can fully utilise all the sunlight, water and nutrients that are available in the ecosystem. Consider the tree community. Trees are tall growing with all their leaves in their crowns. They intercept most, but not all, the sunlight that falls on the ecosystem. Some sunlight reaches the ground, even in a closed-canopy stand. Other communities of plants, small ones that grow on the forest floor, are needed to use the sunlight that filters through the tree canopy. In the absence of such communities, e.g., ferns, herbs, shrubs, less primary, or plant, biomass will be produced in the ecosystem each year.

If we look under the ground, it will be obvious that both trees and communities of low growing plants are needed fully to use all the available soil water, nitrogen and minerals. Trees are deep-rooted, while low-growing plants are shallow-rooted. The roots of these two types of plants do not compete with each other, but mainly occupy different zones in the soil profile. You encountered this idea earlier when reading about growing trees on terrace risers (Box 32-3).

In our discussion so far we discern the emergence of an important principle, namely, that the greater the number of species (i.e., the greater the species diversity) the greater is the annual biomass production. But before we develop this principle further, let us look at the matter, in our imagination, not from the standpoint of the ecosystem, but from that of the individuals of a particular species. They think to themselves: 'where is a suitable place for us to live'? What they mean is: where can we find a source of food (or raw material with which to make food) that is not being used by some other species. Thus ferns, for example, have found that there is a place for them to live in a closed-canopy forest on the forest floor. There is a special word used to denote 'a suitable place to live'. It is <u>niche</u>. Thus we can say that in a forest ecosystem there are many distinct niches. Each is occupied by a different species of organism. And each species has just those physical characteristics and behaviour patterns that make it possible for it to live in the particular niche in which we find it. Thus ferns have a low-growing form, a shallow root system and the ability to make their food from very little sun light.

In the foregoing example of a forest ecosystem we have distinguished two niches — one for tall-growing plants and one for low growing plants. In reality, the situation is much more complex. The diagram in figure 40-1-1 shows several, though certainly not all, niches for plants in a forest ecosystem. One niche is for very tall trees like oak, *utis*, *deodar*. Next in height are trees that are smaller and which can grow well in partial shade like *kafal* and *angyar*. Below these is a niche filled by shrubs like *guwiya*, *ghingharoo*, *ruvins*, *kilmoor* etc. Occupying a niche at ground level are grasses, ferns and herbs. Grasses and some herbs grow only where the tree canopy has opened, as where an old tree has died, or on cliffs where trees cannot grow. This is a different niche than the one occupied by ferns which can grow only in dense shade. There are often more than one species of similar plants, like say *angyar* and *kafal*, that appear to occupy the same niche. However you can be certain that there is some difference in the way each gets its food, however insignificant it may seem. As was said earlier, each species may be considered to occupy a distinct niche.

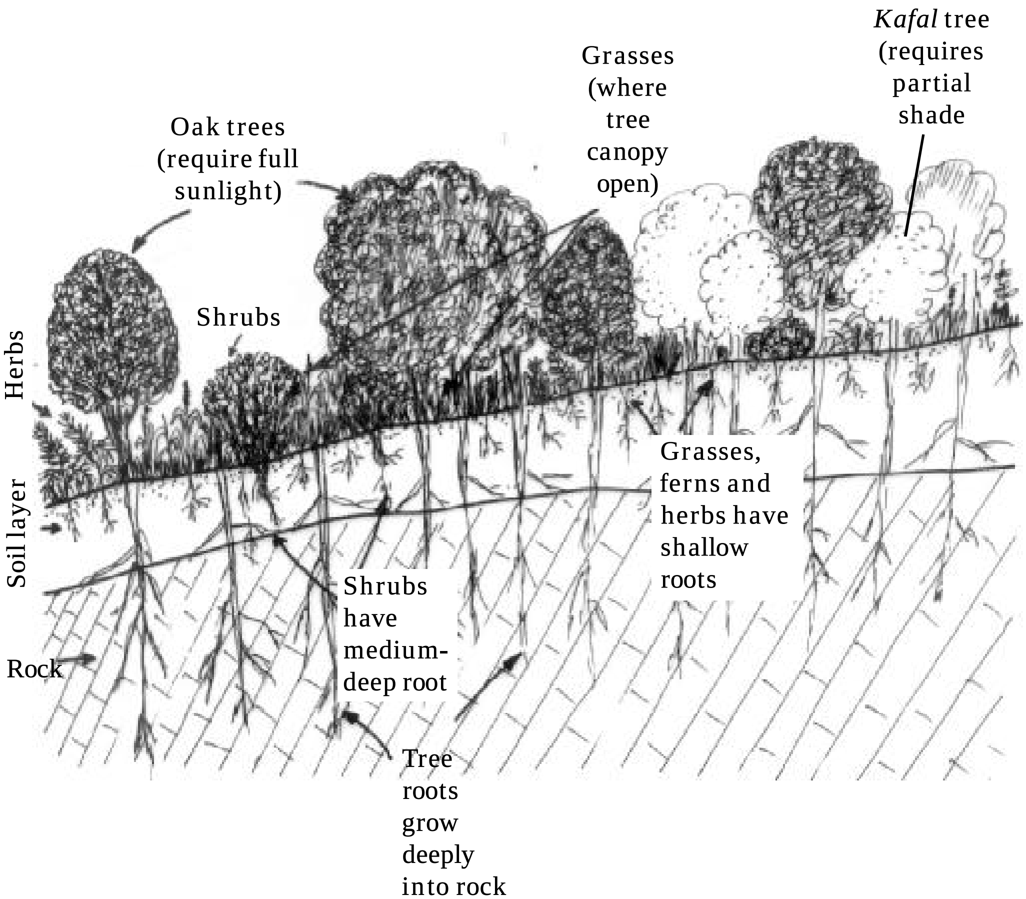


Figure 40-1-1. Diagram showing various plant niches in an oak-climax forest

The foregoing examples help us to understand why there are so many communities, and so many species within each community, living in a single ecosystem. Similar examples may be given for animals and decomposers. Thus there are niches for herbivorous animals (deer, leaf-eating insects like *kurmula* beetles) and for carnivorous animals like leopards, lizards and praying mantis). Large decomposers like slugs and earthworms eat dead leaves, and bacteria and fungi eat their faeces. A 'place to live', or niche, may also have a temporal dimension. For example, owls and hawks are both aerial predators living in the same ecosystem. Both catch and eat small animals, but one hunts at night and the other during the day, each make use of the food supplies available at those times (e.g., rats at night and lizards in the daytime).

As the broad categories of living organisms — plants, animals and decomposers — are mutually dependent, so too is each species dependent upon every other. We can also say that every niche represents a function which must be performed if the ecosystem is to be healthy and productive. For example, bees collect nectar as food, but in doing so pollinate the flowers they visit. The 'bee niche' is both 'a place to live' and an ecosystem function.

The first principle of species diversity may be stated as follows:

Principle 1. The greater the species diversity, the greater the total annual biomass production of an ecosystem.

Remember that the term 'biomass' means all living tissue, be it plant, animal or decomposer. Principle 1 refers to the total living tissue produced in an ecosystem in one year. Thus it is the sum of the tissue of all new organisms appearing during the year and the growth increment of all existing organisms. It is calculated in terms of dry-matter equivalent. Also remember that in an ecosystem in equilibrium the annual rate of biomass production is exactly balanced by the annual rate of decomposition.

The easiest way for us to verify principle 1 is to look at degraded natural ecosystems such as most of our village ecosystems presently are. As an ecosystem degrades many species die out. If the ecosystem is then rehabilitated, these same species reappear. These changes affect productivity. The Vivekananda Institute reports the following data for rehabilitating enclosed areas of degraded village support area near Almora. These areas were, of course, originally forest.

Block	Dry grass production, kg/nali/year	Number of species of plants
No enclosure	20	13
Two years protection	76	22
Long-term protection	112	38

(Note: The third block was being maintained as a *ghasni* and trees were not allowed to grow.)

Greater species diversity also results in greater stability of an ecosystem. Stability may be defined as the ability of the ecosystem to minimise the extent of year-to-year fluctuations in biomass production caused by fluctuations in weather, and by such disasters as disease and pest epidemics, fire and landslides. Take for example a landslide site. Both the slide zone and the debris fan at the bottom of it are rendered bare of vegetation. Subsoil is exposed which is devoid of humus. Trees cannot establish themselves in such soil. Other species of plants must colonise the site, build up the soil's content of humus and nitrogen and form a mat of decaying organic matter, and so make it possible for tree seeds to germinate and for the seedlings to survive and grow. In a healthy ecosystem all the species of colonising plants will be found, though they are not very numerous nor do they contribute much to the biomass production of the forest. These are grasses, annual broad-leaved plants, some types of herbs and leguminous trees and shrubs. *Utis* is a common coloniser of landslide debris fans — it takes nitrogen from the air by means of the mycorrhizal association on its roots (Box 26-1). The colonisers quickly revegetate the landslide site and pave the way for the return of the characteristic climax forest communities. The process is like the healing of a wound in the flesh of an animal. In this way species diversity contributes to the healing of the ecosystem and its speedy return to full productivity.

Another example: each species of plant is normally attacked exclusively by particular pests (e.g., leaf-eating insects) or diseases (e.g., leaf blight, stem rot). The severity of attack of these on any species is minimised if plants of this species are growing mixed with plants of other species which are not attacked by this particular pest or disease. That is, the pest or disease-causing organisms have difficulty in moving from one host plant to another as these plants are surrounded/separated by many plants of non-host species. Even then, epidemics do occur some times and all the plants of a host species may be destroyed. When this happens, plants of other, non-affected, species compensate the loss of biomass production by making use of sunlight, nutrients and water the affected plants are no longer able to use.

We can summarise what has been said in the foregoing two paragraphs by stating a second principle of species diversity.

Principle 2. The greater the species diversity, the greater the stability of the ecosystem. Greater stability further contributes to long-term average annual biomass productivity.

For a clear-cut illustration of the two principles of species diversity given in this box we can look at a field ecosystem. This was done in Box 31-1, which you can review.

BOX 40-2

ECOSYSTEM EARTH 2.
GLOBAL WARMING

An ecosystem, though a definite unit with clear boundaries, is not independent. There are flows of oxygen, carbon dioxide, water, minerals and energy into and out of all ecosystems. In a healthy ecosystem the outflows of these things is egual to the inflows. In this Box we are concerned with the inflow and outflow of carbon dioxide in particular. Thus we begin with the following fact:

1. An ecosystem in which biomass productivity is maximum and is neither increasing nor decreasing consumes as much carbon dioxide as it produces.

From this fact we deduce the following two further facts:

2. In such an ecosystem the amount of carbon contained in all the living organisms in that ecosystem remains constant. (Annual variations of course occur, but constancy is seen over longer time spans of decades or centuries.)
3. An ecosystem that is being degraded produces more carbon dioxide than it consumes, and its carbon content declines.

Since people began cultivating the land, more and more of the forest ecosystems of the world have been degraded. Six thousand years ago the Ganga basin, for example was entirely covered with thick forests of broad-leaved trees. As human population increased and more and more land was needed to grow food, these forests gradually disappeared. Two centuries ago Uttarakhand was covered with forest, but today less than one third of it remains, and what does remain is in general very thin. The process continues today around the world; the last great forests, those in Siberia, Canada, South America, Central Africa and Southeast Asia, are now being cleared to provide cultivated land and timber. We can reasonably say that ecosystem earth as a whole is being degraded by human activities. This means that ecosystem earth is producing more carbon dioxide than it consumes.

The eco-sphere forces us to recognise that the excess carbon dioxide produced by the planet must be accumulating within the planetary ecosystem — there is nowhere else for it to go. Careful measurements over the past 40 years or so reveal that this carbon dioxide is accumulating in the atmosphere. (Sea water does not absorb carbon dioxide above a certain limit). In 1700 the average level of carbon dioxide in the atmosphere was 280 parts per million (ppm) of air. In 1958 it was 315 ppm and in 1988 it was 350 ppm. At the present rate of increase it will probably be about 700 ppm by 2050. About one half of the increase since 1700 is calculated to be due to ecosystem degradation and one half to the burning of fossil fuels (coal, petroleum, gas).

