Chapter I. Plant and animal production

I. Ecosystems

1. Natural ecosystem

An ecosystem comprises **all the organisms** and also **the physical environment** with which they **interact**. Both of these **biotic** and **abiotic** components are linked together via **nutrient cycles** and **energy flows**. **Energy** enters the system via **photosynthesis** and is then incorporated into the **plant tissues**. After feeding on plants and on one another, **animals play a significant role in the movement of matter and energy in the system**. They also help in influencing the quantity of plant and microbial biomass present. By breaking down dead organic matter, decomposers release carbon back into the atmosphere and facilitate **nutrient cycling** by converting all the nutrients stored in dead biomass back to a form which can be readily used by plants and microbes.

An ecosystem is a physically defined environment, made up of two inseparable components:

1.1. biotope (abiotic components)

The abiotic components of an ecosystem include all **chemical** and **physical elements** i.e. **non-living components**. They consist of abiotic factors like climate, type of soil or rock, altitude, temperature, nutrients, and minerals, salinity, pH of water, light intensity etc.

1.2. Biocenosis (biotic)

They are the **living things** that have a direct or indirect influence on other **organisms** in an environment. For example, **plants**, **animals**, and **microorganisms**. Biotic components can be classified into three categories:

- **Producers:** These include all the **autotrophs**. They use light energy and synthesize food on their own, e.g., plants, green algae, etc.
- **Consumers:** These include all the **heterotrophs** that directly or indirectly depend on producers for their food. Consumers are further categorized as **herbivores**, **carnivores**, **omnivores** and **parasites**.
- **Decomposers:** (**detritivores)** break down dead **plant and animal material** and **wastes** and release it again as energy and nutrients into the **ecosystem for recycling**.

2. Natural ecosystem productivity

A food chain is a chain which shows how organisms are linked to each other through food. **A food web** shows how two food chains are connected. **Every food** chain begins with **producers** and ends with **top carnivores.**

Food webs ensure the **transfer of matter and energy**, but in a food chain, the matter produced by each link is much less than that of the previous link because:

- Not all organic matter is consumed.
- Some of this matter is not assimilated and will be rejected.
- Some is degraded by respiration to produce energy.

The figure below illustrates this transfer of matter.

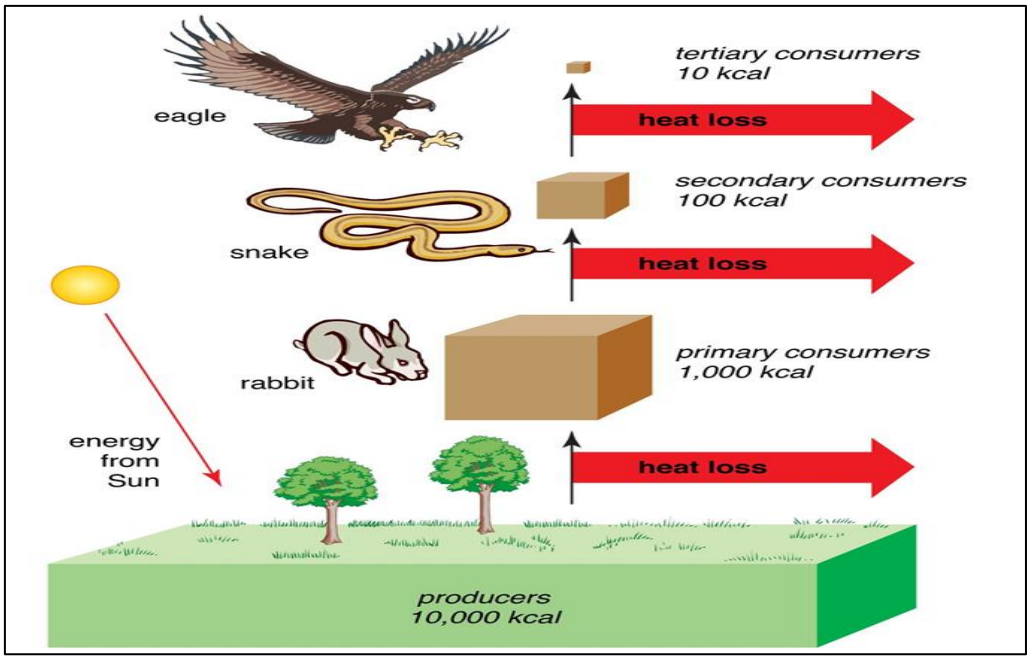


Figure 1: Energy flow and trophic levels.

