CHAPTER 6
Meaning and Importance of Agricultural Ecology

OBJECTIVES

At the end of this chapter, students should be able to:

â define agricultural ecology and ecosystem.
â state four components of the agro-ecosystem.
â describe the interactions between farm crops/farm animals and the biotic and
abiotic components of the ecosystem.

6.1 Introduction

Agriculture is important for provision of food for any nation. The business of agriculture is carried
out within the ecosystem. The environment is very important because it constitutes all the physical surroundings around us. Therefore, all the living organisms that have been domesticated by man in agriculture are all components of the environment.
These domesticated plant and animal species interact together in the environment to form the agro-ecological system.

6.2 Meaning of Agroecology and Ecosystem

Ecology is the study of the relationships between organisms and their environment.
The study of an individual organism or a single species is termed *autecology* while the study of groups of organisms is called *synecology*.
Human activities have interfered with the complex ecological relationships. Such human activities include agricultural activities like large-scale farming that involves the use of pesticides and expansive land-clearing, oil exploration, construction works and urbanisation. These have seriously disturbed the natural balance in the ecosystems. Agricultural ecology is the study of agricultural ecosystems and their biotic and abiotic components as they function within themselves and in the context of the landscapes that contain them. Application of this knowledge can lead to development of more sustainable agricultural ecosystems that are in harmony with their larger ecosystem and eco-region.
The ecological system is usually written simply as ecosystem and it consists of the complex interactions between plants and animals in their natural environment. It is a natural system of relationships in which energy and matter are circulated in a continuing cycle in the environment. It is also a network of systems in which different kinds of organism depend on one another for food supply and survival. This complex network of food dependence is often described as food chain or food web.

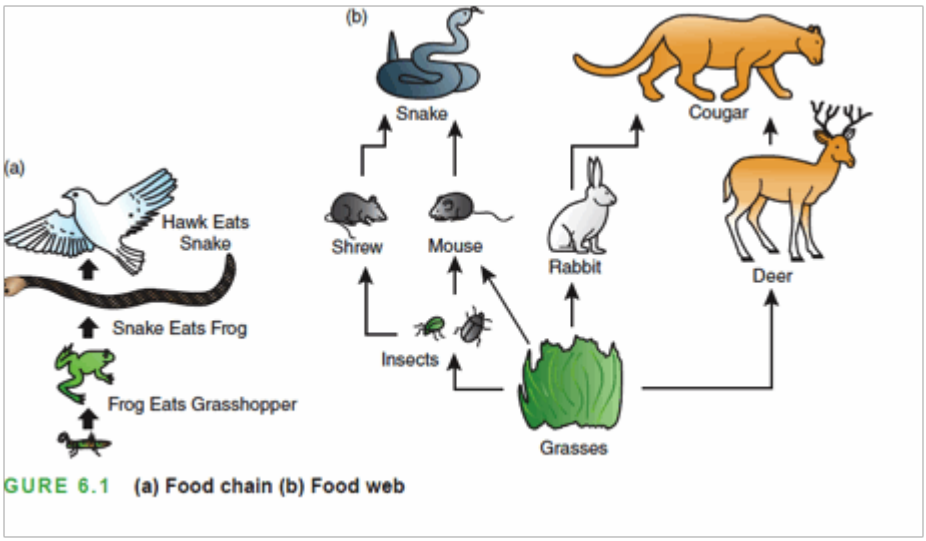
6.3 Components of the Agro-Ecosystem

The agricultural ecosystem is made up of both living (biotic) and non-living (abiotic)

components, and together, they constitute the ecosystem structure. The non-living
matter constitutes the abiotic factors while the different living organisms such as the plants and animals in their environment are called the biotic factors.

6.3.1 Abiotic factors

The **abiotic factors** are also known as the physical factors of the environment and they
consist of (i) the climate ; (ii) the physiographic (land shape/form) and (iii) the edaphic (soil) factors.
The climate is made up of the weather factors such as the rainfall, humidity



GURE 6.1 (a) Food chain (b) Food web

temperature, wind and sunshine as they affect the living components.
The physiographic factors consist of the topography and other features that relate to the shape of the land and terrain. The edaphic factors relate to the soil and its characteristic conditions such as the structure, texture, soil air and the soil pH.

6.3.2 Biotic components of the ecosystem

The biotic or the living components of the ecosystem are divided into two categories –
the autotrophs and the heterotrophs.