Light from the sun passes through the earth's atmosphere without heating it. This light strikes the surface of the earth (land and water) and is converted to heat, warming the surface. The warm surface then radiates heat (infrared radiation) into the atmosphere. Infrared radiation however does not pass easily through the atmosphere. Carbon dioxide intercepts it and slows it passage, like a blanket slows the loss of heat from your body on a cold winter night. If there was no carbon dioxide in the atmosphere the earth would be freezing cold and no life would be possible. The more carbon dioxide there is, the warmer the earth's climate. This characteristic of carbon dioxide is often referred to as the greenhouse effect. A greenhouse has glass walls and roof. The sun's light enters, but the resulting heat escapes only slowly. The air inside a green house is warmer than the air outside. In cold climates plants can be grown in a greenhouse during the winter that normally only grow in the summer.

It has been calculated that the rise in atmospheric carbon dioxide content by the year 2050 will probably cause the average atmospheric temperature of the globe to increase by about 5 degrees. The rise at the poles will probably be 10 degrees, while at the equator it will be 2 degrees. Countries at the latitude of India can expect a rise of about 3 degrees. In the temperate countries which produce the bulk of the worlds surplus grain, temperature rise, and a greater frequency of drought years, is expected to reduce production drastically. The same is likely for India too. Ice in the polar regions will melt, raising level of the ocean and flooding coastal areas like those in West Bengal and

Bangladesh. Glaciers on the Himalaya will retreat, melting at lower altitudes. This will cause more flooding of the rivers fed by them, like the Ganga and the Brahmaputra. In Uttarakhand the snow line and the tree line will move up by perhaps 500 metres. The optimum zones for various tree species (Box 3-1) will also move up. Overall, world food production is likely to be reduced. This will lead to conflicts, starvation and death.

What can be done to minimise global warming? Part of the excess carbon dioxide in the atmosphere has been produced by burning fossil fuels. In place of fossil fuels we will have to use forms of energy that do not produce a net gain at carbon dioxide. These include bullock power, solar power (solar panels) and wind power.

Global warming is also partly due to ecosystem degradation. Each of us must work to stop further degradation of his/her own home ecosystem, and then to rehabilitate it. The place to begin is the support area. As we have already learned, rehabilitating our own village support area is in our own immediate interest. It will produce more and lead to a better standard of living for us now and in the future. Thus by attempting to solve our own problems, we will contribute to solving a global problem.

Date: ....

Code : Trees 10
Month : July

EXERCISE 41

SUPPORT-AREA REHABILITATION PROJECT 5. TRANSPLANTING OF TREE SEEDLINGS

INTRODUCTION

This exercise is the third in the series of projects for restoring trees in our village ecosystem. July is here again, and it is time for tree planting. Last year in class eight (Exercise 29 'Tree Seedling Production') we prepared seedlings. If our tree seedlings are ready for planting, now is the time to plant them. We should also fill in the gaps in last year's plantation where trees have died (Exercise 16 'Transplanting Tree Seedlings'). Do all this plantation work as early as possible, so the seedlings get a long period in the rainy season to establish themselves.

PROCEDURE

1. Your teacher will assign each team specific areas in which to transplant seedlings. In that area your team will transplant all the types of seedlings specified in your management plan (Exercise 25). Your teacher will distribute the different types of tree seedlings to each team according to need.

2. Dig pits and transplant your seedlings, following the procedures you learned last year (Box 16-1).

3. Last year when we enclosed our project area, we topped all unwanted plants like lantana (*kuri*), parthanium (*gajar ghas*) and cactus (*nagphani*). They may have grown back. Top them again now. They must be kept severely cut back.

4. Inspect your seedlings about once a month. Keep the pits free of weeds. Be sure to repair the bund of each pit as often as is necessary.

FOR THE TEACHER

In Exercise 29 students made plans for their project area. In this exercise they will follow their plans. If necessary, you may suggest some changes. You will have to arrange extra periods needed for this work.

Table 41-1. Survival percentage of tree seedlings after one year

Type of Tree	Number of seedlings transplanted	Number of seedlings surviving at the end of the academic session	Survival percentage

5. Also inspect the boundary fence and check dams, if any, once a month,and make repairs.
6. Complete Table 41-1 at the end of the academic session. Then answer the questions below.

QUESTION

What do you think are the reasons for mortality in your seedlings? How could the mortality percentage have been reduced?

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

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

Date: ....

Code : Animal 3
Month : August

EXERCISE 42

THE DOMESTIC ANIMAL POPULATION OF OUR STUDY VILLAGE 2

PROCEDURE

1. Visit your team's allotted household to count animal numbers as you did in May. Record your data in Tables 42-1 and 42-2.
2. Enquire from the house holders how many goats were sold or consumed during the 12-month period immediately preceding your visit today. Record the figure in Table 42-3 in column 2.
3. Enquire from the householders how many sheep were sold or consumed during the 12-month period immediately preceding your visit today. Record the figure in Table 42-3 in column 3.
4. Also enquire how much wool was obtained during the 12-month period immediately preceding your visit today from the sheep kept by the householders. Record the figure, in kg, in Table 42-3 in column 4.
5. Exchange data with other teams and complete Table 42-3.

FOR THE TEACHER

Take up Box 42-1 after the exercise.

Table 42-1. Numbers of different types of animals in your assigned household on the day of your vosit

Type of Animals	Number
Cows	
Cow calves	
Bullocks	
Buffaloes	
Male buffaloes	
Buffalo calves	
Goats	
Pigs	
Chickens	
Horses	
Others	

Note: A cow is a female that has calved at least once. Similarly for a buffalo. A bullock is male that has begun to work.

Copy these data in Table 42-2 in the appropriate column and row. Exchange the data with other teams. Complete the Table 42-2 by calculating totals and averages.

Table 42-2. Average number of different types of animals per household on the day of your visit

Team No.	**Number of animals**										
	Cows	**Bullocks**	**Cow calves**	**Buffaloes**	**Male buffaloes**	**Buffalo calves**	**Goats**	**Sheep**	**Pigs**	**Chickens**	**Horses**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Total											
Average											

Table 42-3. Average numbers of goats and sheep sold or consumed, and wool produced, per family per year

Team number (1)	Number of goats sold or consumed (2)	Sheep	
		Number sold or consumed (3)	Wool produced, kg (4)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total			
Average			

QUESTIONS

1. Was any buffalo purchased or sold by the residents of your assigned household during the 12 months preceding your visit today? How many? What was the reason for purchase/sale in each case? Enquire for each animal whether the purchase/sale was done within the village or outside the village. For purposes of this question buffalo heifers about to calve for the first time should also be considered 'buffaloes'.

2. Did any animal die in your assigned household during the previous year? What type of animal? Why did it die?

3. Does any family in your study village maintain horses? How many are there in the village? What work do they do?

4. Does your assigned house hold keep any chickens? How many? Describe their feeding and management.

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

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

BOX 42-1

ECOSYSTEM EARTH-3

AN ENERGY CRISIS

Consider again the eco-sphere model (Box 37-1). The only thing that enters it is sun light. The only thing that leaves it is heat. This is true of the planet earth also. Thus all the energy we use in our daily lives comes ultimately from the sun – in the food we eat and the fuel we burn. Our food comes from green plants, either directly, or through our animals. Fuelwood too. Gas (in cylinders) kerosene, coal, petrol and diesel are derived from the undecayed remains of plants that lived millions of years ago. (This is why they are termed 'fossil' fuels.) Some electricity is generated by falling water at dam sites, but the energy that lifted the water to the sky to make rain and rivers comes from the sun.

Two exceptions to this generalisation should be mentioned. Their contribution to our present energy supply is small. One is geo-thermal energy. This takes the form of hot water or steam issuing from the earth where subterranean water has been heated by the hot interior of the earth. Hot water can be used to heat houses. There is a hot water spring next to the temple at Badrinath where one can have a bath in even the coldest weather. Steam from the earth can be used to run steam turbines to generate electricity. In Iceland, almost all the people's energy needs are met in this way.

The other exception is nuclear energy. Nuclear energy is generated by the controlled decay of radioactivate isotopes of the element uranium. The heat generated is used to make steam which turns steam turbines. Nuclear power plants are very hazardous, and for this reason more of them are unlikely to be built in the future. A few years ago a nuclear plant at Chernobyl in the Ukraine exploded. The radioactive debris killed many people living nearby, and caused cancer in many more. When a charge of isotope in a nuclear plant is used up, the residue nevertheless remains highly radioactive. It must be disposed of, but it is difficult to find sites from which there is absolutely no danger of it seeping into the atmosphere or the ground water, and thus spreading from the storage site. It seems likely, therefore, that our chief source of energy in the future will remain the sun.

Fossil fuels (coal, petroleum, natural gas) are formed over millions of years and under special circumstances. When the existing supplies are finished they will not be renewed. When they are used up the people of the planet earth will have to manage, as they did before the industrial revolution, on the sun's current energy input. But now there are many more people than there were then, and all our industry and transport are designed to use fossil fuels.

The earth's store of fossil fuels is enough to last for perhaps several centuries, even if the amount used every year continues to rise. But we have seen (in Box 40-1) that even by the middle of this century there may be severe climate warming due to the "green house" effect. If we burn all the remaining fossil fuel that exists, the earth may become uninhabitable. We must, therefore, discontinue the use of fossil fuels as rapidly as possible. How will this be done?

To discontinue the use of fossil fuels will require that we make greater use of the sun's current energy input. The amount of energy received each day from the sun is immense. We must find ways to capture as much of it as we can for our own use. Probably the greatest potential is the more efficient use of green plants, particularly trees. To realise this potential, the earth's support areas will have to be managed much more efficiently than they are today. Other methods of harnessing the sun's energy can be made use of, such as hydro-electrical power generation, biogas plants (gobar gas plants are one type of these), and windmills. Solar panels capture the sun's light and convert it directly to electricity. More geo-thermal energy can be made use of, and also the generation of electricity from ocean tides. Bullocks use only the sun’s energy that is captured by the plants that they eat.

In our own village many of these methods of capturing the sun's energy will be employed to meet our local energy crisis. The most important of these will undoubtedly be the use of trees. Our village support area will have to be managed in the most efficient possible way. Now is the time we should begin improving the management of our support area.

Date: ....

Code : Fodder 3
Month : August

EXERCISE 43

ESTIMATING FODDER CONSUMPTION 2

PROCEDURE

1. Visit your team's allotted family and weigh the amounts of various fodders fed to animals on the day of your visit. The procedure is the same as for Exercise 39. Record your figures in the spaces provided here.

   Green grass = ... kg

   Dry grass and straw = ... kg

   Green tree leaves = ... kg

   Green fodder crops = ... kg

   Notes

   1. Green grass is grass harvested while it is still growing.
   2. Dry grass is harvested when the grass has become mature and produced seeds. Straw is what is left threshing grain (wheat, paddy, *maudua*, *madira* etc.) including the chaff.
   3. Green fodder crops are *berseem*, lucerne, cowpea, oats, maize, sorghum and sugarcane tops.

2. Transfer this data to the appropriate line in Table 43-1. Share your data with other teams and complete Table 43-1.

FOR THE TEACHER

Take up Box 43-1 after the exercise.

Table 43-1. Average amount of different fodders fed per household (August)

Team number	Green grass	Dry grass and straw	Green tree leaves	Green fodder crops
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				
Average				

QUESTIONS

Ask the members of your assigned household the following questions.

1. What is the source of the green grass fed to animals of stall? (Green grass includes weeds from cultivated fields.) Give your answer in terms of headloads that were brought form each source.

