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Economic Geography

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 - Unit 2 Concepts in Economic Geography
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-

BLOCK 2 RESOURCES

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 - Unit 18 Transport and Flow Networks
-

BLOCK 3: PRIMARY SECTOR

Among the various sectors of Economy, primary sector holds a special importance. Agriculture and its allied activities are very important for human societies, as it provides food and other edible materials, besides numerous other usages. It is concerned with the collection and availability of the numerous naturally available materials in the form of resources, as bestowed by the nature, for various direct and indirect usages by the human societies. It includes various activities like agriculture, fishing, forestry, hunting, mining and quarrying, etc.

Third Block is divided into four Units that deal with the diverse aspects of primary sector.

Unit 9: Agriculture

Ninth Unit is devoted to the study of agriculture. It will provide you a nuanced glimpse of agriculture. It deals with major agricultural systems of the world including subsistence farming, commercial grain farming and plantation, etc. It also describes land use pattern, cropping pattern and changes therein along with productivity.

Unit 10: Animal Husbandry and Fishing

Tenth Unit is devoted to the study of animal husbandry and fishing. You will study and learn about the twin activities of dairy farming and fishing in India and the world.

Unit 11: Forestry

Eleventh Unit is devoted to the study of forestry. You will study forest products and their two types, viz., timber and non-timber products. A brief discussion about forests and livelihood along with tribal and forests rights has also been dealt with.

Unit 12: Minerals and Mining Activities

Twelfth Unit is devoted to the study of factors of industrial location. You will study about metallic and non-metallic minerals. Besides, it also deals with methods of mining. Effects of mining on landscape and environment with concurrent thematic issues and problems have also been highlighted with an intention to sensitize the learners.

Our best wishes are always with you to complete this final semester course of your Bachelor's programme successfully.

UNIT 9

AGRICULTURE |

Structure

9.1	Introduction Expected Learning Outcomes	9.4	Cropping Pattern and Changes
9.2	Agricultural Systems of the World Subsistence Farming Commercial Grain Farming Plantation	9.5	Productivity
9.3	Land use Pattern	9.6	Summary
		9.7	Terminal Questions
		9.8	Answers
		9.9	References and Further Suggested Reading

9.1 INTRODUCTION

So far, in the first two Blocks of this course, you have studied about introduction to economic geography and resources along with its diverse kinds. Third Block is devoted to the study of primary sector and begins with the study on agriculture and its diverse aspects. The word 'Agriculture' has its roots in Latin word known as '*Agercultura*'. It is a combination of two words namely '*Ager*' which means a field or soil and '*Cultura*' means to cultivate the field or soil. It refers to the art and science of growing crops and raising husbandry, analogues to cartography (art and science of map making), with which you are already familiar. It is believed that humans laid down the foundation of agriculture approximately 12,000 years before present, when they used to survive and sustain on twin activities of hunting and food gathering. Pursuit of agriculture not only provided humans better food to consume but also gave a definite piece of land where they could settle down permanently. However, it also refers to a wide range of diverse and distinct activities. It encompasses cultivation and production of crops, vegetables and flowers, besides animal husbandry and their associated crucial health and energy providing products.

Importance of agriculture can be gauged from the fact that it alone occupies both the largest proportion of total geographical area (approximately 500 million hectares of land), as well as proportion of persons engaged in agriculture sector as opposed to other four higher order sectors of economy. These four are secondary, tertiary, quaternary and quinary sectors. Even as recently as in 2020, some underdeveloped nations of the world showed heavy

reliance on labour force for agriculture, as high as to the tune of 36 percent in Pakistan and 66 percent in Ethiopia. Such nations often lack diversification of economic activities unlike their counterparts, i.e., developing as well as developed nations. As far as contribution of agriculture and allied sectors to national economy seen in terms of Gross Domestic Product (GDP) is concerned, it is approximately 15 percent in case of developing countries like India, whereas in case of developed countries of UK and USA, the corresponding figure is merely 2 percent (Mishra and Puri, 2020). According to Census of India 2011 statistics, agriculture sector and its allied activities alone employs 54.6 percent of the working population (India, A Reference Annual, 2022).

Therefore, this Unit is divided into several Sections to deal with a few important and diverse aspects of agriculture. Section 9.2 discusses the major agricultural systems of the world, which includes subsistence farming, commercial grain farming, and plantation. Section 9.3 is devoted to the study of land use pattern and its various categories or their offshoots. You will learn about cropping pattern and changes after studying Section 9.4. Last Section 9.5 will throw light on agricultural productivity and production of primary crops by groups for major regions of the world.