Trophic levels can be represented by numbers, starting at level 1 with plants. Further trophic levels are numbered subsequently according to how far the organism is along the food chain.

Level 1: Plants and algae make their own food and are called primary producers.

Level 2: Herbivores eat plants and are called primary consumers.

Level 3: Carnivores which eat herbivores are called secondary consumers.

Level 4: Carnivores which eat other carnivores are called tertiary consumers.

Level 5: Apex predators which have no predators are at the top of the food chain

3. Agrosystem

Agricultural ecosystems are artificial ecosystems created in the process of developing land and coastal/aquatic areas for farming, animal husbandry and fishing. The definition of an agroecosystem is a dynamic association of crops, pastures, livestock, other flora and fauna, atmosphere, soils and water. As the name implies, at the core of an agroecosystem lies the human activity of agriculture. However, an agroecosystem is not restricted to the immediate site of agricultural activity (e.g., the farm), but rather includes the region that is impacted by this activity, usually by changes to the complexity of species assemblages and energy flows, as well as to the net nutrient balance. Traditionally an agroecosystem, particularly one managed intensively, is characterized as having a simpler species composition and simpler energy and nutrient flows than "natural" ecosystem.

Table 1: Natural ecosystems and Agrosystems.

Property	Naturel ecosystems	Agroecosystems
Human control	Low	High
Net productivity	Medium	High
Species and Genetic diversity	High	Low
Trophic Interactions	Complex	Simple
Habitat heterogeneity	Complex	Simple
Nutrient cycles	Closed	Open
Stability (resilience)	High	Low

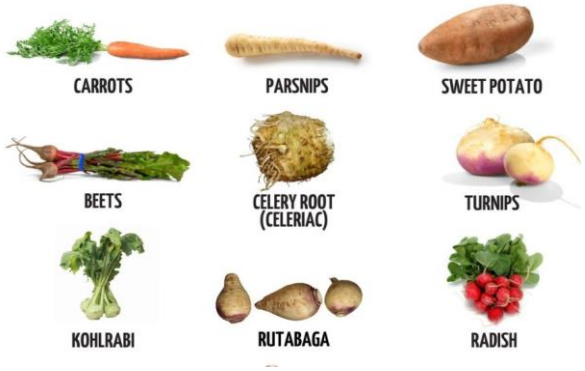
II. Productivity of agrosystems

1. Vegetable matter

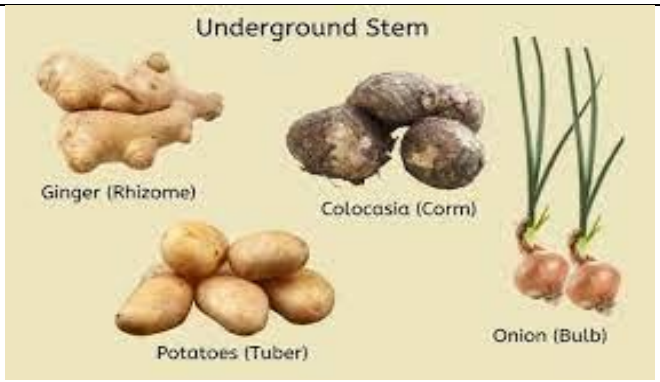
Vegetable, in the broadest sense, any kind of plant life or plant product, namely "vegetable matter"; in common, narrow usage, the term *vegetable* usually refers to the fresh edible portions of certain herbaceous plants-roots, stems, leaves, flowers, fruit, or seeds. These plant parts are either eaten fresh or prepared in a number of ways, usually as a savory, rather than sweet, dish.

Most **fresh vegetables** are **low in calories** and have a **water content** in excess of 70 percent, with only about 3.5 percent protein and less than 1 percent fat. Vegetables are good sources of **minerals**, especially **calcium** and **iron**, and **vitamins**, principally A and C. Nearly all vegetables are rich in dietary **fibre** and **antioxidants**.

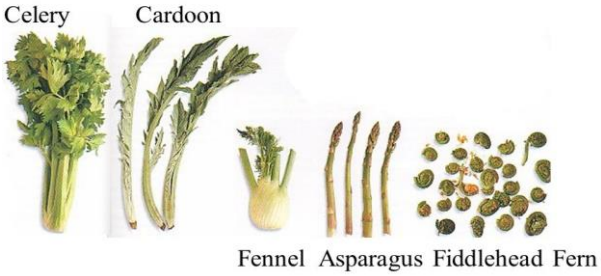
Vegetables are usually classified on the basis of the part of the plant that is used for food.