2. What is the main species of grass plant fed to the animals at stall today?

3. Where are animals grazed today? Is it the same place(s) as in May? If different, what is the reason?

4. What fodder crops were fed to the animals?

5. Are the animals sent for grazing today also fed cut green grass at stall today? If so, why?

6. What animals, if any, are fed dry grass today?

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

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

BOX 43-1

SPECIES ADAPTATION

In Box 40-1 'Species Diversity' it was said that every organism tries to find ' place to live', or a 'niche', an available source of food, or, in the case of plants, a place to grow where it can obtain an adequate supply of sunlight water and nutrients, in competition with organisms of other species. When they find such a place or situation we say they are adapted to that place or situation. Every species is adapted to a particular ecosystem (or group of similar ecosystems) as well as to a particular niche within that ecosystem. Thus *kans* grass *(Saccharum* species) is adapted to natural forest ecosystems of the *Tarai* and *Bhabar*. Within these ecosystems, it is adapted to open places in the tree canopy where there is full sunlight at ground level. At places other than these *kans* cannot survive and we say it is not adapted to these places. For example, in a *sal* forest, under a closed tree canopy there is not enough sunlight and ferns and shrubs that thrive in the shade crowd it out. We can say that *kans* is not adapted for the conditions of a climax *sal* forest.

At higher altitudes it is too cold for *kans*, and plants of other species that are adapted to a colder climate are more vigorous such as, *bimausiya* grass (see Box 34-2). In these places *kans* will not grow and we can say *kans* is not adapted in this region. The activities of people sometimes change an ecosystem. When an ecosystem changes, some existing niches may be destroyed, while some new ones may be created. In the case of *kans* grass we know that where trees are removed, the niche occupied by shade-requiring ferns and shrubs is destroyed, but a niche for grasses, which require full sunlight, is created. *Kans* grass can grow over large areas of treeless land, as in uncultivated village land.

Another example showing species adaptation

Every species of tree is found only in a specific attitude zone (Box 3-1 'Altitude'). Thus sal trees grow only in the Tarai and Bhabar and up to an altitude of about 1000 m on the outer slopes of the outer

Himalayas. Deodar trees grow only in the middle and inner Himalayas between 1500 and 2500 m Deodar trees cannot live at Haldwani, nor can sal trees live at Gwaldam.

Species that indicate ecosystem degradation – some examples

When an ecosystem is degraded by bad management many native species are destroyed, or, as we said earlier, many niches are destroyed. Thus when a natural, climax, mixed forest is degraded by grazing, fire and over-cutting, the tree species disappear. They are no longer adapted to the changed conditions in the ecosystem. In their place foreign species of plants may appear naturally which are adapted to the changed conditions in the ecosystem. Their leaves are not palatable to animals and hence they are not disturbed by grazing or by people wanting to collect fodder. They are also resistant to fire. Some of these species come to cover the land completely where it has been badly degraded. If we do not understand the principles of species adaptation, we may conclude that these foreign species are the cause of degradation. In reality they are the result. Or, we can say that they are indicators of bad ecosystem management.

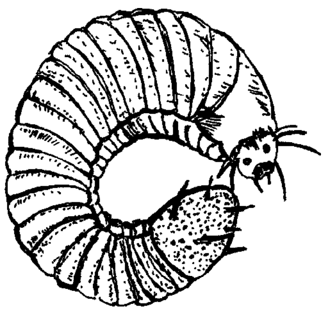
The most wide-spread indicator of mismanagement in the hills of Uttarakhand is *chir* pine. Except for a few areas, in valleys at an altitude of around 1000 m, *chir* pine is a foreign species. In reserve forest blocks, it has been planted even at higher altitudes and has spread naturally to our village uncultivated land because of our bad management. We can say that, *chir* pine is adapted to degraded village uncultivated land because it does not produce palatable fodder leaves and because it is resistant to fire, at least to some extent.

Chir pine is, of course, a valuable species since it produces good stemwood. It is only undesirable when it grows to the exclusion of all other species.

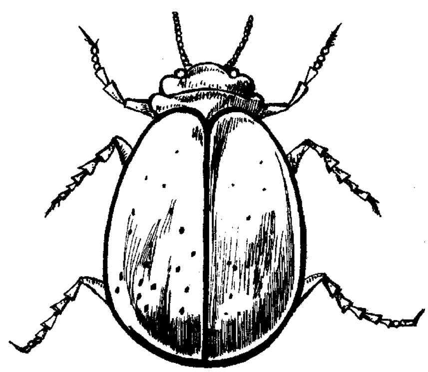
Another common indicator species in some parts of Uttarakhand is the shrub lantana. We can see it many places in the *Bhabar*. It is adapted to degraded ecosystems because its leaves are unpalatable. After fire, it sends up new shoots from its roots. Even if burned every year, it thrives. Needless to say, it cannot establish itself in a healthy climax forest ecosystem, and was not seen anywhere 100 years ago. Once we rehabilitate our village bare land it will not be able to grow any more. However, it is a lot of work to suppress it sufficiently to allow our new plantations to establish. The only way is continuously to cut it back.

Indicator species like lantana produce little or no biomass that is of direct use to people. Nevertheless, we must recognize the important role they play in nature. If they did not grow on degraded land, soil erosion would be more severe than it is. And, these plants do produce organic matter from leaves, stems and roots to enrich the soil. They are protecting our land to some extent until the time we begin to rehabilitate it.

When an ecosystem is degraded, some species may be able to find another niche for themselves in the same ecosystem, and hence do not disappear when their original niches are destroyed. Their presence in new niches is an indication of ecosystem degradation. *Kurmula* is an example of this in Uttarakhand. This insect feeds on the root of plants in its larvae stage and on leaves in the adult, beetle stage of its life. Unlike many insects it feeds on many species of plant and not just one. The beetles emerge from the soil during June and July and, in a natural forest ecosystem, feed on the leaves of oak, *poplar, bhimal, tun, utis* and *kharik* trees. They lay eggs in the soil. The grubs hatch and begin feeding on the roots of trees and other forest plants. When the village support area is mismanaged and broad-leaved tree disappear, the niche of *kurmula* also disappears. It has, however, been able to find a new niche for itself in



Kurmula
Larvae form



Kurmula
Beetle form
(adult)

cultivated fields, feeding on crops. Unirrigated, upland paddy, *mandua*, *madira*, *bhatt*, gram, french been are all damaged by the grubs. The beetles feed on the leaves and flowers of maize, *bhat*, french been, and also on the flowers of fruit trees like plum, apricot and ornamental plants like dahlia. The damage to these plants is likely to decrease with support-area rehabilitation and good management. It is probable that the population of *kurmula* is controlled to some extent in the support-area by natural predators which are absent in cultivated fields.

Varieties within species and their adaptation

In most hill villages of Uttarakhand wheat is grown. Yet the wheat is not be the same in all. There are considerable variations in height of plant, size, colour and taste of grain and in many other characteristics. There are hundreds of types of wheat and each has its own name. These different types are called 'varieties'. Still, they are all wheat, that is they belong to one species of plant and they can all be interbred. Varieties are also found in animals. There are for example, many varieties of cow in India. Varieties in the case of animals are termed 'breeds' (see Box 15-1).

Why are there so many varieties or breeds of a single species? How did they originate? The answer to both questions is that these varieties and breeds have been created by a process of selection by the people who raise them. Take the case of wheat. When settling a new area people bring seeds with them. They plant these in the new environment. Not all plants in the field are exactly the same. Some may be larger, more vigorous or more healthy than the rest. In making seed for the next year, the seed heads of these plants will be saved. Next year, most of these seeds will produce plants similar to the ones selected the year before. Again the most productive, healthy plants will be selected to make seed. In this way a variety of wheat is evolved over many years that is adapted to the conditions of the village ecosystem. It may be very different from the variety that was originally brought with the settlers. We can see that there will be nearly as many varieties of wheat in the hills of Uttarakhand as there are villages. The same is true for all species of cultivated crops. In Central India, for example, there are an estimated 40,000 varieties of paddy. In a single village more than one variety may be sown;

different varieties are sown in different fields because of differing soil texture.

It should be noted that people select plants and animals not only for reliable yield, but also to meet their needs and tastes. The amount of straw and the taste and colour of grain are two examples.

In the plains people have selected cattle to give large bullocks which can plough large fields and pull heavy carts. In the hills there are no carts, and fields are very small. Bullocks must be agile rather than massive.

Varieties/breeds are usually most productive, and most suited to the needs of the people who raise them, in the village(s) where they have evolved – that is, in the ecosystem(s) to which they are adapted. If we introduce varieties/breeds from other ecosystems they will usually not be as good as the existing, adapted ones, at least initially, and not until a long process of selection has been carried out. They will probably not produce as well in their new home as they did in the ecosystem from which they were brought. The soils may be different, or the weather, or they may not be able to resist the disease organisms and pests they find in their new home and which were absent in their original one.

Many varieties have been evolved by scientists for irrigated land. To grow these successfully farmers must provide plenty of irrigation water and use chemical fertilisers and pesticides. In other words, they must modify their field and village ecosystems to grow these varieties. In doing this, however, we now realise that we have degraded our ecosystems, as we have seen in Box 5-1 ‘Pests’.

Date: ....

Code : People 3
Month : October

EXERCISE 44

THE HUMAN POPULATION OF OUR STUDY VILLAGE

INTRODUCTION

Human beings are one of the four major components of the village ecosystem. Their's is the major role in making and managing the ecosystem and in maintaining its health. In this exercise we will estimate the size of the human population, and whether it is increasing, decreasing or constant. We will then consider the possible effects of this on the village ecosystem.

PROCEDURE

1. Each team should visit its assigned household and request the head of the household to help them to make a 'Family Tree' of their family. In the blank page opposite you will make two family trees, one representing the family at present and the other representing it as it was ten years ago. Different branches of the family tree represent members of the family, and indicates the relationships among them. Here, as an example, is the family tree of Mohan Singh (who is the head of the family).

Family tree of ten years ago:

Paruli Devi (mother of Mohan Singh – very old)

↓

Mohan Singh + Shanti Devi (wife of Mohan Singh)
(44 years) (42 years)

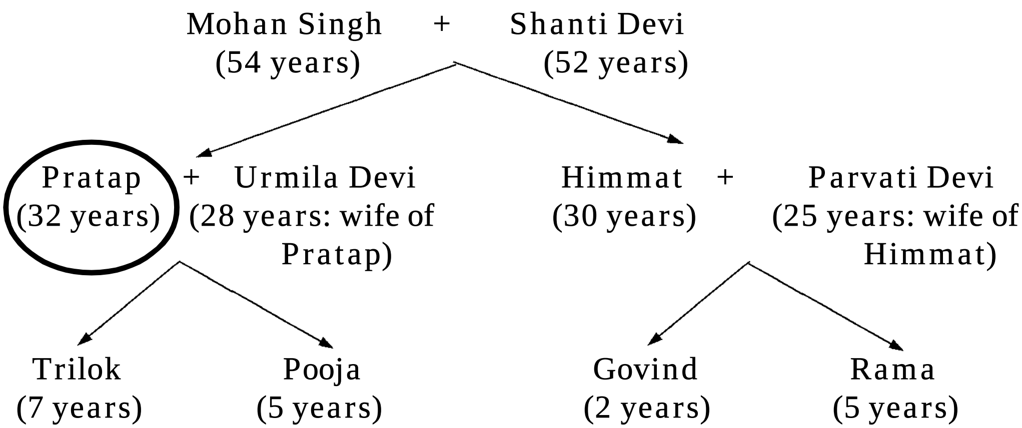
Pratap (son: 22 years)
Himmat (son: 20 years)
Pushpa (daughter: 16 years)
Vimla (daughter: 19 years)

At that time there were seven members in the family of Mohan Singh.

FOR THE TEACHER

Take up Boxes 44-1 and 44-2 after doing this exercis.

Today the family tree of Mohan Singh looks like this:



In the present family tree of Mohan Singh his old mother is no longer living and both Pushpa and Vimla have been married and gone to their inlaws (other villages). Pratap and Himmat have been married to Urmila Devi and Parvati Devi, respectively. Each couple has two children. Both are living separately with their wives and children. The circle around Pratap's name means that he is working and living outside the village. At present, therefore, there are ten members in the family, but only nine are living in the village. The 'population' of this family living in the village has increased from seven to nine; the proportionate increase is 9/7 = 1.28 in the past ten years.

