Environmental studies and Disaster management

Food Chain, Food Webs and Ecological Pyramids & Ecosystems

Food Chain

A **food chain** shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal

1. Plants are called **producers** because they are able to use light energy from the Sun to produce food (sugar) from carbon dioxide and water.
2. Animals cannot make their own food so they must eat plants and/or other animals. They are called **consumers**. There are three groups of consumers.
    a. Animals that eat ONLY PLANTS are called **herbivores** (or primary consumers).
    b. Animals that eat OTHER ANIMALS are called **carnivores**.

- Carnivores that eat herbivores are called secondary consumers
- Carnivores that eat other carnivores are called tertiary consumers

e.g., killer whales in an ocean food web ... phytoplankton → small fishes → seals → killer whales

3. Animals and people who eat BOTH animals and plants are called **omnivores**.
4. Then there are decomposers (bacteria and fungi) which feed on decaying matter. These decomposers speed up the decaying process that releases mineral salts back into the food chain for absorption by plants as nutrients.

The consumer organisms are heterotrophic. Unlike the autotrophic plants, which manufacture their own food from simple inorganic chemicals, the herbivores must utilize the energy-rich compounds synthesized by the plants. In turn, the carnivores obtain energy for their metabolism when they consume the herbivores.

Phytoplanktons → Zoos planktons → Fish → Grasses → Rabbit → fox → Grasses → grasshopper→ Frog → Snake → Hawk → Small Bacteria → Bdellovibio → Protozoa → Phytoplanktons

Food Web

There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (and hence energy) to stay alive. Most animals are part of more than one food chain and eat more than one kind of food in order to meet their food and energy requirements. These interconnected food chains form a **food web** ie. Interlocking pattern of food chain is called food web.

This interdependence of the populations within a food chain helps to maintain the balance of plant and animal populations within a community. For example, when there are too many zebras; there will be insufficient shrubs and grass for all of them to eat. Many zebras will starve and die. Fewer zebras means more time for the shrubs and grass to grow to maturity and multiply. Fewer zebras also mean less food is available for the lions to eat and some lions will starve to death.

When there are fewer lions, the zebra population will increase.

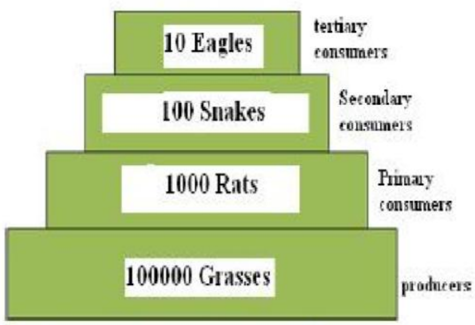
Difference between food chain & food web: In food chain, if one species gets affected, then species in all tropic levels are also affected. But in food web if one species gets affected, it does not affect other tropic levels.

ECOLOGICAL PYRAMIDS

Graphical representation of structure and function of tropic levels of an ecosystem is ecological pyramid.

Types:

Pyramid of Numbers → Represents the number of energy individual organisms present in each tropic levels.



Producer – occupy Ist tropic level

Primary consumer occupy IInt tropic level

Because no of rats are lower than no of grasses.

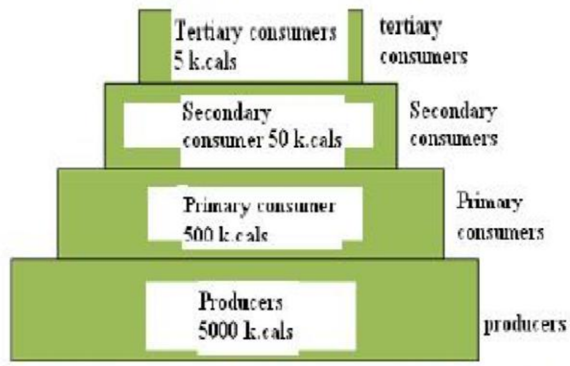
Secondary consumer occupy IIIrd tropic level

Bcause no of snakes are lower than no of rats

Tertiary consumer occupy IVth tropic level

No & size is very low.

Pyramid of Energy: Represents the amount of energy present in each tropic level.



