

Chapter 02: Introduction to Ecology and agroecology (Principal concepts):

I-Ecological concepts:

1-Organization of living beings:

Levels of organization in ecology help scientists generally study the anthropogenic impact, energy flow and changes in population dynamics. Natural organisms can be studied at small or large levels, which are:

- **Organism:** The specimen or the first unit of living beings. We focus at this level on the relationship of an individual organism with its abiotic environment (temperature, moisture, light, soil etc....).
- **Population:** A group of organisms of the same species in a specific area. Ecologists are interested in the biotic and abiotic factors that affect a population's size and distribution.
- **Community:** It's about populations of different species in an area, with a focus on community structure, composition and the biotic interactions between these groups, such as predation and competition.
- **Ecosystem:** A community together with its function, which is the pools and fluxes of energy and matter within and between biotic and abiotic factors.
- **Ecoregion (Landscape):** Recurring patterns of ecosystems, associated with characteristic combinations of soil and landform. Ecosystems within an ecoregion are more similar to each other than to ecosystems elsewhere.
- **Biosphere:** It represents all of the Earth's organisms interacting with each other and the global environment.



Figure 01. Organization levels of living beings

1-1-Concept of Ecology:

The word **ecology** is derived from the Greek “oikos” meaning house and “logos” meaning study (Study of the natural house of species). The word ecology is of recent origin having been first proposed by the

German biologist **Ernst Haeckel** in **1869**; as the study of organisms, populations, and communities, as they relate to one another and interact in the ecosystems they comprise.

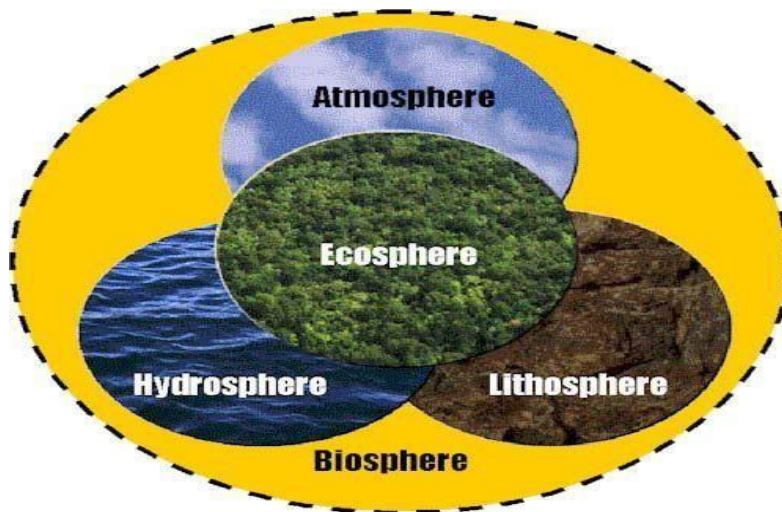


Figure 02. Position of the Ecosphere in the Biosphere

1-2-Types of Ecology:

According to the group of organisms to be studied, there are three types of Ecology:

- **Autecology or species ecology:**

It deals with the study of an individual species of organisms in its population. The ecologists study the behavior and adaptations of a particular species to the environmental condition at every stage of that individual's life cycle.

- **Demecology or Ecology of population:**

It includes the study of populations of different species with concern to birth rate, death rate, different factors affecting number, growth, and sizes of populations.

- **Synecology or Ecology of communities:**

It deals with the study of communities and Ecosystems, their composition, their behavior and their relation with the environment.

1-3-Concept of ecological niche:

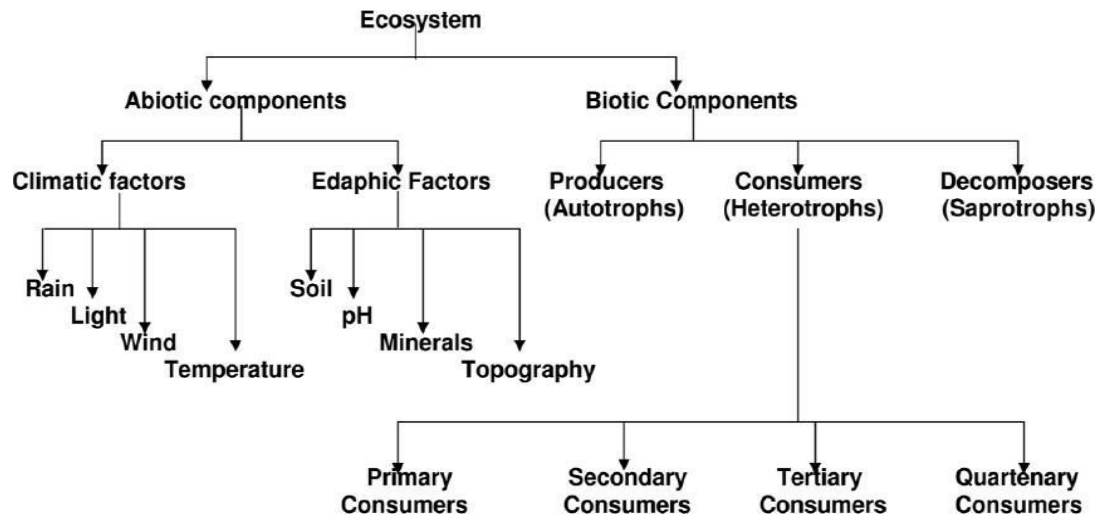
The Niche is the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes. It is a complete description of how the organism relates to its physical and biological environment, as well as his principal role within a community, mainly translated by the variable behavior recorded at different seasons and different times of the same day.

1-4-Factors affecting an Ecosystem:

The structure of an ecosystem explains the relationship between biotic and abiotic and components:

- ✚ Biotic (living) components.

✚ Abiotic (non-living) components.



1- Organic matter cycle:

1-1- Concept of Organic matter:

Organic matter refers to any material that contains carbon compounds, derived from living tissues including substances such as plant and animal residues, dead organisms, and other biological materials. Organic matter plays a crucial role in nutrient cycling, soil structure and fertility. It serves as a source of energy and nutrients for soil organisms and productivity.

1-2- Matter cycle between photosynthesis and decomposition:

The majority of life on Earth is based on food chains, which revolves around organic matter production, as plants use sunlight, water and carbon dioxide to make food via the procedure of **photosynthesis**. While **decomposition** is the process by which dead organic substances (Plants, animals and humans) are broken down into simpler inorganic matter such as water, simple sugars and mineral elements.

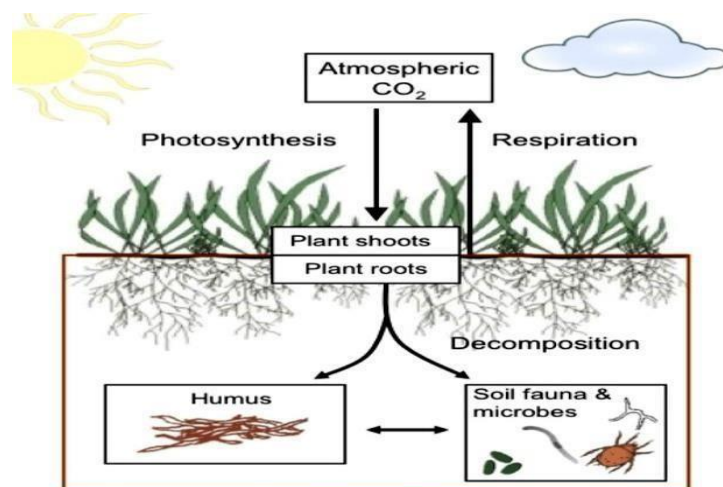


Figure 03. Matter cycle between photosynthesis and decomposition

❖ Matter production (Photosynthesis):

Plants are the only autotroph organisms that serve as primary producers in food chains. They represent the foundation of the ecosystem pyramids by obtaining energy and nutrients from using sunlight through photosynthesis to make organic substances from inorganic ones, according to the following sources and equation:

- Carbon dioxide is obtained through tiny pores present in the leaves of the plant called stomata.
- Oxygen is also released through the stomata (respiration).
- Water is obtained by roots and then passed on to the leaves through the vascular plant tissue systems.
- Sunlight is absorbed by chlorophyll, a green pigment located in chloroplasts; where photosynthesis takes place.