Here are some guide lines for collecting this information:

a) If the head of the family is not there, or not living in the village,request his wife or his brother to help you.

b) All the new members in the family at present should be less than ten years of age.

c) If a family member has a job outside the village, but sleeps and eats at home, he/she is considered to be 'living in the village'. Be sure to circle the names of all the family members who do not sleep and eat at home except for occasional holidays. In our calculation of population increase/decrease, we should include only those family members that are dependent upon the village ecosystem for food, fuelwood and water.

2. Calculate the proportionate increase or decrease in the population of your assigned family over the past ten years. To calculate this proportion, divide the present population by the population ten years ago. If population has increased you will get a number greater than 1.0; if it has decreased you will get a number less than 1.0. Enter your figure in the appropriate line in Table 44-1. Exchange data with other teams and calculate the total and average.

Table 44-1. Average proportionate increase/decrease in population of families in study our village

Team Number	Name of head of assigned household	Proportionate change in family member
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		
Average		

QUESTIONS

1. The population of Uttarakhand between 1991 and 2001 increased from 70 to 85 lakhs. Calculate the population growth ratio during this period?

$$\text{Population growth ratio} = \frac{\text{Population in 2001}}{\text{Population in 1991}}$$

Proportionate population increase in Uttarakhand between 1991 and 2001 = ...

2. The population of the whole of India is also increasing as shown in the following table.

Year	Population (crores)
1901	24
1911	25
1921	25
1931	28
1941	32
1951	36
1961	44
1971	55
1981	68
1991	84
2001	100

Calculate the proportionate population increase for India between 1991 and 2001. Compare this figure with that for Uttarakhand.

3. World population is also increasing as shown in the following table.

Year	Population (crores)
1900	150
1910	170
1920	180
1930	200
1940	230
1950	260
1960	300
1970	360
1980	420
1990	520 (appox)
2000	600 (appox)

Calculate the proportionate population increase for world between 1990 and 2000. Compare this figure with that of India and Uttarakhand.

____

____

____

____

____

____

4. We may assume that the average proportionate population increase of the ten families, (Table 45-1) in your study village is that of the whole village for the last ten years. Compare the proportionate increase of your study village with that of Uttarakhand, India and world.

____

____

____

____

____

____

5. If the proportionate population increase of the human population of your study village continues as it has for the last ten years, how will it affect the village ecosystem?

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

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

BOX 44-1

HUMAN BEINGS IN THE ECOSYSTEM

Human beings are a part of the ecosystem in which they live. We may think of our village as an ecosystem (Exercise 5). The village ecosystem comprises all the cultivated land as well as the uncultivated land of the village together with all the plants, animals and decomposers living on the land. If there is a pond in our village, it is also a part of the village ecosystem together with all the plants and animals that live in it.

From one point of view, we, the human residents of the village ecosystem, are like any other animal species in that we obtain our food from it and produce waste that is recycled to new plant growth. From another point of view we are different because we consciously change the ecosystem in which we live. If we make these changes wisely, the ecosystem will continue to provide us a constant livelihood; if we are unwise, it will deteriorate and thus fail to support us in the future.

Our remote ancestors obtained their requirements of food and medicine by gathering and hunting what the natural forest ecosystem provided; they did not grow crops or keep domestic animal like cattle, buffaloes and goats. They collected dry wood for fuel. Their numbers were small and they did not disturb the natural forest ecosystem. As human population increased, however, we began making changes in our ecosystem. We cleared the original forest at places to grow crops (Box 4-1 'The stone axe'). We domesticated animals to provide us food and power for ploughing. These animals were grazed in the forest. In this way a natural, climax forest ecosystem was converted into the village ecosystem we know today.

What happens when a climax forest ecosystem is converted to a present-day village ecosystem? Consider first the effect of making cultivated fields. After a field is ploughed the soil surface remains completely bare of vegetation. Even after a crop begins growing the soil surface is not fully covered as it is in a natural forest. Regular weeding of the field further keeps the surface bare. Not only is the surface bare, but due to ploughing and weeding, the soil is loose. Bare fields with loose soil suffer accelerated erosion (Box 18-1 'When it rains'). This is more serious if the field is sloping. Also, cultivated crops are shallow-rooted compared to trees. Therefore the loss of plant nutrients through leaching is more in cultivated fields than in undisturbed forest. Both accelerated soil erosion and accelerated leaching result in a negative ecosystem balance for nutrients.

What has been said in the previous paragraphs can be summarised as follows: when people produce food and other necessities, rather than simply collecting them, they may degrade the ecosystem in which they live unless they manage the land wisely.

The wisdom they need to manage the land must be learned from nature itself, as we observe it in an undisturbed, natural ecosystem at the climax stage. There appear to be five features of such an ecosystem that we must strive to imitate (Box 11-1):

1) Complete, continuous vegetative cover;
2) Soil surface continuously covered with a layer of decaying biomass;
3) Continuous addition of organic matter to the soil;
4) Species diversity;
5) Species/varieties of plants and animals that are well adapted to the conditions of the ecosystem.

We may not be able to imitate these completely, but the closer we come to doing so, the more nearly our village ecosystem will remain in equilibrium.

What can we do to imitate nature in the management of our village ecosystem? Let us first consider uncultivated land.

Uncultivated land

Some of the uncultivated land of the village is common land. Most of this is bare of trees and so produces little biomass. We can plant trees here (Box 24-2 'Restoring trees in village common land'). Field boundaries belong to individuals and can be planted with trees. Such trees will produce biomass in the form of fuelwood, fodder and also mulch (Box 24-3 'Trees in and around our fields'). Further, they reduce

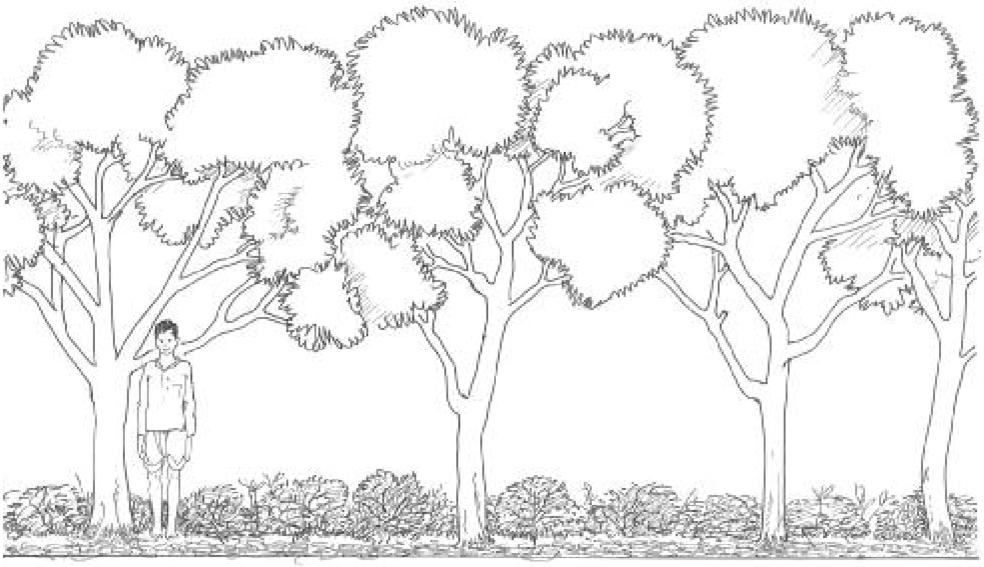


Figure 44-1-1. Production of fuelwood from well managed village common land. Note the closed canopy cover, the under story of grasses, shrubs and herbs and finally the layer of decaying leaves on the soil surface. This plantation imitates a natural forest.

soil erosion by covering the soil surface (Figure 44-1-1). Their deep roots act us 'nutrient pumps' (Box 32-3 'The management of terrace risers').

Cultivated land

There are many ways in which we can imitate a natural forest in the management of cultivated land. All of them will help to make our soil fertile through the retention of nutrients in the ecosystem.

1. Grow more trees in and around fields (Box 24-3, 'Trees in and around our cultivated fields'). This gives more biomass from which to make compost and mulch for our fields. Trees also protect our land from soil erosion and excessive nutrient leaching.

2. Do not burn any crop residues like paddy/straw and sugarcane trash. Instead use them for animal bedding or mulch or put them directly into the compost pile.

3. If you have four or five animals, build a gobar gas plant. This can reduce your need for fuelwood and trees can be used to produce fodder rather than fuelwood (Box 38-2, 'Gobar gas plants'). Human waste can also be recycled easily in a gobar gas plant.
4. Collect and use animal urine in making compost (Box 36-1 'A method of collecting animal urine')
5. Grow mixed crops. These are more resistant to diseases and pests than single crops (Box 31-1, 'How to grow mixed crops' and Box 31-3 'Managing fruit trees'). They make better use of available sunlight, moisture and nutrients. Also remember that 'weeds' are part of our crop mixtures. They produce biomass for food, fodder and mulch and they help protect the soil. They must, however, be controlled in their growth so that they do not overcome crop plants. Trees and shrubs when they are grown in and around our fields are also a part of our crop mixtures.
6. If water balance in the village is disturbed (i.e., falling ground water level or water logging) a change in cropping pattern from crops that have a high water requirement, like sugarcane and short paddy varieties, to traditional crops like sorghum, millet, wheat, pigeon pea, traditional long-straw varieties of paddy can help restore it (Box 22-1, 'Village water cycle in the village ecosystem1. plains')

Domestic animals

In a healthy ecosystem domestic animals help in the recycling of biomass to the soil and produce food and animal power (Box 38-1 'Role of domestic animals in our village ecosystem'). The numbers and types of animals should meet these requirements.

Today most village ecosystems are disturbed, or we can say that they are sick; too few trees, lack of adequate biomass recycling, use of chemicals and too few animals, and animals that are not well adapted to the conditions of the village ecosystem.

Many families now own tractors and no longer have bullocks. Animal numbers are not enough to process all the available biomass into compost. Some biomass, like paddy straw and sugarcane trash are burned in the field instead of being recycled (as animal fodder, animal bedding or mulch). Of course we can recycle these forms of biomass without animals (compost, mulch), but if we have animals (bullocks, buffaloes) we can get extra services (draught power) and food (milk) at no extra cost except labour. Tractors have some advantages over bullocks but we must consider their disadvantage too.

Some families are keeping crossbreed cows for milk production since they have tractors and do not need bullocks. These cows are not, however, well adapted to our village ecosystem, Box 38-1, 'The role of domestic animals in our village ecosystem').

Whenever we grow new crops/crop varieties, or rear new breeds of animals, we tend to lose our existing varieties/breeds. Later, if the new types are not successful, we cannot go back to the old types because we no longer have seeds/animals of those types (see example in Box 5-1, 'Pests: our problem').

Human beings

We, the people who live in our village, are part of the village ecosystem, and what we do or do not do affects the health of the ecosystem. Our waste, like that of our crops and animals can be effectively recycled in gobar gas plant (Box 38-2).

We must also manage the ecosystem wisely, as pointed out at the beginning of this box. How do we manage well? It is not enough for each family to manage its land and animals well. Each family, its land and its animals, are a part of the larger village ecosystem. All must therefore act together if the ecosystem is to remain healthy, or to make it well again.

All the residents of the village must get together to discuss ecosystem problems, and find ways of solving them. For example, if the water table is falling due to over pumping for water-demanding crops like sugarcane and dwarf paddy varieties then one solution is to switch from these crops to those that require less water. However, every family in the village would have to agree to switch. Voluntary cooperation is essential in all such cases. You will recall how the people of Tangsa (Box 25-2) and Sukhomajri (Box 30-4) villages and the people in the Arvari river catchment (Box 22-3) worked together to improve the health and productivity of their village ecosystems.

We must also keep in mind that our village ecosystem has a definite carrying capacity. It must be able, with good management, to meet at least our minimum needs (food, clothing, housing and cash to pay for education, medicinal care and the necessary things that our land does not produce). If our numbers exceed this carrying capacity it will lead to hardship and probably ecosystem degradation.