Expected Learning Outcomes

After studying this unit, you should be able to:

- discuss a few important agricultural systems of the world;
- explain the land use pattern;
- comprehend the cropping pattern and changes therein; and
- describe the issues related to agricultural productivity.

9.2 AGRICULTURAL SYSTEMS OF THE WORLD

All of you are well aware as to what does system mean in general. It could encompass diverse spheres such as solar system, navigation and satellite system, human system, computer system, transport and communication systems and so on. Basically, system refers to a systematic or taxonomic concept. Quintessentially, it is identified on the basis of similarities that exist between one and other components of any phenomena. Since agriculture with similar attributes is often distributed in space in a mosaic-like pattern, distribution of the resulting systems does not necessarily form a contiguous area. However, agriculture of the same system are usually dispersed and intermingled with others in reality. Hence, the identification and description of farming types or agricultural systems have remained an intriguing subject matter for geographers.

The concept of agricultural systems was first developed in Russia. Subsequently, a German geographer named Eduard Hahn (1892), contributed to the regional distribution of agricultural zones, akin to climatic zones. In 1924, another scholar named Sapper revived Hahn's approach by directing attention to the significance of agriculture not as commercial, but vital for the sustenance of large population. In 1930, a scholar named

Engelbrecht published a map entitled “The Agricultural Zones of the Earth”. In this manner, the interest of German geographers in agricultural zones, led to the production of world map aimed at depicting the distribution of several aspects of agricultural life.

With fifteen years of collaboration between a renowned scholar, Derwent Whittlesey and his colleague D. Jones Wellington, it became possible to draw crude world map of agricultural regions. They also provided a brief sketch of the recognised types in 1926. Subsequently in 1932, they published a revised map entitled “Types of Agricultural Land Occupancy”. Following this, a series of articles appeared in economic geography that drew focus on agricultural regionalisation on a continental scale, which contributed valuable facts to Whittlesey's classification scheme.

Whittlesey's Agricultural Regions of the World

A pioneering systematic and scientific attempt to delineate agricultural systems was performed by Derwent Whittlesey through a paper titled “Major Agricultural Regions of the Earth” published in 1936 in the Annals of the American Association of Geographers (Vol.26: 199-240). Whittlesey defined agricultural region in terms of an uninterrupted area with some kind of homogeneity in respect of specifically defined outer limit.

His classification schemata of agricultural regions are determined by the interaction between physical and non-physical set of variables. Physical variables include terrain, climate, soil and water whereas non-physical variables include techno-organisational, demographic, cultural and infrastructural variables.

Through his monumental paper, Whittlesey delineated four major and thirteen minor types of agricultural systems of the Earth. He did this on the basis of the following five characteristics or functional forms of agriculture:

1. The crop-livestock combinations.
2. Intensity of land use (refers to the methods and techniques used for cultivation and livestock management).
3. Processing, marketing and disposal of farm produce.
4. Degree of farm mechanisation (indicative of systematic and scientific management practices).
5. The ensemble of buildings and other structures associated with agriculture (being put to use in order to facilitate the farming operations).

The four major and thirteen minor kinds of agricultural systems of the world, as identified by Whittlessey are mentioned below:

A. Ecological or Near Ecological System

1. Nomadic herding
2. Shifting cultivation

B. Subsistence Systems

3. Rudimentary sedentary tillage

4. Intensive subsistence tillage with rice dominance
5. Intensive subsistence tillage with rice non-dominance
6. Subsistence crop and livestock farming
7. Mediterranean agriculture

C. Commercial Systems

8. Livestock ranching
9. Commercial grain farming
10. Commercial livestock and crops farming
11. Commercial dairy farming
12. Specialised horticulture

D. Cash Crop System

13. Commercial plantation tillage

His scheme is considered as a basic and most fundamental to delineate the world into agricultural systems of one or other types, which shows a semblance. It is widely used in many atlas maps as well as under-graduation and post-graduation textbooks, to explain the agricultural systems of the world. Later on, many scholars tried to modify and revise his scheme, prominently R.S. Thoman in 1962 and D. Fryer in 1965.

It is considered a herculean task to develop the agricultural systems of the world due to many overlapping and complex agricultural operations in the actual field. In this Unit, we will only discuss three major systems namely subsistence farming, commercial grain farming and plantation with some additions and recent changes therein.