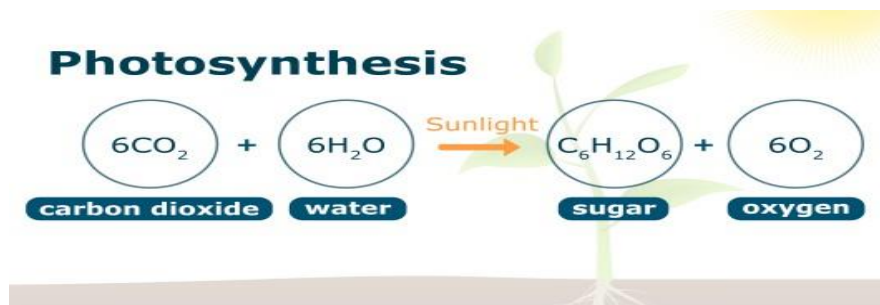
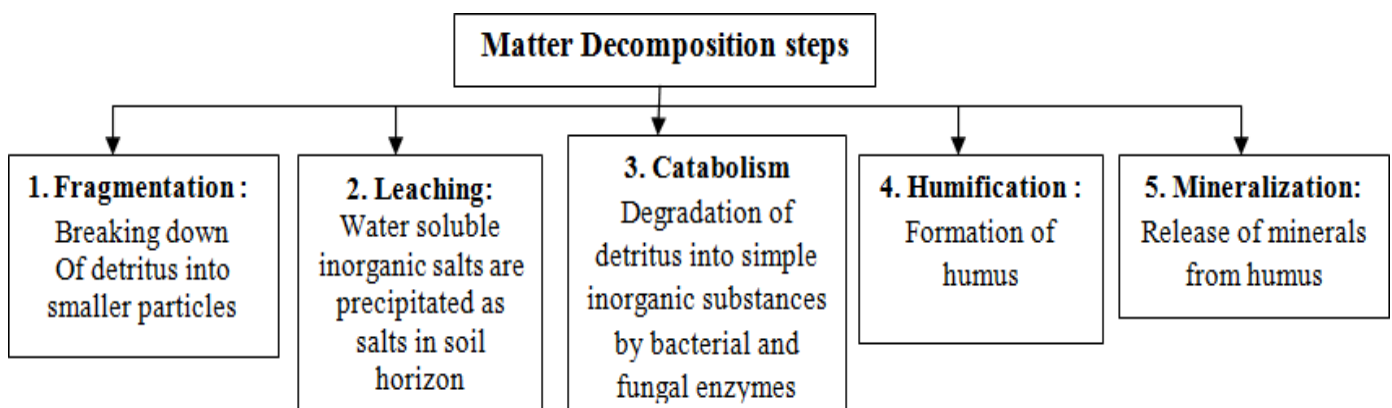


Figure 04. Photosynthesis equation

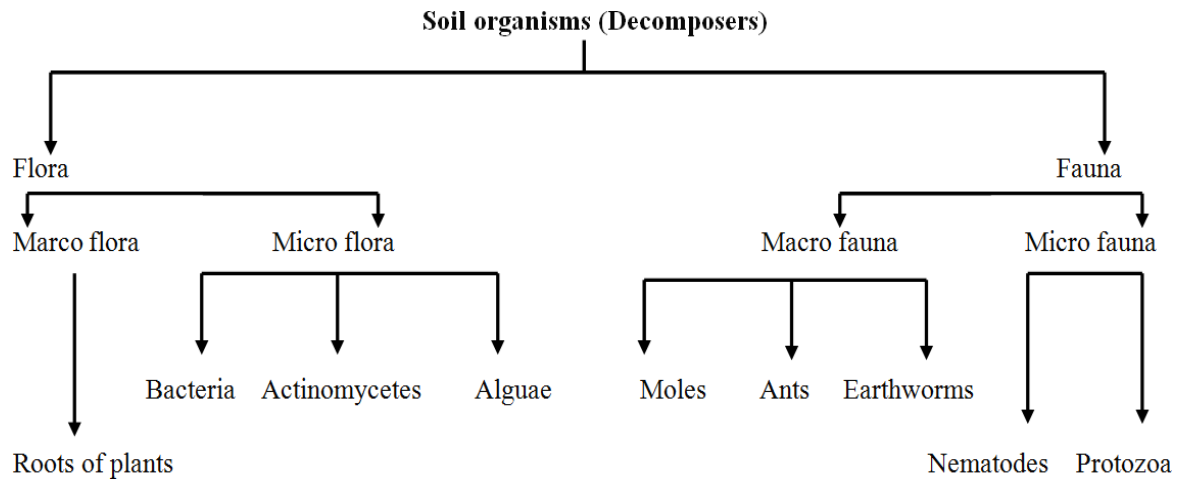
❖ Matter degradation (Decomposition):