BOX 44-2

ECOSYSTEM EARTH 4. A POPULATION CRISIS

In southern Africa, in the Kalahari desert, there live a people known as bushmen. As they have done for thousands of years, they move constantly from place to place in their desert ecosystem searching for food. They hunt and collect what they can to eat. Because food is scarce, their population is small and more-or-less stable. Rainfall in the desert is always low, but in poor rainfall years the bushmen often suffer and probably some of the weaker members die from lack of food. By and large, however, the bushmen keep their population stable and within the carrying capacity of their ecosystem by limiting their rate of reproduction. They know from experience the food-producing capacity of ecosystem, and they know that if they exceed their food supply the excess population cannot migrate because all the land around the desert is occupied by other people. On an average they limit themselves to two children per couple.

We know from the studies of anthropologists (those people who study human societies) that human beings began growing plants for food about 6000 years ago. Before that all people on the earth were hunters and gathers, like the bushmen. In the hunter-gatherer stage of human history the world's population was very small. It increased only very slowly, and that too primarily by the migration of people to as yet unpopulated regions of the globe. By 6000 years ago almost the entire globe was populated. With the advent of cultivation, communities could produce more food from some ecosystems than they could obtain by hunting and gathering. The most favourable ecosystems were forests of broad-leaved trees because rainfall was adequate for successful cultivation. Forests were cleared to make fields for growing crops.

Population in these modified ecosystems increased with the greater food supply. Also, since the clearing of forest and the cultivation of crops required much labour, family size increased. People slowly forgot the concept of carrying capacity because the forests seemed endless in extent in relation to the population then existing. Their seemed always more forest that could be cleared as population grew. There were also ecosystems as yet unoccupied (except by hunter-gatherers) to which excess population could migrate. Cultivation also made possible the rise of cities. A city is a very special type of ecosystem unto which food, fuel and water must be imported from surrounding ecosystems where a surplus of these things is produced. City ecosystems are centres of manufacturing and trade, and their residents exchange goods and services for fuel and food.

In this changed world the concept of carrying capacity was obscured by the fact that overpopulation could be relieved by migration. City dwellers have no awareness at all of their ultimate dependence on the land.

The principles of ecosystem management which we have come to recognise today were not understood. Most ecosystems, when cultivation was introduced, were badly managed. We know that clearing forest to make fields for growing crops disturbs a natural forest ecosystem. To keep the ecosystem reasonably stable thereafter requires careful management. In particular, sufficient area of support area must be left as forest, and it must be managed to give high and sustained production. Communities of cultivators usually left too little support area and they grazed their animals in what was left. They did not construct their cultivated fields properly, giving rise to accelerated soil erosion, excessive rainwater runoff and the drying of springs. Within periods of a few centuries many ecosystems were ruined. The farming population and the city dwellers alike migrated or perished. This is what is thought brought an end to the Indus valley civilization of which only the ruins of its great cities like Mohanjodaro remain. There are many Mohanjodaros around the world. We are still making Mohanjodaros of our ecosystems today because our way of thinking has remained as it was 6000 years ago when cultivation first began. So, at a time when the earth's human population is rapidly increasing, its carrying capacity is declining.

Modern technology has helped us boost food production in some ecosystems. We did not see that this technology also degrades our ecosystem in the long run. And it has had the undesirable effect of encouraging us to think that by the application of modern technology a population growth crisis can be avoided forever. When we look at the ecosphere, however, we realise that the planet's resources — soil, water and air — are finite. Technology, at its best, can only help us to use these resources more efficiently. It cannot create new resources.

We are thus forced to conclude that the present population crisis is our own creation. Its cause is faulty thinking.

A knowledge of the global ecosystem and of sound ecosystem management principles (population control and sound land and water management practices) can help us to change our thinking. The ecosphere model makes it very clear that the earth as a whole is finite. Every smaller ecosystem within the whole is also finite. When all these smaller ecosystems no longer produce enough food and fuel, where will people migrate to and from where will we import food and fuel. World statistics on population growth, food production, ecosystem destruction, and fuel and water availability suggest that a population crisis has already begun. In most of the world the crisis is already visible as increasing poverty, malnutrition, water and fuel scarcity, and over crowding. Migrations to cities in the hope of finding employment are increasingly futile. Perhaps there is still time, however, to control population and manage our land and water to achieve sustainable production. Where do we begin? In our own village.

Date: ....

Code : Fodder 4
Month : November

EXERCISE 45

PROJECT FOR RESTORING TREES IN OUR VILLAGE ECOSYSTEM 6. MEASURING GRASS YIELD 2

INTRODUCTION

The grass plants in your project area will be ready for counting and harvesting. Do these operations in the same ways you did them last year (Exercise 34). Then you can compare this year's and last year's results.

PROCEDURE

1. Each team should select a one meter square sample area, as was done last year. The sample area need not be the same as last year. Estimate "percent plant cover", and write your estimate here:

   Percent plant cover = ...

2. Next count the numbers of plants in the sample area. Record your results in the appropriate spaces in Table 45-1. Transfer your team's data to Table 45-2. Complete Table 45-2.

3. Finally, harvest all the grass in your assigned area, weigh it, enter your figure in Table 45-3, and complete Table 45-3.

4. Compare last year's results with this year's taking the help of Table 45-4. Are there any differences in yield between the two years' results? If so can you explain them in terms of differences in the plant community?

Table 45-1. Numbers of plants in sample area

Number of
total plants

Total of
nine sections =

Numbers of
non-grass plants

Total of
nine sections =

Numbers of *Themeda*
plus *Arundinella*
grass plants

Total of
nine sections =

Table 45-2. Data on plant cover of sample area

Team no. (1)	Percent plant cover (2)	No. of *Themeda* and *Arundinella* plants (3)	No. of other grass plants (4)	No. of total grass plants (5)	No. of non-grass plants (6)	Total no. of plants (7)	Percent grasses in plant cover (8)	*T & A* grasses as % of all grasses (9)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
Total								
Average								

Notes for completing Table 45-2.

1. The figure for column 5 is obtained by subtracting the figure in column 6 from the figure in column 7 (i.e., Column 5 = Column 7 – Column 6)
2. Column 4 = Column 5 – Column 3
3. $$\text{Column 8} = \frac{\text{Column 5}}{\text{Column 7}} \times 100$$
4. $$\text{Column 9} = \frac{\text{Column 3}}{\text{Column 5}} \times 100$$

Table 45-3. Weights of fodder cut from project area

Team number	Weight of fodder cut by team
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

Table 45-4 Comparison of two years' results

Year (1)	Percent plant cover (2)	Percent grasses in plant cover (3)	T and A as a percent of total grasses (4)	Yield of dry fodder, kg/nali (5)
Last year (8th class)				
This year (9th class)				

QUESTIONS

1. What changes, if any, do you see between last year's and this year's results?

____

____

____

____

____

____

2. If you have found differences, how do you explaion them?

____

____

____

____

____

____

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

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

Date: ....

Code : Animal 4
Month : December

EXERCISE 46

THE DOMESTIC ANIMAL POPULATION OF OUR STUDY VILLAGE 3

INTRODUCTION

In this Exercise you will complete your observations on the animal population of your study villgae.

PROCEDURE

1. Visit your team's allotted household and repeat the observations made earlier in Exercise 38 and 42 on animal numbers. Record your data in Tables 46-1 and 46-2
2. Transfer the data from Tables 38-2, 42-2 and 46-2 (last lines) to the appropriate line in Table 46-3
3. Transfer data from table 46-3 (last line to the appropriate line column 2 in Table 46-4.

FOR THE TEACHER

Take up Boxes 46-1 and 46-2 before beginning the exercise.

Table 46-1. Numbers of different types of animals in your assigned household on the day of your vosit

Type of Animals	**Number**
Cows	
Cow calves	
Bullocks	
Buffaloes	
Male buffaloes	
Buffalo calves	
Goats	
Sheep	
Pigs	
Chickens	
Horses	

Note: A cow is a female that has calved at least once. Similarly for a buffalo. A bullock is male that has begun to work.

Table 46-2. Average number of different types of animals per household on the day of your visit

Team No.	Number of animals										
	Cows	Bullocks	Cow calves	Buffaloes	Male buffaloes	Buffalo calves	Goats	Sheep	Pigs	Chickens	Horses
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Total											
Average											

Table 46-3. Average numbers of animals in assigned household during the year

Month	Number of animals										
	Cows	Bullocks	Cow calves	Buffaloes	Male buffaloes	Buffalo calves	Goats	Sheep	Pigs	Chickens	Horses
May (Ex 38)											
August (Ex 43)											
December (Ex 46)											
Total											
Average											

Table 46-4 Calculation of the total numbers of animals of each type

Type of the animals (1)	Average number of animals per household (2)	Number of househods in the village (3)	Total number of animals in the village (4)
Cows			
Cow calves			
Bullocks			
Buffaloes			
Male buffaloes			
Buffalo calves			
Goats			
Sheep			
Pigs			
Chickens			
Horses			

Note : Round off figures in column 4 to the nearest whole number.

QUESTIONS

Before writing your answers to the following questions, discuss these matters with the members of your assigned family. Your teacher will arrange for a class discussion of the answers of all the teams.

1. Does each household have a pair of bullocks? If not, how is ploughing done? Describe hiring or sharing arrangements in detail.

2. After being mated a cow will deliver a calf after about nine months. When she calves she will begin giving milk. For one or two months after calving she will not come in heat. After two months she should be mated again. About two months before giving birth to another calf we should stop milking her so that she gains strength for the next calving and lactation. In this way, a cow should produce a calf every year and during the year produce milk for about 10 months -- if she is healthy. Do the cows in your village follow this pattern? (Hint : You can answer this by using the information you have obtained.) If not why not? If these cows are not calving regularly what can be done?

3. Buffaloes are seasonal breeders. That is they only come is heat during the rainy season. Further, the time between mating and calving is about 11 months for buffaloes. From the data for the buffaloes you have collected, are they calving regularly? If not, why not?

4. Are there any seasonal differences in the numbers of animals of different types? If so, describe them. If so, why do these differences occur?

Answer the following questions yourself.

1. Domestic animals have definite roles in the village ecosystem (see Box 38-1). They eat crop residues, tree leaves, grass, fodder crops and kitchen waste and in return they give draught power, milk and compost for feeding the soil. What do you think: In your village are the numbers of animals enough to preform these activities? Are all these activities being carried out adequately?

2. If you judge that the existing animals are more, or less, than required to ensure the sustained productivity of the village ecosystem, should the numbers of some types be increased (or decreased)? Which types, and by how which?

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

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

BOX 46-1

ANIMAL CARE

In Box 15-1 we learned how animals become domesticated. They submit to human purposes in return for protection and care. We provide them shelter where they are comfortable and safe from wild animals. We care for them by providing food and ensuring that they remain healthy and produce offspring. If we do all these things properly our animals will be contented and give us food, fibre, work and companionship.

Shelter

Animal shelters must have a roof to protect animals from rain, snow, hail, and from hot sun in the summer. They should also have walls to protect the animals from attacks by wild animals (for example leopards, jackals and pine martins). The walls must have doors which can be closed at night and in cold weather and windows which can be closed in cold weather. Window must have bars so they can be left open at night in warm weather. Another important feature of an animal shelter is a *pucca* (paved) floor. If the floor is *kachha* (unpaved), the soil gets wet with urine and dung and becomes mud. The animals get dirty and wet and can get sick in cold weather. The floor should have a drain to take away urine (see Box 36-1). Also, the floor must be cleaned daily and the dung removed to the compost pile. The design and place of animal shelters vary with climate. In the plains an animal shed is usually next to the house and is often a separate structure. In the hills it is part of the house, forming the lower story.

In cold weather animals require bedding in their shelter to keep them warm. The bedding may be dry tree leaves, dry sugarcane leaves, paddy straw, etc. It is removed daily and put into the compost pile. Actually it is a good practice to put down bedding daily throughout the year. That way all crop residues and all dung go to the compost pile. (All animal dung should go to the compost pile and not dried and burned.)