Autotrophs

These are the organisms that are capable of synthesizing their own food from inorganic
material such as nitrogen, phosphorus and potassium taken from the medium in which
they grow whether soil or water, using the solar energy from the sun by a process known
as photosynthesis. All green plants and some forms of bacteria are examples of autotrophs. They are also known as producers in a food chain as they are able to produce their own food. This food is directly or indirectly used by other species along the food chain.

Characteristics

â Autotrophs are self-feeding or self sustaining members of the ecosystem.
â They synthesize complex organic compounds such as carbohydrates, proteins
and fats, from simple inorganic molecules, with the help of sunlight energy or

by
inorganic chemical reactions. Depending on the method by which they synthesize their food, autotrophs are further classified into two categories :
â *Phototrophs* – These are mostly plants, which use light as source of energy.
â *Chemoautotrophs* – Bacteria or fungi that obtain their food by inorganic chemical reactions.

Heterotrophs

These are the organisms which obtain energy and matter from the organic molecules that are made by the autotrophs. These organisms cannot synthesize complex food materials from simple inorganic sources like the autotrophs. Therefore they depend on the producers (the plants) or autotrophs, for the supply of organic compounds that they require for their growth. They are also called consumers.

Characteristics

â They obtain energy from producers.
â They function as consumers in the food chain. The complex organic compounds
that are produced by the autotrophs are broken down into simple substances that
provide energy to the heterotrophs. Heterotrophs are also classified into two categories as photoheterotrophs and chemoheterotrophs, depending on the energy source.

The consumers (Heterotrophs) are further classified into different categories, based on their mode of consumption as follows.

â *Herbivores* – these are the heterotrophs that obtain their energy and matter directly from plants.
â *Carnivores* – These are animals which feed on other animals. They are also called secondary consumers.

TABLE 6.1 Similarities between autotrophs and heterotrophs

Similarities

1 Autotrophs and heterotrophs are organisms and both are part of some ecosystem.

2 Both autotrophs and heterotrophs together form various trophic levels in the food pyramid.

3 Both autotrophs and heterotrophs require sunlight and water to live and obtain energy by conversion of chemical molecules.

TABLE 6.2 Differences between autotrophs and heterotrophs

	Differences	
	Autotrophs	Heterotrophs
1	Autotrophs can synthesize their own food through photosynthesis or chemosynthesis.	Heterotrophs cannot synthesize their own food through photosynthesis or chemo-synthesis, they use already made organic molecules from the autotrophs.
2	Autotrophs contain the pigment chlorophyll that plays a key role in synthesis of food.	Chlorophyll is absent in almost all heterotrophs.
3	Autotrophs obtain energy by converting inorganic raw materials into organic compounds.	Heterotrophs convert complex organic compounds into simpler ones to obtain energy.

â *Omnivores* – These are animals that feed on both plants and animals.
â *Saprobes* – These are organisms that obtain their energy by breaking down remains of dead plants and animals.

6.4 Ecological Relationships between Biotic and Abiotic Components of the Environment

6.4.1 Producers

The green plants are the producers of food in the ecosystem and they occupy the primary level. They are called the producers because they have the special ability to carry out photosynthesis. This is the process whereby green plants use the energy from sunlight to fix simple inorganic materials obtained from the environment such as phosphorus, nitrogen and potassium to produce carbohydrate.

The carbohydrates that are formed are stored in various parts of the plants such as in the fruits, stems, leaves and in the roots. These stored foods form the resources that other organisms at higher trophic levels obtain from the plants.

6.4.2 Consumers

These are living organisms otherwise called heterotrophs that feed directly or indirectly on the plants at various levels. These are classified variously as follows.

Herbivores – These are organisms that feed directly on plants. They are usually called the primary consumers. Their body morphology and habit have been adapted to grazing or foraging on plants or plant products. Examples of herbivores are the ruminants such as cattle, goats, sheep, horses and donkey and some insects such as locust, grasshoppers and aphids.

FIGURE 6.2 Herbivores

Carnivores – These are organisms that feed directly on the flesh of other organisms. Their body morphology, physiology and habits have been adapted to feeding on other organisms either as predators or as parasites. Examples of predators are lions, hyenas, dogs, cats and eagles. There are also insect predators such as the praying mantis and the parasites such as the gall midge parasitoids. Many of the parasites and predators have been used in agriculture for biological control.

FIGURE 6.3 Omnivores

Both the herbivores and carnivores interact together at higher level to produce more
complex relationships such as the secondary carnivore (which feed on the primary carnivore) and tertiary carnivore (which feed on the secondary carnivore).