It is a basic cleaning tool of nature, and a principal metabolic process, where organic residues are degraded and decomposed by oxidative processes involving rotting organisms' species (Soil biota). It is one of the significant and essential processes of the ecosystem that corresponds to the disintegration or rupture of complex organic matter into a simpler inorganic matter in the following steps:



1-3- Concept of Soil Biota:

Soil biota is a term that represents all organisms that spend all or a portion of their life cycle within a soil profile and constitute the land food webs (matter decomposition). It consists of the micro-organisms (bacteria, fungi, and algae), soil animals (protozoa, nematodes, mites, springtails, spiders, insects, and earthworms).



2- Energy Flow in Ecosystems:

Energy flows from the sun through ecosystems and from one organism to another. This energy cycles through ecosystems from producers to consumers and back into the nutrient pool through decomposers. Trophic levels describe the feeding levels of organisms.

2-1- Concept of food chains:

A food chain is a linear sequence of organisms where nutrients and energy are transferred from one organism to another organism. It begins with the producer, follows the chain with the consumers and ends with the decomposer organisms. After understanding the food chain, we realize how one organism is dependent upon another one for survival. Every food chain is consisted of:

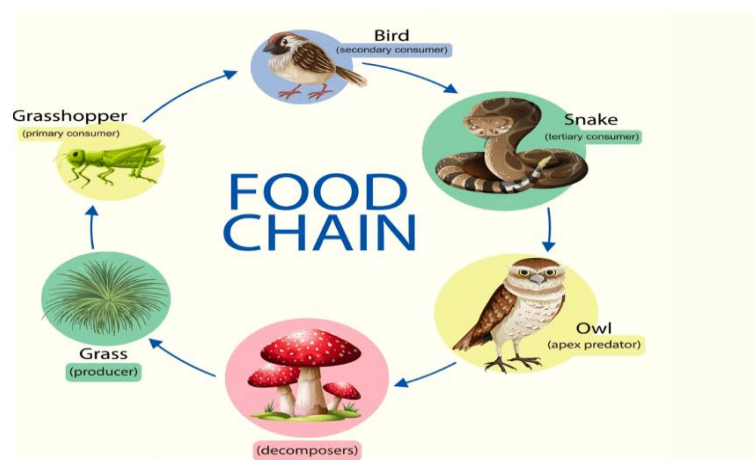


Figure 05. Example of a food chain.

- **Producers:**

Producers are plants that produce, or create, their own food by using light energy from the sun, carbon dioxide from the air, and water from the soil. The process that makes them Autotrophs is called photosynthesis.

- **Consumers:**

Animals are consumers. They cannot produce their own food, so they get their nutrients and their energy by consuming (eating) other plants and animals. There are 3 groups of consumers: carnivores, herbivores, and omnivores.

- **Decomposers:**

Bacteria and fungi are decomposers. They eat dead plants and animals, break them down and decompose or dispose of them. When that happens, they release nutrients and minerals back into the soil, which are then used by plants during photosynthesis.

2-2- Concept of Food Webs:

A food web is made up of interconnected food chains. Most communities include various populations of producer organisms which are eaten by any number of consumer populations. The green crab, for example, is a consumer as well as a decomposer.