During the day animals may be tied outside the animal shelter. The place where they are tied should have a large tree to give shade to the animals during the day time in the plains during the summer. Otherwise, the animals must be put in their shelter during mid-day.

A *pucca* standing place with mangers or feeding boxes should be provided for the animals both inside the shelter and outside.

Feeding

Cattle, buffaloes and goats should be given their fodder at stall. They should not be grazed. As you know, grazing destroys tree seedlings, and sometimes even grass. Sheep should also be fed at stall during the winter. In the summer they are taken to high altitude pastures where trees do not grow. Thus grazing by sheep does not cause any harm there, unless there are too many of them, in which case the grass may be destroyed. It is best to feed animals their fodder in no-waste mangers (Box 39-2) or to chaff it and feed it in ordinary mangers or boxes.

Our animals must be given green fodder every day if they are to be healthy and productive. The amount to give is: 10 kg per day per animal for dry cows and buffaloes, resting bullocks and young animals; 20 kg for milking cows and working bullocks; and 30 kg for milking buffaloes. These figures are for juicy fodders like tender monsoon grass and berseem. Tree leaves, jowar chari and green sugarcane leaves are less juicy (that is, they contain a lesser percentage of water) so that, in general 1 kg of these equals 2 kg of grass and berseem. Animals should also be given dry fodder (wheat bhusa, paddy straw and dry grass), as much as they will eat. Leftovers and wastes from the kitchen should also be given to them.

In addition, cattle and buffaloes are given extras food in the form of a mixture of grains, oilcake, wheat bran, rice bran. Extra food is given when animals are in advanced pregnancy, when they are milking, and when they are working. The dry ingredients of the mixture should be coarsely ground, and the entire mixture moistened with water before feeding it. Approximately the amounts of extra food to be given are:

	Sufficient green fodder	Insufficient green fodder
Dry cow and buffalo	none	1 kg
Pregnant cow and buffalo (last two months)	1 kg	2 kg
Milking cow and buffalo	1 kg for 2 kg (above 4 kg)	1 kg for 2 kg milk
Idle bullocks	none	1 kg
Working bullocks	1 kg	2 kg

All cattle and buffaloes require salt and mineral mixture. These should be added to the extra food mixture at the rate of one percent each. Dry cows and buffaloes and idle bullocks may be given a little salt and mineral mixture in their manger from time to time. Alternatively you may purchase salt and mineral blocks. These are placed where animals can lick them. Blocks are good for goats and sheep also.

Cleaning

It is essential to keep our animals clean. They must be given a clean place to sleep. Fresh, dry bedding should be spread daily. Occasionally animals should be brushed and, in hot weather, bathed. By keeping them clean they are less likely to get sick. Moreover, if they are clean there is less chance for the milk to become dirty during milking. Before milking the animals' udders should be wiped with a clean wet cloth. (Use warm water in cold weather.) A clean udder also means less chance that the calf will become sick.

Health care

The most important reason for poor health and low productivity of our animals is a lack of the required amount of green fodder in their diet. They simply do not get enough energy and essential nutrients. The symptoms are slow growth, late maturity, sterility, low milk production and many ailments. The key to better health and productivity is planting more trees. We can say that our animals will be healthy only if our village ecosystem support area is covered with healthy trees.

Even if our animals are well fed they may sometimes become sick. In many cases we can treat them ourselves, but in some cases we will have to take the help of the local stockman or veterinary doctor. Here are some suggestions for treating common ailments. These are a few of the common practices in various parts of Uttarakhand and Himachal Pradesh.

1. Abscesses and wounds

The area around the abscess or wound must be cleaned thoroughly with clean water and then disinfected. A suitable disinfectant can be purchased from a chemist's shop. Alternatively the abscess/wound can be washed with cow (or buffalo) urine. Urine is a disinfectant, a pain killer and it promotes healing. A piece of cloth or cotton wool can be soaked with urine and applied as a pack, held in place by a cloth bandage. The urine should be collected directly from the cow or buffalo in a clean, dry container. Alternatively, a paste can be made of *dhatura* leaves and fruits. This is applied on the cleaned and disinfected abscess/wound and held in place by a clean cloth bandage. If the wound is a cut and needs stitching, request your local stockman or veterinary doctor to do it.

2. Fracture

A broken leg can be treated as follows: a. Where the fractured ends of the bone are displaced, gently, but firmly, pull and push them into alignment. b. Next wrap strips of green bark from a *kharik* or *semal* tree around the leg at the site of the fracture and tie them in place with a cloth bandage. Leave the bark in position for 15 days or so. The broken bone should have healed by that time. Alternatevely, a cloth soaked with cow or buffalo urine may be wrapped around the site of the fracture. It may be kept wet pouring more urine over it from time to time.

3. Bruises and sprains

Pour cold water gently and continuously on the affected area for some time as soon as the bruise or sprain is noticed. This will reduce the swelling and pain.

4. Anoestrus (not coming in heat)

A remedy common in Himachal Pradesh is to feed the animal a mixture of *methi* seeds (50 g.), molasses (250 g) and *bajra/madua*.

5. Bloat

Cattle and buffaloes sometimes suffer from an accumulation of gas in their stomachs. Here are three suggestions for treating this problem. First, the animal may be fed a paste of: ajwain (25 g), *hing* (10g), garlic (3-4 cloves), salt (100g) and mustard oil (100 ml). Two: boil 10g *hing* in 1 litre water, cool and give it to the animal, using a bamboo tube to administer it if necessary. Three: take a leaf of *nagfani*, peel it, roast it on a *tawa* and then feed it to the animal once or twice a day. With these treatments also make the animal walk about; this will help it to belch.

6. Dysentery (bloody faeces)

Here is a treatment from Madhya Pradesh. Mix 50 g crushed mustard seed and 250 ml of curd and feed it to the animal. Repeat this three times a day.

7. Foot-and-mouth disease

This is an infectious disease that causes sores in the mouth and on the feet. The animal does not eat and production goes down. Here again, cow or buffalo urine can be used. Wash the feet and mouth thoroughly several times a day. Another treatment is a paste of marigold and *tulsi* leaves, garlic and powdered lime rubbed on the sores.

8. Indigestion (loss of appetite)

a) Mix 10 g of *hing* with 250 g wheat *atta* and roast on a *tawa*. Cool and feed to the animal. Repeat daily until the animal is well. b) 100 g *methi* seeds are boiled in1 litre of water and administered with the animal's drinking water. c) A mixture of black pepper (50 g), *ajwain* (50 g), mustard seeds (20 g), mustard oil (300 ml), and water (1 litre) is boiled until it is reduced to 500 ml. This is cooled, divided into two doses, and one is given in the morning and the other in the evening.

9. Retained placenta

Whole wheat (250 g) is soaked overnight then cooked. *Jaggery* (100 g), *saunf* seeds (25 g), cardamom (3-4 pods) and *jeera* seeds (25 g) are added to the cooked wheat, and the whole is given to the animal with its feed.

10. Worms

Worms hatch out and grow in the intestines of an animal. Their eggs pass out in the faeces, and can be taken by other animals along with their food. This happens particularly when animals graze. If grazing is stopped the problem of worms is solved to a large extent.

Worms take some of the food of the animal and make it weak and unproductive. Sometimes worms are seen in the faeces. It is not always possible, however, to determine whether or not an animal has worms. Therefore you should treat all your animals regularly for worms -- once before the wet season and once after. You may get medicine for this from your local stockman or veterinary doctor or purchage it from the chemist. A good home remedy is as follows: for the adult animal (cow, buffalo or bullock), grind margosa (*neem*) leaves and 250 g peach leaves together and squeeze out their juice. Mix with a little water and give one half in the morning and one half in the evening. If necessary, use a hollow bamboo tube to administer it.

11. Poisoning

When animals are grazing they occassionally eat poisonous plants and become ill. When this happens give the animal slightly-warmed *ghee*. The ghee will reduce the effects of the poison.

Breeding

Our animals should produce offspring regularly to replace animals which are sold, which die or which are eaten. Also, you know that cows and buffaloes only give milk after giving birth to a calf. As far as possible, they should calve every year. She goats and sheep also give birth to young ones every year, though some types of goats may give birth three times in two years.

Female cattle and buffalo calves are usually ready for mating when they are 3 to 5 years old, depending on how well they have been fed. Females come into heat (that is, they are ready for mating) every 28 days or so and remain in heat for about 36 hours each time. During this heat period the male will mate with them. Cows which are not mated, or which do not become pregnant after mating, repeat the cycle of heat periods throughout the year. Buffaloes come into heat only between July and October, and thus can be mated only during that period. If a buffalo or cow does not come in heat, she should be shown to a veterinary doctor or treated with a home remedy as suggested in the previous section.

The pregnancy period of cows is about 9 months and for buffaloes is about 10 months. When the calf is born the cord connecting it to its mother should be tied near the calf's stomach with a string. Then cut it with a clean knife or blade just below the point where it is tied and disinfect the cut end. After calving, be sure that the afterbirth comes out. If it does not come out within a few hours, try a remedy given in the previous section, or ask for help from the stockman or veterinary doctor. For 3-4 days the mother will give very thick milk (colostrum). Be sure that the calf drinks as much as it wants of this.

Do not mate a cow/buffalo again for 2-3 months after calving, even if she comes into heat.

Select a bull for mating with your cow or buffalo which is strong and healthy, and which comes from a mother which is a good milk producer. That way the calf is likely to be a good milk producer or draught animal when it grows up.

Box 46-2

EXERCISE FOR BULLOCKS

You have learned from previous lessons that the chief cause of the deterioration of support area is grazing. A prerequisite to rehabilitation is, therefore, to discontinue grazing. Thus, year by year, as we enclose the support area block by block, the area left for grazing will decrease. Increasingly, therefore animals that are normally sent out to graze will have to be stall-fed on fodder cut by hand. At first sight it may appear that stall feeding will require much extra time and labour compared to grazing. However grazed grass constitutes only a small part of the total. Students of the Gandhi Intermediate College, Panuanaula, District Almora, found, for example, that in the four village ecosystems they studied, grazed grass accounted on an average for only 15 percent (on an air-dry basis) of the total annual fodder supply. Further, if all the fodder to be cut in the rehabilitated support area is conveniently close to our houses, time will be saved compared to the present when cut fodder must be brought from distant places. You will recall that this was the case in Tangsa village (Box 25-2). And even if more labour is required for stall feeding compared to grazing, the rewards in terms of higher production of fodder and fuel wood are well worth it.

Stall feeding also has another advantage over grazing. Animals use a lot of energy walking about grazing. With stall feeding this energy is saved. In the case of cows this saved energy can go to produce more milk.

Nevertheless, there is a problem with the stall feeding of bullocks. When bullocks graze they also get exercise which is essential if they are to remain fit and ready for work when the ploughing seasons come. If bullocks are stall-fed they do not get this exercise. How are we to solve this problem?

You might hear the suggestion that bullocks will not do much harm if they graze since their numbers are relatively few in relation to the area of the support area. This notion, however, is wrong because even a few animals can completely ruin a large area of newly-planted fodder trees. A few animals can also completely block the natural regeneration of natural, broad-leaved forest by eating new seedlings.

Even more commonly heard is the suggestion that once a new plantation is well established, and the trees reach a height of 4-5 m grazing can do no harm. This idea too is false. In any well-managed stand there are always gaps to be filled with new seedlings. These will be promptly destroyed by grazing animals. The animals' treading over the ground will cause some amount of soil erosion. Also, grazing prevents us from managing plantation as fodder bushes or fuelwood coppices.

If these two suggestions are unacceptable, what alternatives are there? Here are two for consideration:

1. A small area of the support area can be left for bullocks to exercise in; about 3-4 nalis per bullock should be about right. The area should be enclosed with a wall. All the bullocks of the village can be put in the enclosure for a few hours every day. They will be fed at stall; there will not be much grass for them in the enclosure. With so many animals in such a small area, the grass community will rapidly be degraded and severe soil erosion may occur. Therefore several such enclosures — say, about four — could be set up. Any one enclosure would be used for only one year. During the three years when it is not used for bullocks to exercise in, the grass community would recover. Possibly useful amounts of dry grass could even be harvested. In the first rest year, however, grass should preferably not be harvested.