1. Subsistence Farming

As mentioned previously, one of the main distinguishing features is that farming is done for the purpose of self subsistence or consumption and very less is left for selling in the market. Subsistence farming is characterized by many farming sub-types as per Whittlesey's scheme. However, it is mainly dominated by two major types being practiced over the length and breadth of the world. We will briefly discuss these two types as under:

a) Primitive/Original Subsistence Farming

It is considered as the oldest type of agriculture. At present, we can spot its practice amongst some of the primitive tribal groups in unison with hunting and gathering activities. This form of agriculture is quite similar to shifting cultivation of ecological or near-ecological type. The primitive subsistence farmers also learnt the art of domestication of plants and thereby facilitated themselves to transit into primitive form of agriculture. As understood, it is mainly practiced for the purpose of self-consumption by the farmer's families, rather than for marketing of the surplus produce. However, one farmer may exchange a particular type of produce with the distinct produce of a second or third farmer. It is known as barter trade. In some instances, they may sell their produce in lieu of cash as well. Basically, it is characterized by static rather than dynamic nature of economic structure. One of the key features is that it may provide a freedom from the clutches of both traditional landlords as well as market forces. Thus, they practice completely primitive agriculture with the

help of rudimentary tools and techniques coupled with subsistence way of life, by not indulging in materialistic ways of living human life, unlike other higher order sectors of economy.

Geographical Location and Distribution

Major geographical location of primitive subsistence farming is concentrated in the tropical regions of the world as shown below in Fig. 9.1. A few prominent locations are found in Africa, Central America and South America along with South-East Asia. This form of agriculture is quite akin to that of shifting cultivation. Hence, it is known by different names on the basis of its practice.

For example, it is known as under:

- 'Milpa' in some regions of Africa and Central America;
- Masole in Zaire;
- Conuco in Venezuela and Roca in Brazil;
- Bewar or Podu in India;
- Taungya in Burma, and Tamari in Thailand;
- Chena in Sri Lanka;
- Ladang in Malaysia and Humah in Indonesia; and
- Caingin in Philippines.



Fig. 9.1: Geographical Location and Distribution of Primitive Subsistence Farming.

Salient Features:

This first sub-type of primitive subsistence agriculture has following salient features as under:

- i. **Selection of Site:** First and foremost, the experienced elder farmers are entrusted with a duty to choose a new agricultural site, especially in the previously unused suitable patches of the forests. As such, these are generally located far away from the settlement units of villages. With

the passage of time, such farmers are pushed to the interior locations, as low-lying cultivable lands are claimed by the more advanced category of farmers, equipped with modern techniques of farming. Owing to their secluded location mainly in the forests, the growth and development of primitive subsistence farmers or in other words shifting cultivators still remains a challenging task.

- ii. **Typical Name:** This form of agriculture is also known as 'slash and burn agriculture'. Before making the patch of a forest suitable for tilling, fire method is used to clear the forest. Due to this, the burnt grasses and trees turn into ash, which is supposed to enhance the fertility of soil for good crop yields.

This practice of clearing a patch of forest or natural vegetation can still be spotted in the slopes of Himalayas in India and elsewhere. Farmers or pastoralists burn the patch of forests either to illegally cultivate or to obtain better growth of grasses in the ensuing agricultural season to feed their livestock. A tree which remains un-burnt is either chopped off or left to decay through natural processes.

- iii. **Small Land Size:** Such prepared cultivable patch of forest land is of smaller size, often varying between 0.5 hectare to 1 hectare. Apart from being small in size, the cultivable fields are not distributed evenly and are located in many secluded patches, often interspersed with forest cover.

- iv. **Farming Methods:** Practice of this type is characterised by rudimentary methods, with the help of primitive tools. These are hand tools like sticks and hoes for ploughing of soil, without the help of draught animals. Some farmers sow the seeds simply by spreading them over the surface of the soil, which is called broadcast method. After sowing the seeds, crops are left to grow on their own naturally. In fact, it is highly labour-intensive form of agriculture.

- v. **Principal Crops:** Main crops are maize, millet, rice, beans, banana, tapioca, cassava or manioc and yam, etc. These crops are grown at regular intervals, so as to provide the food for the entire year by delaying the harvesting season.

- vi. **Rotation:** One of the distinct features is 'rotation of tillable field', unlike 'rotation of crops' in some other agricultural systems of the world. Agricultural fields are left for fallowing (when no crops are sown to recoup the soil fertility). This is done due to reduced soil fertility over the period of time, attack of pests and insects, weeds and shrubs along with outbreak of disease, etc. Then, new patches of the forest are cleared for tilling of land, by employing the same method as already mentioned earlier.