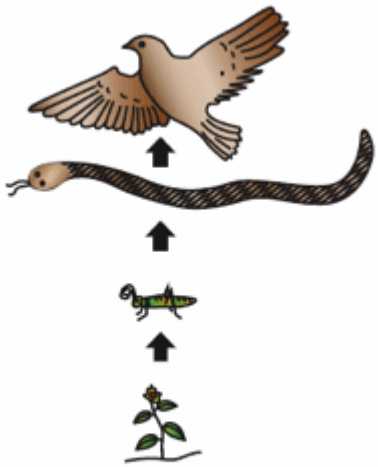


FIGURE 6.4 Food chain

Omnivores – These are organisms that feed on both plant and animal materials. Their body morphology and physiology have been adapted to feeding on these materials. Examples include man, many birds like the weaver bird that feed on grains and insects.

FIGURE 6.5 Omnivores

Saprobes – At the end of the relationship are the saprobes, which feed on all others whether the producer or the consumer. They are otherwise called the decomposers. They are organisms, usually microorganisms that feed on and break down the complex molecules accumulated by the other groups whether herbivore, carnivore or omnivore.
Examples are bacteria and fungi.

FIGURE 6.6 Mushrooms

The energy (obtained initially from sunlight) and matter (inorganic matter which had

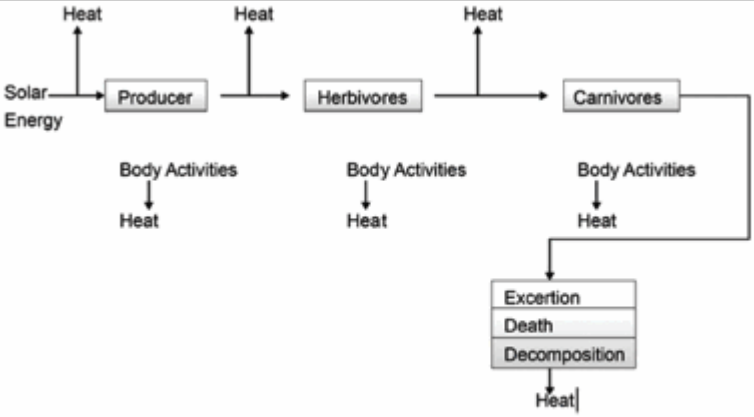


FIGURE 6.7 Energy and material circulation in the ecosystem

been obtained from the medium on which the plant grows) are circulated in the ecosystem and thereafter returned to the medium whether soil or water.

6.5 Classifications of Ecosystem

Based on the degree of disturbance by man, the ecosystem can be classified into natural and man-made ecosystems.

Natural Ecosystem

The natural ecosystem is an assemblage of different plant and animal species in an undisturbed environment. The species diversity is very high and very complex. It consists of large number of wild undomesticated species. The number of species that are interacting together is very high. All the natural factors that control and maintain balance in the ecosystem such as predation, competition for food and space, parasitism are all at work to keep the populations of species under check and balance. Examples of natural ecosystems are the oceans, the seas, the fresh water, swamps, the undisturbed forests and the deserts.

Man-Made Ecosystem

These are the artificial grouping together of selected domesticated species. This consists of different species whether local or imported that are raised by man. These may be crops or animals that have been

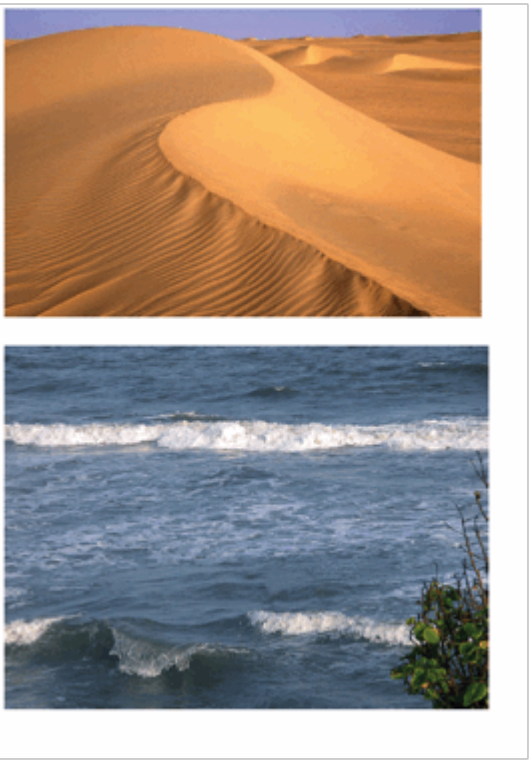


FIGURE 6.8 Natural ecosystem

FIGURE 6.9 Man-made ecosystem

selectively domesticated by man. It also includes some organisms that have found their ways into other areas by way of the different activities of man that allows them such as the water hyacinth. The species diversity in this kind of ecosystem is usually very low due to the deliberate actions and maintenance by human beings. Some

maintenance operations which are carried out in the agro-ecosystem include weeding to remove other unwanted plants, slashing and thinning or to encourage a particular species such as manuring. Examples of man-made ecosystems are agro-ecosystem (farm lands), forest ecosystem (teak plantation) and aquatic ecosystem (fish ponds).