* At each tropic level there is a heavy loss of energy
* Hence there is a sharp decrease in energy at all level

Ecosystems

The first steps in the evolution of agriculture were the tending of particular plant species and the taming of useful animal species. The next steps were

(a) domestication of these species so as to gain control of their reproduction thereby enabling selective breeding of more productive types and

(b) creation of special environmental conditions which would enable these improved types to realize their higher production potential. These environmental modifications involve soil tillage, soil water management, weeding and pest control. The resulting combination of humans, domesticated plant and animal species and their modified environments is an *agro-ecosystem*, in contrast to natural ecosystems in which humans play no special role. In agro-ecosystems, the farmer is an essential ecological variable, influencing or determining the composition, functioning and stability of the system.

Agro-ecosystems may be viewed as food procurement systems in which the natural ecosystem has been modified to various degrees in order to increase output of food and other useful products of value to humans. The dominants in agro-ecosystems are selected plant and animal species which are tended and harvested by humans for particular purposes. According to the nature of the modifications, agroecosystems range from shifting agriculture, nomadic pastoralism, and non-industrial continuous agriculture to ranching, industrial agriculture and feedlot animal production. The first three systems are practiced primarily for subsistence, and may therefore be called **subsistence agro-ecosystems**, while the last three are **industrial agroecosystems** which are geared to a market economy. Agroecosystems which involved field crop husbandry *viz*., shifting agriculture, non-industrial continuous agriculture and industrial agriculture are also referred to as field crop ecosystems.

Intensive and extensive agro ecosystems

Agro-ecosystems are classifiable according to whether they are extensive or intensive. Extensive systems may be defined as those where the annual output of consumable nitrogen is less than 20 kg per ha. Outputs of crop or livestock products per unit area are low, and these outputs are dependent largely on natural soil nutrient reserves and management which conserves these reserves. Forms of subsistence agriculture such as nomadic pastoralism and shifting agriculture are widespread examples. In intensive agro-ecosystems, very high outputs are maintained by large inputs of nutrients. Both the volume and rate of nutrient cycling are much higher than in extensive systems, particularly in industrial agriculture. Since nutrient inputs are almost entirely in the form of inorganic fertilizers, nitrogen fixation and soil organic matter are both depressed to very low levels. Losses of nutrients from the system through exports of produce are great, while considerable leaching losses, of both soil nutrient reserves and nutrient inputs occur particularly in wetter environments when land is bare during part of the growing season.

Agro-ecosystems which involve a significant livestock sub-system as well as a cropping subsystem are known **as *mixed farming*** systems. They are usually intermediate in intensity between extensive and intensive agro-ecosystems.

Shifting agriculture

Shifting agriculture is a very widespread agro-ecosystem in the tropics. It includes a wide range of different localized systems which have developed in response to local environmental and cultural conditions. The essential features of the agro-ecosystem are that fields are rotated rather than crops, and a fallow period restores soil fertility. Disturbance to the soil is also negligible since there is no soil tillage. The system is well suited to nutrient poor soils in areas of low population density. Provided the fallow period is long enough, relative to the cropping period, the agro-ecosystem is sustainable indefinitely. The cropping phase is just another human induced and managed disturbance in the natural, continuing pattern of gap creation and secondary succession in forest. The cleared area, during the period of cropping, is often referred to as a swidden. Because of their great age and highly leached condition, most soils in the moist tropics are too poor to sustain high levels of crop production without fertilizer application. In shifting agriculture, the fertilizer requirement is provided in the form of ash by felling and burning the forest vegetation prior to cropping. When the land is abandoned after one to three years of cropping, soil regains its original fertility characteristics through forest regeneration, provided the fallow period is of sufficient duration.