Root vegetables



Edible tubers, or underground stems



Different types of vegetable stems

Fruits

Green leavy vegetables

2. Livestock farming

Livestock farming refers to all the activities carried out to ensure the production, reproduction and maintenance of domestic animals in order to obtain various products or services. In wealthy countries, it mainly involves the production of meat, milk, eggs, sometimes leather and, more locally, labour and manure. In some traditional societies, wealth and prestige are still expected.

Livestock farming includes phytophagous animals (rank 1 consumers or secondary producers). It costs much more than crop production. For example, to produce 1 kg of meat, a cow needs 10 kg of grass. To produce 1 kg of grass, 400 to 500 litres of water are needed. Producing one kg of meat therefore requires 4,000 to 5,000 litres of water.

The primary purpose of livestock farming is to feed people, by transforming plants into animal products.

2.1. General Classification of Animal Products

- Animal Foods: Animal foods refer to the edible parts of the **animal carcass** (body of the **animal after it is killed**) or those products obtained from the live animal. The animal foods comprise **meat, milk, eggs** and the processed products from these as well as the edible parts of the carcass such **as kidneys, brain, liver, heart, intestine and tongue** (usually called offal).

- Slaughterhouse by-products: These refer to inedible parts obtained from the animal **after it is killed** comprising **rumen** contents (undigested or partially digested food remaining in the largest intestine (called rumen) of animals such as cattle, sheep and goats); blood, bone, hair, horn, hoofs, feathers, skin (skin of small animals e.g., sheep, goats and rabbits) and hides (skin of large animals e.g. cattle). However, blood, bone, skin and hide may be classified as animal foods depending on the existing or acquired custom and tradition of the people.

- Manure: This is the waste or remnant of food eaten by the animal that was not digested or absorbed but has gone through the whole of the intestine and is passed out through the rectum or anus. It is usually used as organic (natural) fertilizer that helps to promote plant growth. Manure can also be used in the production of biogas. Biogas is gas obtained when manure is mixed with plant or crop material, which then decomposes by the action of microorganisms (especially bacteria) in the absence of oxygen. This is done in a small container or a large tank. The biogas, which is basically methane can be used for cooking or used as fuel to power generators to produce electricity.

2.2. Types of livestock farming

2.2.1. Intensive livestock farming

This is the rearing of a large number of animals over a small area. This technique allows high productivity and low-cost meat production. However, the close proximity of many animals of the same species encourages the development and spread of disease, so preventive phytosanitary treatment is important on these farms, as are hygiene conditions. Intensive livestock farming also requires large quantities of feed (fodder or seeds) and therefore the development of high-yield agrosystems.

2.2.2 Extensive livestock farming

Extensive livestock farming or extensive grazing is a method of rearing cattle, sheep, etc. characterised by a low density of animals per hectare. This type of farming is essentially based on

the use of available natural resources (water, pasture, etc.). It is generally practised in large areas to which the animals have access by moving around.

The differences between the two farms are illustrated in the table below:

Intensive livestock farming	Extensive livestock farming
- Quantitative model	- Qualitative model
- Large livestock	- Large to medium-sized livestock
- Productive animals	- Hardy but productive animals
- High animal density	- Low animal density
- Use of inputs	- No use of inputs
- Animal well-being is not taken into account	- Promoting animal welfare (well-being)

3. Environmental impacts of livestock farming

- It is one of the leading contributors to global warming due to its massive carbon monoxide emissions during the burning of fossil fuels as a result of mechanization, as well as methane produced by animals during digestive processes. Increased temperatures caused by raised greenhouse gases also indirectly affect harmful insect pests making them more active earlier in the season than usual leading to greater crop loss for some animal feed ingredients kept in storage.

- The production process generates significant amounts of waste products such as manure and antibiotics which can contaminate local waterways when improperly managed or disposed of. Intensive animal production as well uses large amounts of antibiotics which leads to increased antibiotic-resistant bacteria in humans or other organisms.

- Livestock production also requires large amounts of water which can lead to water pollution when runoff enters rivers or groundwater sources, carrying excess nitrogen or phosphorus from fertilizers that are used on pastures where animals graze. This water contamination leads to tremendous damage to marine life.

- Land use is also affected by other grazing practices such as overgrazing and monoculture grazing systems resulting in soil erosion problems. Soil erosion leads to loss of fertility and vegetation cover, which reduces biodiversity levels around agricultural lands.

- Energy use: Livestock farming requires significant amounts of energy for feed production, processing, and transportation. This can lead to increased energy consumption and carbon emissions, which contribute to climate change and environmental degradation.