Ecological studies are carried out in different ways.

â Physiological ecology focuses on the relationships between individual organisms and the physical and chemical features of their environment including their responses to such physical and chemical features.

â Behavioural ecology relates to study of the behaviours of individual organisms as they react to their environment.

â Population ecology deals with the study of processes that affect the distribution and abundance of animal and plant populations.

â Community ecology relates to studies on how communities of plant and animal populations function and are organized concentrating on particular subsets of organisms such as plant communities or insect communities.

â Ecosystem ecology studies large-scale ecological issues, ones that are often framed in different measures such as biomass, energy flow, and nutrient cycling.

â Applied ecology deals with the application of ecological principles to the management **of populations of crops and animals**

â Theoretical ecology deals with the use of simulations and mathematical models of

particular practical problems to develop models of general ecological relevance.

6.7 Interactions of the Components of the Terrestrial and Aquatic Ecosystems

6.7.1 Predation

This is a relationship in which one organism eats another. Herbivores eat plants. Carnivores eat animals. There are also carnivorous plants that feed on animals. Carnivorous plants consume insects because the soil in which they grow is very poor in nutrients and the plants need more nitrogen. Although, these plants still get their energy from the sun through photosynthesis, the body morphology and physiology of these predators is adapted for predatory habits. Usually the predator is bigger than the prey.

It has other physiological advantages such as comparatively larger body size, aggressive behaviour, agility and greater strength over the prey. An example of predation is the praying mantis (predator) which preys on the grasshopper (prey).

FIGURE 6.10 A praying mantis and a grasshopper

6.7.2 Parasitism

This is similar to predation in that one species benefits at the expense of the other. The differences are that the host is not usually killed in the process and the parasite is usually smaller than the host. The parasite can be located inside the body of the host, such as roundworms. These are called internal parasites or *Endo-parasites*. They may however be located on the external part of the host body such as ticks and leeches. These are called *external parasites or Ecto-parasites*.

The plant sucking insects such as aphids and mealy bugs are called plant parasites.

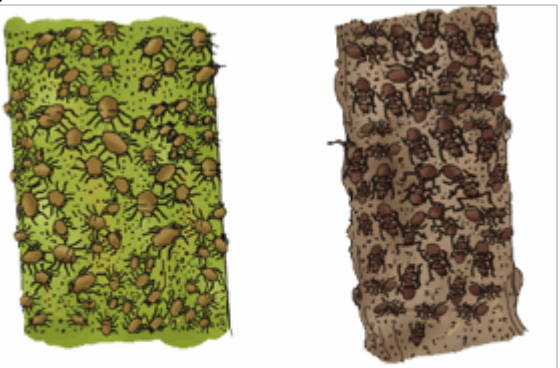


FIGURE 6.11 The plant-sucking insects

6.7.3 Commensalism

This is a type of relationship in which one individual called the commensal benefits and the other called the host is neither harmed nor helped by the interaction. For example, the epiphytes on the trunks of rain forest trees in Nigeria are helped by the trees which give them a surface on which to grow but the trees do not seem to be disturbed by the epiphytes, unless the weight of the epiphytes gets heavy and the tree branches break or fall off.

6.7.4 Mutualism

This occurs when two or more organisms of different species benefit from their association. This is sometimes called symbiosis.A good example is the relationship between pollinators and plants. In this case, the plants have their pollen transferred from flower to flower and the animal pollinator (bee, butterfl y, beetle and hummingbird) obtains food (usually

in the form of nectar or pollen). Dispersal of seeds is also often accomplished through a mutually benefi cial relationship between the plant and its animal disperser. Many animals eat the sweet fruit that surrounds the seeds and later deposited the seeds in new locations at some distance away from the parent plant in the fecal droppings which also adds to the soil fertility. All these types of interactions occur between species in every ecosystem.