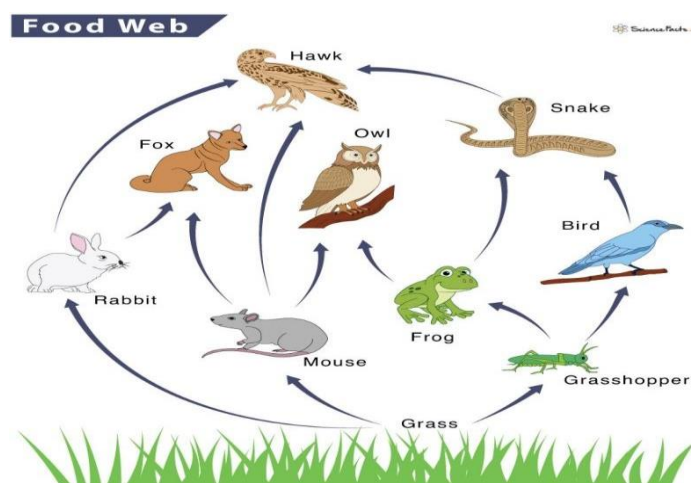


Figure 06. Example of a food web

II-Agrosystem concepts:

1-Definifion of an agrosystem:

An agrosystem is an ecosystem supporting the food production systems in farms and gardens. It is defined as a set of plant and animal communities that interact with the physical and chemical environment and are used by humans to produce food, fibre, fuel, and other products for human consumption and processing.

Agroecosystems are natural communities that occupy about 40% of a global land surface and which have been modified by humans for agricultural purposes and transformed to cultivable lands and grasslands.



Figure 01. Agricultural land

2- Components of Agroecosystems:

The components of an agroecosystem are variables depending on the specific type of agricultural system. However, some common components of agroecosystems include:

❖ Abiotic Components

- Climate (Temperature, light intensity, day length, CO₂).
- Resources (Water availability, nutrient supply.....).
- Landscape (Topography and relief).
- Soil (Fertility, salinity and pH levels).

❖ Biopic Components :

- Pests (Parasites, herbivores.....).
- Competition relationships between plants.
- Symbiotic relationships (Subterranean organisms and pollinators).
- Farmers (Including their management of natural factors).
- Livestock (Raising of livestock, such as cows, chickens, or pigs, for the production of meat, milk, or other products).
- Crops (Cultivation of crops for human consumption or other purposes, such as animal feed or industrial use).

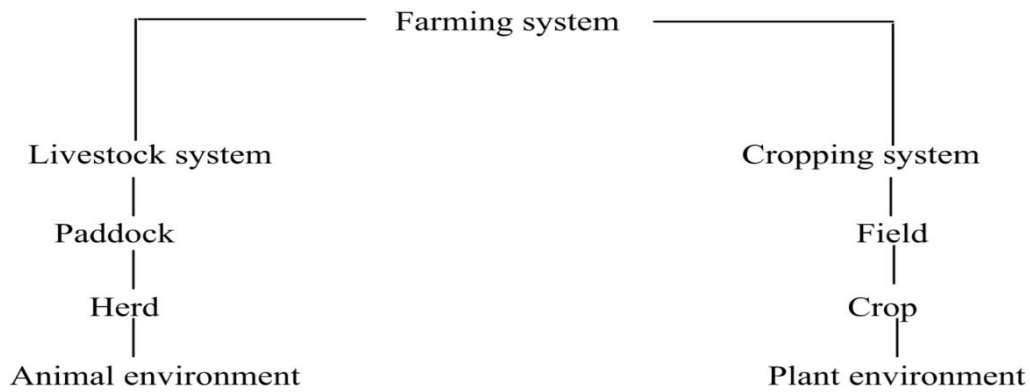


Figure 02. Farming land system

3-Agroecosystem food chain elements:

Components of agroecosystem food chain are:

3-1- Producers (Autotrophs):

Producers are also called autotrophs because they make use of abiotic factors, to produce their food using the energy from the sun along with water and carbon dioxide. In agriculture, producers are green plants and algae.

3-2- Consumers (heterotrophs):

Dependent components of an Agroecosystem, they do not make their food but rather depend on the autotrophs for food. In the food chain, they are referred as secondary or tertiary organisms. For Agroecosystems, consumers are human beings that eat crops, vegetables, fruits, or other animals' products. They can also be predators or parasites.

3-3- Decomposers (Saprotrophs):

Organisms that feed on death and decayed plants and animal materials. They break down organic matter into inorganic components (carbon and nitrogen). The inorganic matter broken down by these organisms will return to the soil as nutrients for plant use (bacteria, fungi, earthworms)



Figure 03. Agricultural production cycle.