2. Bullock pairs could be yoked and driven along any convenient road, path or vacant field for, say, half an hour daily.

In making a village, support area rehabilitation plan, be certain to make a definite provision for bullock exercise.

Date: ....

Code : Fodder 5
Month : December

EXERCISE 47

ESTIMATING FODDER CONSUMPTION 3

PROCEDURE

1. Visit your team's allotted family and weigh the amounts of various fodders fed to animals on the day of your visit. The procedure is the same as for Exercise 39. Record your figures in the spaces below:

   Green grass = ... kg

   Dry grass and straw = ... kg

   Green tree leaves = ... kg

   Green fodder crops = ... kg

   Notes

   1. Green grass is grass harvested while it is still growing.
   2. Dry grass is harvested when the grass has become mature and produced seeds. Straw is what is left after threshing grain (wheat, paddy, *maudua*, *madira* etc.) including the chaff.
   3. Green fodder crops are *berseem*, lucerne, cowpea, oats, maize, sorghum and sugarcane tops.

2. Transfer this data to the appropriate line in Table 47-1. Share your data with other teams and complete Table 47-1.

Table 47-1. Average amounts of different fodders fed per household (December)

Team number	Green grass	Dry grass and straw	Green tree leaves	Green fodder crops
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				
Average				

3. Now enter data for the average amounts of fodder of each type from the last lines of Tables 39-1, 43-1 and 47-1 to the appropriate lines of table 47-2 Complete Table 47-2.

Table 47-2. Average amount of fodder fed to animals per family/ day for the entire year

Month (1)	Green grass (2)	Dry grass and straw (3)	Green tree leaves (4)	Green fodder crops (5)
May (Exercise 39)				
August (Exercise 43)				
December (Exercise 47)				
Total				
Average (Divide total by 3)				

4. Transfer the figures from the last line of Table 47-2 to the appropriate lines of Table 47-3. Complete Table 47-3

Table 47-3. Average amount of fodder consumed per household per day on an air-dry equivalent basis

Type of Fodder (1)	Amount, kg/household/day (2)	Factor to convert to an air dry equivalent basis (3)	Air-dry equivalent basis, kg/household/day (4)
Green grass		1/3	
Dry grass and straw		1	
Green tree leaves		1/3	
Green fodder crops		Barseem, lucerne, cowpeas and oats = 1/4, maize = 1/3, sorghum, sugarcane leaves =1/2	
Total	xxx	xxx	

PROBLEMS

1. Calculate the average annual consumption of fodder per household. Show all calculations on the opposite page. Convert your answer from kg to quintals. Write your answer here:

   Average annual fodder consumption
   (Air-dry equivalent) = ... qt/family

2. Next, calculate the fodder consumption of the whole village in terms of quintals per year.

   Total village consumption of fodder
   (air-dry equivalent) = ... qt/year

QUESTIONS

1. Were green fodder tree leaves fed on the day of your visit? Which species of tree leaves?

Species	Proportion of total leaves

2. Which of the tree leaves fed today are the best? Which are the worst why?

3. Are different species/classes of animals fed different species of tree leaves? If so, why?

4. Your have identified those species of tree which in the opinion of the householders and in your opinion, are the best for feeding animals. Be sure to includ these species in your support-area rehabilitation plan (Exercise 55)?

5. Were grazing animals fed green tree fodder and dry fodder at stall?

Type of animal	Number	Approximate amount fed in kg	
		Green	Dry

6. To which animals were green tree leaves fed?

Type of animal	Number of animals	Approximate proportion of total leaves

7. How are bullocks fed when they are working in the field? Is it different from the way they are fed in those seasons when they are not working? If so, why?

8. Calculate the amount of green tree leaves as a percentage of total dry-season fodder fed at stall. The equation for doing this is:

$$\text{\% tree-leaf fodder in total dry season fodder} = \frac{\text{Green tree leaves, kg/household/day (from Table 47-2)}}{\text{Green tree leaves Kg/household/day (from Table 47-2)} + \text{Dry grass and straw, kg/household/day (from Table 47-2)}}$$

9. What is the significance of the figure you have calculated in problem 8?

10. Is the quality of fodder fed to animals the same throughout the year (see Table 47-2)? If not, why not?

11. If fodder quality is poor in some seasons how does it affect the health and productivity of animals?

12. How would you solve the problem of poor-quality fodder in some seasons?

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

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

Date: ....

Code : Ecosystem 2
Month : April

EXERCISE 48

VILLAGE ECOSYSTEM HEALTH

INTRODUCTION

In Boxes 34-1, 43-1 and 44-1 we read about ecosystem 'degradation' and ecosystem 'stability' and also about 'regression' and 'progression' of plant communities within the village ecosystem. All these concepts can be grouped under one general concept. This is ecosystem 'health'. In this exercise you will describe this concept and the symptoms of good and bad village ecosystem health. On the basis of your understanding you will be able to make good decisions about how to manage your village ecosystem in the future.

REQUIREMENTS

1. Large-sized chart paper (white) - One for each team
2. Sketch pens (black) - One for each team

PROCEDURE

You will work, to begin with, in teams to answer the following questions. Each team will write its answer on a chart paper. Then a person from each team will be requested by your teacher to present his or her team's answers, using the chart prepared by the team. Following this there will be a general discussion by the whole class and your teacher of all these answers. From this discussion one final set of answers will be agreed upon by all the students – and your teacher. These will be written on the black board and, if you like, one chart paper which can be displayed on your classroom wall. You can also make a copy in your workbook on the blank page at the end of exercise.

FOR THE TEACHER

Box 48-1 may be taken up after completing this exercise.

QUESTION

1. When we say that a village ecosystem is healthy or unhealthy what do we mean? (Answer in not more than 30 or 40 words) Here is a hint: What do mean when we say a person or an animal or a plant is healthy or unhealthy? Write your team's answer here:

2. How does a healthy village ecosystem become sick?

3. What are the symptom of good health and bad health in a village ecosystem. (Give not more then three or four symptoms for each.)

4. If our village ecosystem is sick how can we treat it to make it well again? (Give your answer in general terms, and also two or three specific examples.)

5 In what ways is our village ecosystem like a human body or that of a plant or animal?

6. If the people living in the village are not healthy, what will the effect be on the village ecosystem as a whole?

7. In Exercise 26 we determined how effectively biomass is being recycled to the cultivated fields in our village ecosystem. Should some biomass also be recycled to the support area? If not, what effect do you think it will leave on the support area, and in turn on the health of the whole village ecosystem? What biomass could be recycled to the support area?

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

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

BOX 48-1

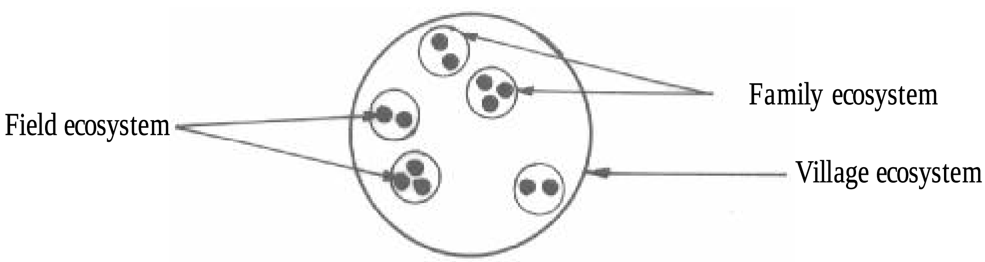
ECOSYSTEMS WITHIN ECOSYSTEMS

Our planet earth is the place where we all live – human beings animals, plants and micro-organisms. Whatever happens on the planet Earth – good or bad – affects us all, wherever we live, in the East, in the West, North or South, in the countryside or in the city. Every being is connected to every other.

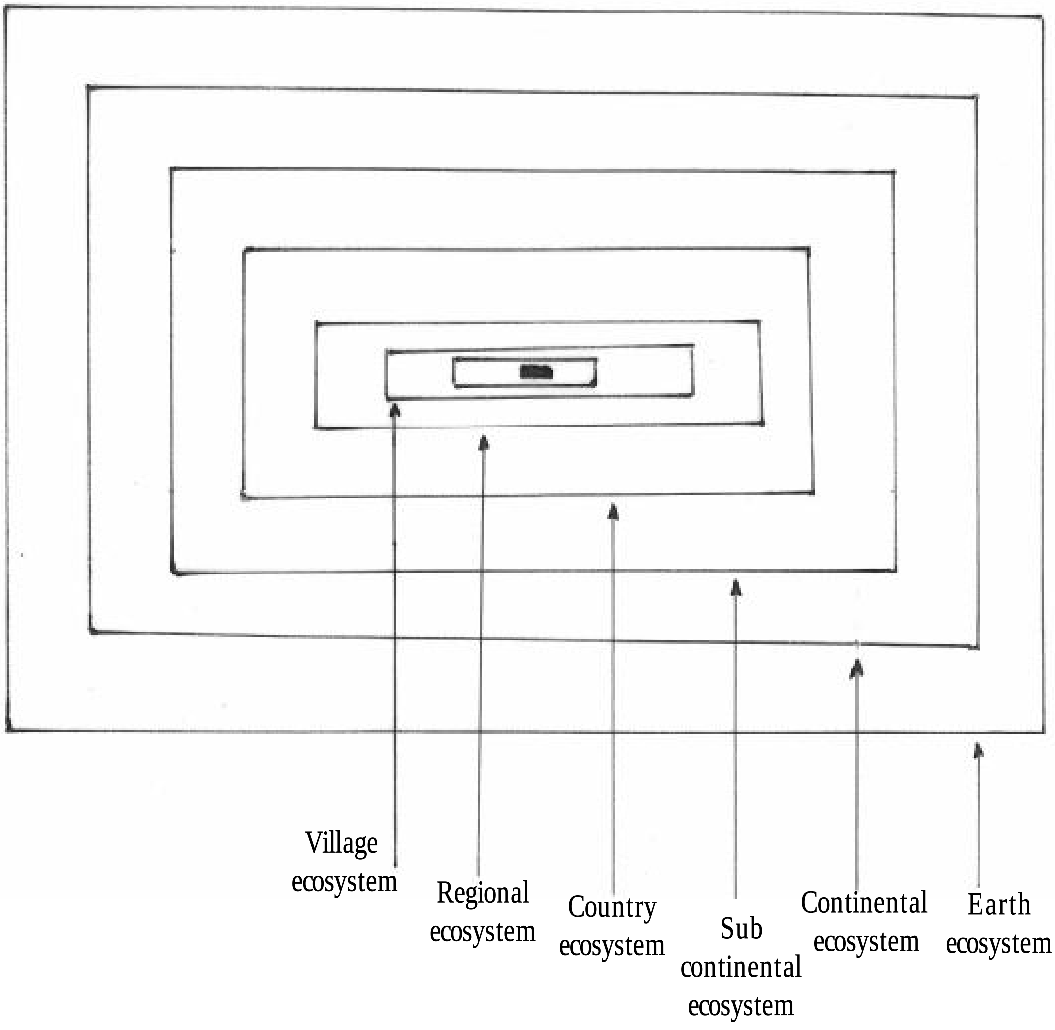
We can understand this interconnection in terms of the concept of the ecosystem. We used this concept in our study of a village. This can help us solve our current problems and manage our land, water, animals, and our community to give us a secure and comfortable life.

In this box we will learn that other entities can also usefully be thought of as ecosystems. Thus a single field in our village can be thought of as an ecosystem. It contains plants, animals and decomposers which are all interdependent. A larger ecosystem comprises all the fields of a family plus their domestic animals and they themselves. All the family ecosystems in turn form a village ecosystem.