- vii. **Migratory Agriculture:** On account of these features, it has been termed as 'migratory agriculture'. It is known to provide livelihood support to the aboriginal tribal groups, who inhabit the tropical rainforest biomes of the world. Recently, many governments have made efforts to bring them under mainstream segment of the populace through the process of resettlement. However, it is still continuing in its original form in these areas.

Recent Changes

However, with the passage of time, a more refined form has surfaced, more prominently concentrated in the tropical lowlands. It is known as 'sedentary subsistence agriculture'. Main feature is settled ways of life of farmers, often concentrated near the cultivable fields and repeated reutilisation of fallow land. In some places, rotation of crops is also brought into operation, by placing better focus to the grown crops as well as piece of tillable land. Unlike primitive type, along with hand tools, draught animals are also used to plough the land. It is capable of sustaining a relatively large population base. Besides, number of animals is also more which includes horse, buffalo and swine, etc. Crops are cultivated during the cool and rainy season and harvested during the dry season. There is a tendency among a few small and marginal farmers to migrate for finding work in plantation form of agriculture, to substitute and augment their income level. They come back home periodically, which is prevalent especially in certain parts of South-East Asia and Central America. In some parts of West Africa and South-East Asia, in addition to subsistence farming, a few of them grow certain cash crops and also collect forest products for selling purposes. In some portions of South-East Asia, some subsistence farmers have also started engaging themselves in village tourism, by opening home stays and also participating in tourism related ancillary activities. These may include transportation, as tourist guide and agents, waiters and cooks besides adventurous activities, etc.

(b) Intensive Subsistence Farming

This form of subsistence farming has already been transformed to a great extent and no longer practiced in its original form. Improved farming methods are used as compared to the first case of primitive subsistence farming. This form is characterised by relatively higher production or output per unit of cultivated land, and comparatively lower production or output in terms of per farm worker. Owing to its peculiar geographical location in monsoonal lands of Asia, it is also popularly called as 'monsoon type of agriculture'.

Geographical Location and Distribution

As stated, it is primarily concentrated in the monsoonal lands of Asian continent as depicted below in Fig. 9.2. Main countries practicing intensive subsistence farming are China, Pakistan, Korea, Japan, India and Sri Lanka, etc. Besides, it is also practiced in substantial portions of continental South-East Asia along with a few pockets of insular South-East Asia. As you know that two most populous countries of the world namely China and India needs to support a large population base. Therefore, the intensity of farming is even greater as opposed to extensive wheat farming regions of commercial grain farming or plantation agriculture, per se. A relatively smaller piece of cultivable parcel of land is necessitated and put under anthropogenic pressure to support ten times more number of people, than the countries having optimum or under population.



Fig. 9.2: Geographical Location and Distribution of Intensive Subsistence Farming.

Salient Features:

It has the following salient features:

- i. **Very Small Land Holdings:** Due to law of inheritance, the fragmentation of owned land of the farming households, among the successive generations is one of the prime reasons of very small size of agricultural fields. Usually, the size of farm is quite smaller as compared to the size of farms either in commercial grain farming or plantation agriculture. For example, in many countries of South-East Asia, average size of farms are even less than half hectare, which renders it economically unviable, if the family size of that farm owner happens to be either large or very large. Such peculiar combination of physical and socio-economic phenomenon's trigger migration of people from rural hinterlands to urban places across the regions, barring the pockets of aboriginal tribal groups. There are a few exceptions also. The average farm size is more than half hectare in the advanced nation of Japan. And, in case of China, agrarian revolution of 1949 brought a tremendous change, which led to the consolidation of small land holdings into bigger collective farms, under the communist regime. This may have made possible the scientific and modern farming operations on large scale and also may have made it more beneficial as well.
- ii. **Intensive Nature of Farming:** Due to population pressure, every possible parcel of arable land is put under cultivation. On the margins of the cultivated farms, narrowly carved out handmade ridges and paths for the movement of farmers, to facilitate the post-sowing operations can be visibly seen. This practice may be done with an aim to save the land and increase crop production. Farmers even try to bring the moist piece of lands, primarily swampy land (by draining and drying out the water) and dry areas (with the help of irrigation) along with gently sloping lands (by cutting and carving into step-like terraces) under

cultivation. However, lands having physical constraints in terms of steeply sloping lands and land not suitable for cultivation are left behind. Nature of farming is deeply intensive, often characterised even with double or triple cropping pattern of paddy or rice in a single agricultural year. However, the areas where only one crop of paddy or rice is raised, agricultural fields are often interspersed with the sowing of certain other cash crops like sugar, oilseed and tobacco, etc. You know that paddy or rice is staple food in many parts of monsoonal lands of Asia, therefore, it has been accorded greater priority as a first ranking crop.