4-Agroecosystem types:

There are many different types of agroecosystems:

4-1- Small-scale subsistence farming:

It involves the production of crops or livestock for the purpose of feeding a family or small community. These systems are often found in developing countries and are characterized by low levels of inputs and technology.

4-2- Large-scale commercial agriculture:

It involves the production of crops or livestock for sale on a larger scale (For export). These systems are typically characterized by high levels of technology and inputs and are found in many developed countries.

4-3- Intensive horticulture:

It deals with the production of high-value crops (Vegetables and fruits), using intensive growing techniques. These systems are found in urban areas and are characterized by a high level of inputs and technology.

4-4- Agroforestry:

It deals with the integration of trees and shrubs into agricultural systems in order to provide a range of benefits, including increased productivity, soil conservation, and carbon sequestration.

4-5- Regenerative agriculture:

It's about the use of techniques such as cover cropping, composting, and crop rotation in order to improve soil health and increase resilience to environmental stresses.

5-Agroecosystems importance:

Agroecosystems are important for a number of reasons:

5-1-Food production: Agroecosystems play a vital role in global food production, providing the crops and livestock that feed the world's population. According to the Food and Agricultural Organization of the United Nations (FAO), agriculture is responsible for the livelihoods of approximately 1.3 billion people globally.

5-1- Economic development: Agroecosystems represent an important source of economic development in many countries. In developing countries, agriculture is a key sector of the economy, and the success of agroecosystems can have a significant impact on the prosperity of all the nation.

5-2- Biodiversity: Agroecosystems can support a wide range of plant and animal species, and the management of these systems can play a role in conserving biodiversity.

5-3- Environmental benefits: Agroecosystems can provide a number of environmental benefits, such as carbon sequestration, soil conservation, and water management.

5-6-Cultural significance: Agriculture is an important part of the cultural heritage of a community and plays a central role in traditions and practices.



Figure 04. Agroecosystem importance

6- Practices in agroecosystems:

6-1- Agricultural positive practices for environment:

6-1-1- Composting process:

It is a natural process of recycling organic matter (Leaves, food scraps, yard tree trimmings) to a valuable fertilizer for soils, by providing an ideal environment for bacteria, fungi, and other decomposing organisms (Worms, sowbugs, and nematodes). Composting methods are used to improve soil's physical, chemical, and biological properties in gardening, horticulture, and agriculture. This technique is based on the following indications for farmers:

1. Collect and store your brown and green wastes.
2. Choose a space in your yard for your compost build or buy a bin.
3. Prepare your ingredients for composting by breaking the green wastes up into smaller pieces and placing them into the bin.
4. Repeat the process as you generate wastes until the bin is filled and add water to keep it moist.
5. Mix the layers constantly to circulate the air and help decomposition and use a garden fork to turn the outside of the pile inward.
6. Allow your pile to cure, or finish, for at least four weeks and always cover the last layer with soil or brown residues. Protect the container with a mesh to avoid animals.



Figure 05. Compost cycle principal steps

6-1-2- Crop rotation process:

Crop rotation is the practice of planting different crops sequentially on the same plot of land to improve soil health, optimize nutrients in the soil, and combat pest and weed pressure through a considerable period of years (3 to 7 years). It's a sequence of crops grown in a specific field, including cash crops, cover crops and green manures. A simple rotation might involve two or three crops, and complex rotations might incorporate a dozen or more. An example of crop rotation is maize, followed by a legume.