Nomadic Pastoralism

Nomadic pastoralism is a subsistence agro-ecosystem which usually prevails in semi-arid or arid regions which are too dry to sustain rain fed, field crop ecosystems. Human densities associated with nomadic pastoralism are low, much lower than in shifting agriculture. This is largely due to two reasons *viz*.,

(a) Low and Unpredictable Primary Production Caused By Low And Highly Erratic Rainfall

(B) Dependence on secondary production by warm blooded herbivores. This result is only a small proportion of the energy fixed in primary production being available to humans, who are secondary consumers in this agro-ecosystem. Pastoralism however allows conversion of low quality, inedible plant biomass *viz*., grass, to high quality foods *viz*., meat and milk, in regions which would not support any people on the basis of crop production. In range grazing, a high proportion of nutrients is recycled via plant residues since the proportion of available herbage consumed by livestock or other herbivores is low. The nutrient cycle is thus small in magnitude and highly dependent on release of nutrients by organic matter decomposition. The rate of this process is impeded by the lack of soil moisture over a large part of the year. The practice of burning speeds up nutrient turnover but it also increases losses of nitrogen. All nutrients are also subject to loss by runoff due to heavy rainfall intensities during the short wet season. Nitrification is also very slow. In nomadic pastoralism, manipulation of the environment is usually limited to selection of grazing routes and watering sites. The environment is manipulated to a greater extent where wells are provided to improve water supplies for cattle and where fires are set off to improve the quality and quantity of natural grazing.

Non-industrial and semi-industrial continuous agriculture

Eco-systems created by humans and characterized by continuous field crop husbandry are often termed *field crop ecosystems*. They are cultivated plant communities which are managed to achieve goals such as the production of food and other useful agricultural commodities; financial gain; and personal satisfaction. Usually, they are managed to achieve a combination of these goals. Field crop ecosystems fall into two main categories *viz*., non-industrial agriculture and industrial agriculture. Those in the former category are largely self contained agro-ecosystems, while those in the latter category are part of, and dependent upon, other elements within larger agro-ecosystems. Field crop ecosystems differ from natural ecosystems in several plant and community characteristics as well as in their functioning.These differences are summarized below

Field crop ecosystems may be categorized as monocultural systems when they are dominated by a single crop species and as multi-crop systems when no single crop species is dominant. There is a continuous gradient from high input monocultural systems at one end of the spectrum to low input multi-crop system at the other. Mixed farming systems, in which cropping and livestock subsystems are integrated within a single agro-ecosystem, constitute a special category of multicropping systems, in which one or more of the crops grown are grazed or used as fodder. Besides outputs in various forms such as meat and milk, the livestock subsystem also provides the cropping subsystem with (a)fertilizer in the form of manure and (b) a source of power for various operations such as soil tillage, weeding and irrigation of crops, and transport and processing of crop harvests. Energy use efficiency is however lowered where the agro-ecosystem includes a livestock subsystem.

Industrial Agriculture

Industrial agriculture is primarily distinguished by the substitution of fossil fuel energy for human labour and animal power. Two persons may be employed per ha in non-industrial continuous agriculture, whereas only 0.1 person may be needed per ha in industrial agriculture. The fossil fuel energy subsidy is used to produce agro-chemicals such as fertilizers, pesticides and herbicides; to manufacture farm machinery; to operate this machinery in the performance of work such as soil tillage, planting and harvesting of crops, and application of fertilizers or pesticides and for irrigation and transport.

Because of the massive amounts of energy required to produce chemical fertilizers, pesticides and weedicides on the one hand, and to manufacture and operate agricultural machinery on the other; industrial agriculture is highly intensive in its use of energy subsidies. The increased use of energy subsidies is associated with increase in energy output per unit area and per man-hour, but the ratio of energy output to energy input decreases. Efficiency of energy use in semiindustrial and industrial agriculture is therefore considerably lower than in non-industrial agriculture with efficiency decreasing sharply as the energy subsidy increases. In industrial agriculture, a primary objective is to maximize yields, and this is achieved largely through increasing use of chemical fertilizers. A major disadvantage of reliance on chemical fertilizers, apart from their cost to subsistence farmers, is their role in further depleting the already low organic matter content of tropical soils. Control of pests and pathogens in industrial agriculture relies heavily on the use of chemical pesticides. Pesticide use has however created almost as many problems as it was designed to solve.

Industrial agriculture displays many of the characteristics of manufacturing industry such as high capital expenditure on buildings and machinery; specialization of production; and large outputs of wastes which are not recycled within the system. Wastes from industrial agriculture, such as chemicals leached in drainage, are significant pollutants of other ecosystems. The most harmful effects of industrial agriculture on the environment are however due to soil tillage and undue exposure of bare soil, resulting in accelerated soil erosion and consequent depletion of the soil resource base.