iii. **Intensive Utilisation of Manual Labour:** Traditionally, wet or flood paddy farming is done with the aid of intensive use of manual labour. Farming tools and methods are often very simple, comprising wood made ploughs, spade, sickle and hoes, etc. known by diverse names in different countries. Ploughing is carried out with the help of different draught animals in different regions of intensive subsistence farming. Usually, labour is shared among the farming households on exchange basis to complete the sowing operations, as it demands intensive labour inputs. Then, fields are prepared with the hands to plant the paddy in row and columns often by female-folks. After the crop attains maturity, it is harvested with sickles and then threshed to separate the grain from the chaff by hand and in some pockets of India and elsewhere, livestock resources are utilised for executing such task. A change has been noticed during contemporary times, especially in some countries, for example, in entire Japan, China and a few pockets of India (especially Green Revolution beneficiary states of Punjab, Haryana, Western UP and a few southern states), Philippines (where International Institute of Rice is located) and machinery is used to plough, plant the paddy saplings and harvest the mature paddy crop on a large scale with the help of modern and scientific inputs like tractors, transplanting machines and harvesters, etc. However, elsewhere with a few exceptions, the farming techniques are still traditional as majority of farmers own very small land holdings, which doesn't allow them to use machinery, coupled with their poor purchasing power parity (PPP). In simple words, it means that they cannot afford to buy such sophisticated and expensive machineries.

iv. **Utilisation of Animal and Plant Manures:** As understood, the application of farm manure in its different forms helps the farmer to increase the crop yield on one hand, and on the other hand, enrich soil fertility. It could be of different types, like, farm wastes (by-product of crops and vegetables left out after harvesting season), animal dung and human excreta, etc. as organic manure. However, with the passage of time, in order to accelerate the production per unit of land, application of inorganic substances known as synthetic and chemical fertilizers are increasingly being used in many parts of intensive subsistence farming areas. These are known by popular acronym NPK, which stands for Nitrogen, Phosphates and Potash, applied to replenish the crucial plant nutrients of the soil to raise agricultural productivity. However, the excessive application of these have unleashed adverse impacts, not only confined to the degradation of land quality and soil plant nutrients, but also started affecting the health of people adversely.

- v. **Dominance of Paddy and other Food Crops:** Usually, most of the monsoonal lands of Asia is characterised by the predominance of rice cultivation due to socio-cultural factors. However, due to the diversity of physical parameters such as climate, relief, soil and availability of tillable land, especially during dry season, other cereal crops are also grown. Groundnut, sugarcane, cotton, oilseeds, millets, sorghum, barley and kaoliang, etc. are also grown in different parts of South-East Asia. For example, in Deccan plateau and a few portions of Indus basin, due to water deficit and inferior soil quality, sorghum or millet is the dominant crop. However, the farming techniques remain intensive, practiced for subsistence purpose. Albeit, a little surplus crop produce is sold in the market for earning some income. In some regions spanning interior of Indo-China, Korat plateau region of Thailand, drier parts of Myanmar, due to very low amount of annual precipitation, coarse cereals like maize, millet and groundnut often fused with cash crops of oilseeds, sugarcane and cotton are also raised in succession in an agricultural year. This is just an indicative description, in reality on actual ground, you may come across several other crop associations, crop combinations and cropping pattern which may surface as a result of changing priorities, often guided by better remuneration facilitated by the modern inputs and market requirements from the increasing group of consumers.

Recent Changes

Many countries practicing intensive subsistence agriculture have undergone significant changes in recent times. Such changes were necessitated by the need to feed large population on one hand, and commensurate agricultural advancements made possible through the utilisation of modern farm inputs. These include use of improved farm machineries, tools and implements, hybrid seeds, fertilizers and scientific techniques of farming to take care of the crucial climatic variables of temperature and rainfall etc. Nowadays, with the advent of many life-threatening human diseases like cancer and heart ailments due to sedentary lifestyles, some farmers have oriented themselves towards organic farming practices as well across the world in a few restricted pockets. For example, in India, the north-eastern state of Sikkim has completely turned its agricultural practices into organic farming.