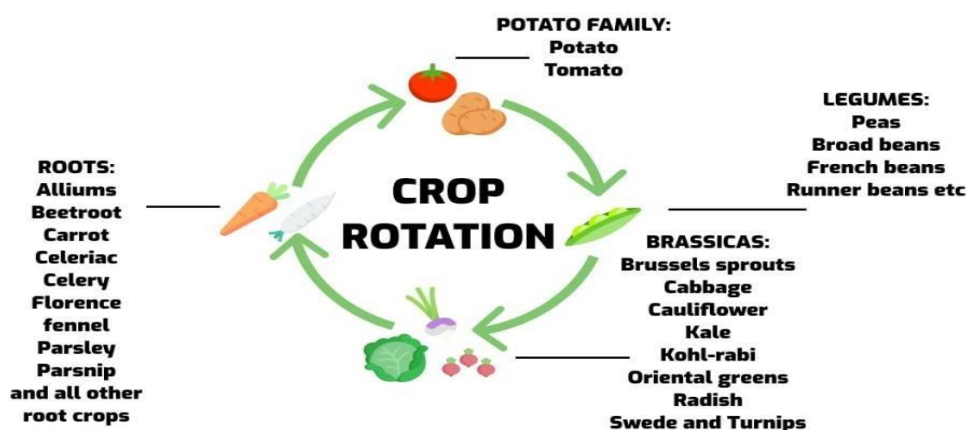


Figure 06. Crop rotation process

6-1-3- Sustainable agriculture:

Sustainable agriculture is farming in sustainable ways meeting society's present needs, without compromising the ability for current or future generations to meet their needs and to conserve the planet's health. Sustainable agriculture consists of environment friendly methods of farming that allow the production of crops or livestock

without causing damages to human or natural systems. Sustainable farming goals are:

- Satisfy human food and fiber needs.
- Enhance environmental quality and natural resource bases.
- Make the most efficient use of renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.
- Sustain the economic viability of farm operations.
- Enhance the quality of life for farmers and society as a whole.

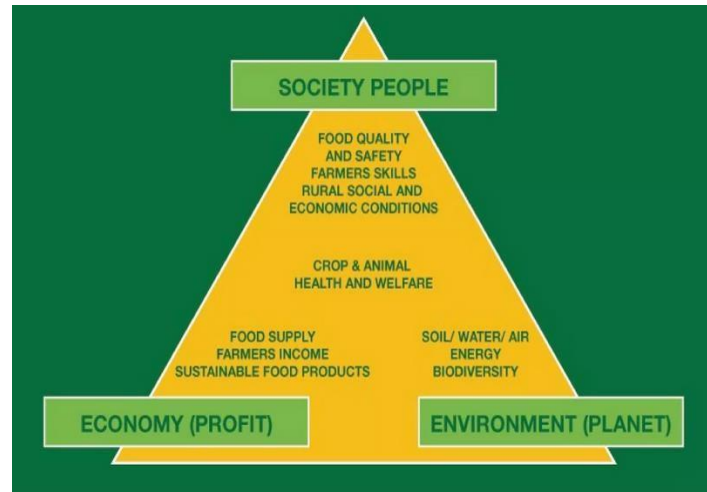


Figure 07. Sustainable agroecosystem principal axes

6-2- Agricultural negative practices for environment:

6-2-1- Genetically Modified Organism (GMO) Seeds:

The negative impacts of genetically modified organism seeds are observed on many environmental aspects. The contamination from the GOM plants has serious ecological, economic and social impacts. Gene flow from these crops poses a threat to wild and weedy crop relatives. The use of these crops can have negative impacts on non-target organisms, soil and water ecosystems. Environmental concerns can deal with:

- The risk of outcrossing, where genes from GMO seeds pass into wild plants and other crops.
- A negative impact on insects and other species.
- Reduction in other plant types, leading to a loss of biodiversity.

6-2-2- Intensive farming:

The purpose of intensive farming is to earn more revenue from agricultural production. It is usually accompanied with the use of chemicals and fertilizers to meet the targets of production. Which then results in higher risks of contaminated products. It's also known by intensive livestock wish means holdings large

groups of livestock together indoors, or on small plots, in high densities for the whole or vast majority of the year to maximize profits and productivity through economies of scale.

❖ **Impact of pesticides and Fertilizers:**

- Fertilizers (Nitrogen and phosphorus and Ammonia) from agriculture, predominantly due to runoff, contaminate water sources, harming aquatic and Aerial ecosystems.
- Application of chemical pesticides participates in increasing the range of exposure, and affecting nearby fields, homes, and schools which contaminates ground and surface water, resulting in many human diseases.

❖ **Impact of intensive livestock:**

- Intensive farming contributes to global warming by releasing large amounts of carbon dioxide into the atmosphere during the production of animal feeds, from the machinery.
- Animal waste and discards are often not treated appropriately when farmers dispose their waste in rivers where they pollute the water and threaten all the ecosystem's biodiversity.