6.8 Examples of Interactions in the Agro-ecosystem under Different Cropping Systems

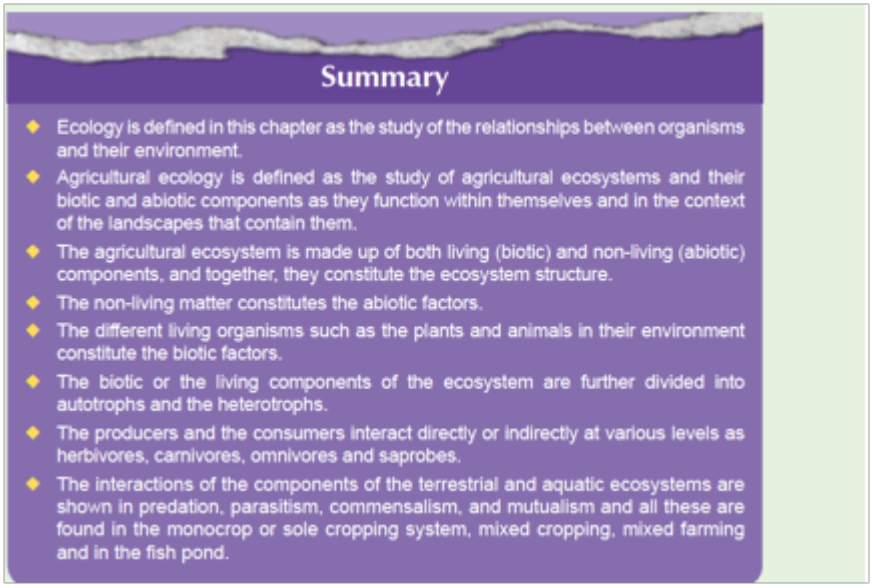
6.8.1 Monocrop or sole cropping system

This is the type of cropping system in which a single crop is planted on a wide expanse of land at a time. Such concentration of a single crop is called a plantation. In such monocrops, the planted crop will favour only a particular group of animals that depend on it. All other organisms that are not favoured or associated with the crop either for food, shelter or reproductive purposes will either migrate away from the plantation or starve to death. This usually encourages outbreak of particular pests because the plantation has provided large amount of food for the favoured dependent species. Most relationship between the animal and the host plant are parasitic in this setting. Example is aphids on cowpea.

6.8.2 Mixed cropping

This is the type of cropping system in which more than one crop is planted on a wide expanse of land at a time. Such mixed crop has a lot of advantages when the right

Activity 1: Go outside and observe the activities of animals (insects, spiders, birds, amphibians, mammals, etc.) in the surroundings and record how they interact with the plants there. Is there any evidence of animals eating plants or of animals helping plants?
Encourage students to create a chart of their observations and suggest the type of relationships observed between the plants and animals studied.



REVISION QUESTIONS

Essay Questions

1. Define agricultural ecology and explain the following briefly.
(a) Biotic factors
(b) Abiotic factors
(c) Autotrophs
(d) Heterotrophs

2. Mention two types of autotrophs and give two examples of each. Enumerate
two characteristics of autotrophs.
3. Define heterotrophs. Mention two types of heterotrophs and enumerate four categories of consumers based on their mode of consumption.
4. What are saprobes? Enumerate three similarities and differences between autotroph and heterotroph.
5. What are herbivores? Enumerate three characteristics of predators and describe two examples of predation.

Objective Questions

1. Agricultural ecology can be defined as
(a) The study of agricultural ecosystems and their biotic and abiotic components as they function within the context of the landscapes that contain them.
(b) The application that can lead to development of more biotic and abiotic ecosystems that is in harmony with their larger ecosystem and eco-region.
(c) The study of the complex interactions between plants and animals in their physical environment.
(d) The complex network of food inter-dependence.

2. The major source of energy for almost all ecosystems on the earth is
(a) moon.
(b) sun.
(c) stars.
(d) fuel.

3. A major process by which autotrophs manufacture food is

(a) photosynthesis.
(b) chemosynthesis.
(c) thermosynthesis.
(d) thigmosynthesis.

4. The biological relationship in which one organism eats another is called
(a) cannibalism.
(b) predation.
(c) parasitism.
(d) mutualism.

5. A carnivorous plant consumes insects because the soil in which they grow is very
(a) fertile in nutrients.
(b) rich in nutrients.
(c) wealthy in nutrients.
(d) poor in nutrients and the plants need more nitrogen.

Answers to Objective Questions

1. (a) 2. (b) 3. (a) 4. (b) 5. (d)