The relationships of these types of ecosystem may be shown as follows:

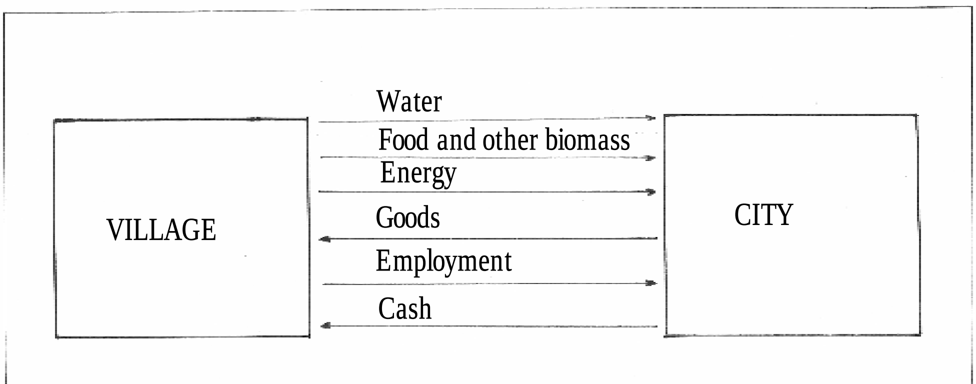


In this way, we see that inside any ecosystem there are many small ecosystems. For the good health or balance of any ecosystem, all the smaller ecosystem it contains must be healthy. Now let us consider still larger ecosystems. A large number of villages taken together can be thought of as a regional ecosystem. For example, the state Uttarakhand is an ecosystem. Still larger ecosystems are countries like India, comprising many smaller regional ecosystems. Then there are groups of countries like Pakistan, India, Bangladesh, Nepal, and Bhutan which together form the Indian subcontinental ecosystem. Several subcontinental ecosystem together form continental ecosystem such as Asia, and all continents together form the world ecosystem or earth ecosystem.



Like our village ecosystem, the ecosystem of our earth is degrading. Growing environmental problems are its indicators. For the good health of the Earth ecosystem it is essential that all the small ecosystems it contains be healthy.

Let us now take a close look at a regional ecosystem. In every region there are cities in addition to villages. The city is very unlike the village. There are many more people per hectare of land than there are in a village ecosystem, and hence most of the land in a city is covered with buildings and roads. Hence the city does not produce all the food for its residents, and must import food from the surrounding villages. As the land of cities is covered therefore it is not able to collect enough water for their many inhabitants and thus water too must be imported (water is mostly taken from rivers). Finally all the energy needed by the people in a city must also be imported in the form of petroleum, coal, natural gas, electricity and fuelwood. Thus while the city is an ecosystem, it is heavily dependent on the surrounding village ecosystems. But at the same time the city produces many goods and services that are needed by the village. The figures given below explains the inter-relationship between cities and villages.



Regional ecosystem

If both city and surrounding villages are healthy, then the entire regional ecosystem of which they are parts will be healthy. Today, most village ecosystems and city ecosystems are sick. In this course we have seen how and why our village ecosystem is sick. Let us now consider the city.

In what ways are cities sick, and how can they be made well? Here are the main ones:

1. Improper management of biomass: 'Wastes' from food and other biomass that flows into the city is not recycled to the land, and therefore it accumulates in dumps or is put into rivers. This causes pollution of ground water and river water. The water is thus unhealthy and causes illness when people drink it. If city people were to make compost of all biomass residues (kitchen waste, human waste and dead plants and leaves), and sell it to villages, city as well as village problems would both be solved.

2. Toxic chemicals: Chemical wastes from factories are not recycled, but put into rivers, again poisoning the water for fish, water plants and human beings. Factories which produce the things we all need but which recycle waste are needed.

3. Air pollution: The air is polluted by the smoke from burning coal and petroleum in houses, factories, trucks, cars and buses. When people breathe this polluted air they become sick. To reduce air pollution we need to burn less fuel and find other fuels that do not pollute the air when burned.

4. Noise pollution: With so many people and activities in a small space, there is much noise. This is also harmful to human health.

There are several ways in which city ecosystems make village ecosystem sick, and vice-versa. Here are the important ones.

1. Polluted irrigated water: River water contaminated by cities (points 1 and 2 in the previous list) is used by village people to irrigate their crops, thus poisoning their land and the food that is produced by it. Some of this poisoned food and water returns to the city, hence everyone is affected.

2. Polluted air: Polluted air from the cities drifts over surrounding villages and the toxic chemicals it contains adversely affect the growth of crops and poisons the food produced by them.

3. Agricultural chemicals: Chemical fertilisers and pesticides (produced in the city) poison land, ground water and food, when

used in the village. All of these affect people living both in the village and in the city.

4. City population: The living standard of people living in the villages (for example, in hill villages of Uttarakhand) is going down because of degradation of our village ecosystem. Therefore they are migrating to cities and the populations of cities is going up which is the one cause of various problems of cities mentioned earlier.

We have learned how to make our village ecosystem healthy and productive. If we do, then many problems of the cities will be solved. For example, by stopping the use of agricultured chemicals we will solve the cities' problems of poisonous food and water. Thus if every one tries to solve the problems of his or her local ecosystem (village or city), everyone, in both cities and villages, will be healthier and more prosperous. The regional ecosystem will be more healthy.

Now, if we solve the problems of our regional ecosystems, we will also be helping to solve the problems of the Earth ecosystem. For example, if we, in our own village and city ecosystems, stop polluting air and water, and people in all village, city and regional ecosystems stop polluting air and water then the Earth's atmosphere and oceans will no longer be polluted. Everyone in the world will benefit.

WHAT WE HAVE LEARNED THIS YEAR

1. What is an 'eco-sphere'? In what ways is it a model of the earth?

2. Why is *chir* called an indicator species when it occurs in the support area of a village situated at an altitude of 2000 m?

3. One management block of the support area of a village situated at 1000 m altitude carries at present only a few *chir* trees and a sparse ground cover of *doob* grass, annual grasses and broad-leaved herbs. Describe, in general how this block might be rehabilitated and managed in the future for fuelwood and/or stemwood production. The slopes in the block are class III and the *gadheras* are class I.

4. What is the cause of global warming? How will it probably affect India, Uttarakhand, our village?

5. The human population of a village increased from 45 to 65 in the past 10 years. What is the proportionate rate of increase? Show your calculation.

6. Explain the meaning of the term ‘canopy cover’.

7. Describe the green-fodder niche in a present-day village ecosystem in terms of food supply and in terms of the species/types of animal that occupy it.

8. How can we avert an energy crisis in our own village in the future?

9. How can a *gobar* gas plant help to increase the production of crops and animals in our village?

10. Explain how a diversity of species of plants and animals makes our village ecosystem more healthy and productive?

11. There is generally a sharp decrease in the milk yields of cows and buffaloes in the month of November. Why does this happen?

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

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

WELCOME

WORK DISPLAY DAY

CLASS NINE

TOPICS FOR DISPLAY

The items for work display day this year, with some suggestions for each, are the following. Most of them will require some additional research on your part and/or special preparations. For this reason, your teacher will make the assignments at the beginning of the year.

1. Fodder - Display samples of fodders with labels giving their names and season when fed. Explain with charts/specimens which fodders are better and why. Explain which types of animals are fed on which types of fodder and why. Amounts of different types of fodders available in your study village. Explain how more better quality fodder could be produces. What would be the effect of this on animals (numbers, types, productivity). (Exercise 39, 43 and 47 Box. 39-1)

2. Animals in our study village - Display with charts the animal population figures in different seasons in your study village. Explain why these differences occur. Show the role of each type of animal in the village ecosystem (Exercise 88 and Box 38-1)

3. Animal management - Explain how animals are managed at present (e.g., summer grazing of sheep, purchase and sale of pregnant/milking buffaloes, sharing of bullocks). Explain how the management of animals would change with support-area rehabilitation (stall feeding, mangers, bullock exercise). How to treat sick animals. What treatment are given by the people of your study village for bloat, indigestion, diarrhoea, fever cough, mastitis, foot-and mouth disease, retained placenta (Do some research to learn remedies and then display them). (Exercises 38, 42 and 46 and Boxes 38-1, 46-1)

4. Support area management - Explain the importance of species mixtures (fodder, variety, availability throughout year, control of insects and pests). Importance of adapted species. Species indicators of support-area degradation. Some appropriate species mixtures for fodder, fuel and stem wood for your area. (Display a chart showing

how fodder mixture would provide fodder all year round, i.e. which types of fodder would be available in each month.

5. Global warming - Explain with charts the meaning of global warming. Describe the signs of global warming in the world, India and in our village. Describe what we can do in our own village to protect ourselves from global warming? (Box- 40-2)

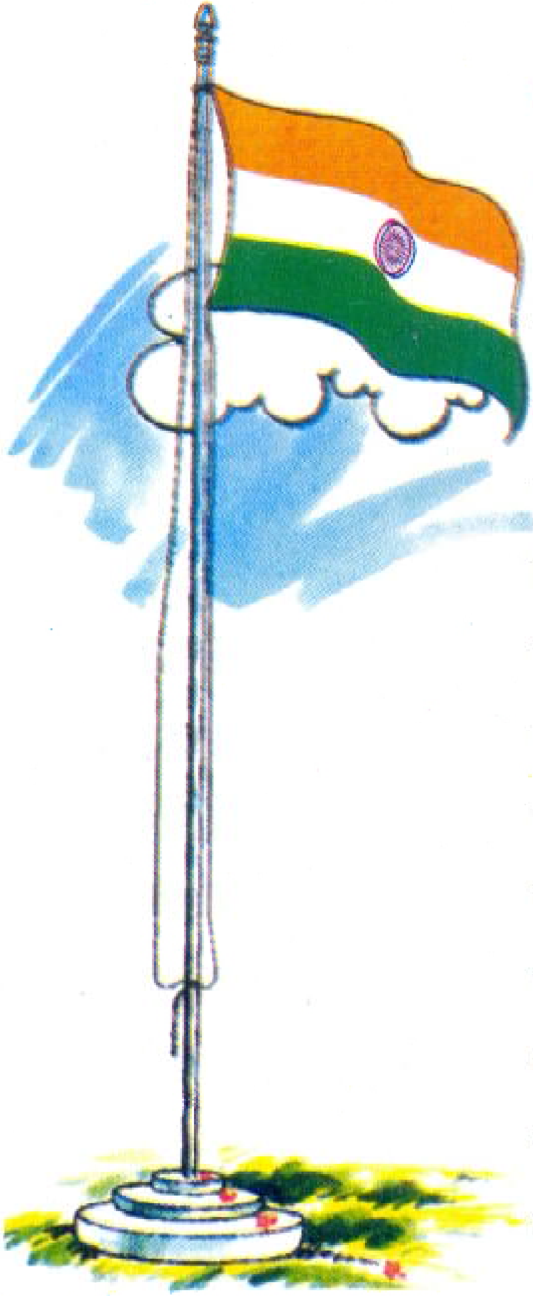
6- Non-waste feeding mangers - Construct a non-waste manger and demonstrate how it works. Explain the benefit from this manger (Box 39-2). It is suggested that the members of the team assigned this topic build one of these mangers in their own homes and train one or more animals to eat from it. This will give you experience and confidence in making your presentation.

7. Human population in our study village - Using a chart explain how to determine the amount of increase or decrease in the human population of a village. Give the figures for your study village at present and 10 years ago. Compare these with the population figures for Uttarakhand and India. Define the concept of carrying capacity. Why is it important to understand this concept and ensure that it is not exceeded? (Boxes 44-1 and 44-2)

8 *Gobar* gas - Explain the advantages of a *gobar* gas plant. Describe its working. (Before undertaking this display, visit a working *gobar* gas plant and familiarise yourself with it.) Make a model for display. Where will these plants work effectively? (Box 38-2)

9. Species adaptation - Explain the concept of species adaptation using charts showing specific examples in your locality. Give examples of indicators of ecosystem degradation and of species migration from one niche to another. (Box 43-1)

You can also prepare a display of your own design on a topic of your choice. Not all the topics given above are suitable for all places (like gobar gas plants). The topic you choose should be suitable for your particular place. For example, if your school is in the plains you might like to set up a display on drought power bullocks and tractors and the advantages and disadvantages of each. Discuss your plan with your teacher and get his or her suggestions and approval.



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।।