Besides, the cultivation of aromatic and medicinal plants by big multi-national pharmaceutical companies on the basis of contract farming can also be seen in some of the Himalayan states, which is primarily a commercial venture.

2. Commercial Grain Farming

As the name suggests, commercial grain farming is a specialised market-oriented form of agriculture, carried out on a large scale. Its origin can be traced back to the great economic and technological changes, believed to be heralded by the Industrial Revolution of the 19th Century. It is mainly characterized by its extensive nature and mechanisation of farming operations, often on mega scale solely meant for trading of final produce. This form of agriculture got both a thrust and momentum due to its vantage continental location, concentrated mainly in the mid-latitudinal regions of the world. Such regions are known for providing huge tracts of level land for

cultivation. However, climatically, due to its interior location secluded from the influence of maritime moisture, it experiences low amount of rainfall, which sometimes may put the success of crops at risk. It is circumvented with the help of modern farm inputs, especially through various forms of irrigation that supplies the much-required essential threshold amount of moisture or water needed for the ideal growth of crops. Often, one of the distinctive features of commercial grain farming is mono-crop specialisation, say, for example, wheat.

Geographical Location and Distribution

It is confined to the geographical regions situated in the mid-latitudes lying between 30 to 55 degrees North and South latitudes, exhibited in Fig. 9.3 below. Broadly, commercial grain farming is practiced in the following popularly well-known geographical regions:

- the *Steppes* of Russia;
- the great wheat belts stretching through south-west and south-east in Australia;
- the plains of interior North America;
- the *Prarries* of Canada and America;
- the *Pampas* of Argentina;
- the *Veldts* of South Africa; and
- the *Downs* of Australia and *Canterbury* of New Zealand.



Fig. 9.3: Geographical Location and Distribution of Commercial Grain Farming.

Salient Features:

Some of the key characteristics of commercial grain farming regions of the world are discussed as under:

- i. **Extensive and Very Large Farm Size:** Mid-latitudinal areas occupy a vast tract of land, which is relatively less expensive than the land

elsewhere. Therefore, the regions practicing commercial grain farming are having huge operational landholdings. It may vary between 240 - 16,000 hectares in size. In North America, the average farm size is 400 hectares.

ii. **Mono-Cropping Pattern:** The regions practicing this farming type specialise in the successful cultivation of a single crop, which is often the cereal crop of wheat. Its peculiar location in the mid-latitudes (laden with less severe climatic conditions), facilitates the cultivation of two successive crops in an agricultural year. Therefore, both spring and winter wheat is grown in mid-latitudinal regions, practicing commercial grain farming.

iii. **High Degree of Mechanisation:** It is characterized by high degree of mechanisation of entire range of farming operations (from ploughing to harvesting), owing to relatively flat and vast tract of open land. Farming operations include sowing of seeds, winnowing, threshing, reaping and sacking of matured crop. All such kinds of farming operations are performed with the help of an array of agricultural equipments, implements and specialised set of sophisticated machineries.

These mechanised tools are getting more and more efficient and sophisticated in consonance with consistent scientific and technological innovations.

iv. **Low Yield per Unit of Land, but Higher Yield per Farm Worker:** The yield per unit of land is comparatively low as compared to forms of intensive cultivation, which is higher in a few nations. However, it is still beneficial, as this form of agriculture often produces large amount of surplus, solely meant for trading purposes. Owing to high degree of mechanisation, it is also characterized by high yield as far as labour force in terms of per farm workers is concerned. This aspect helps to significantly decrease the labour requirement.

Besides, it also has certain other characteristics including lack of irrigation, ownership of large size farms, vulnerability to climatic hazards and susceptibility to market forces to get better remuneration for their final agricultural produce.

3. Plantation

Origin of plantation agriculture can be traced as far back as to around 1500 AD, especially when tropical and sub-tropical regions of the world were colonised by the European powers. These regions are ideally suitable for the growth of certain specialised crops, which cannot be grown in the temperate regions and elsewhere, primarily due to climatic factors. Such crops require higher temperature and good amount of rainfall throughout the year. Besides, it also necessitates the heavy capital investment and cheap labour to create, run, and maintain the large plantation estates. It was further accentuated by the high demand for such crops in Europe. This demand kept on increasing with the increase in population and consumption patterns not only in Europe, but also across the world. It is operated on a commercial basis for exporting the entire produce, often with the help of large-scale enterprises supported with technological inputs. It also involves post-harvest operations including

sorting, processing, packaging, and transportation of the produce for export to the outside markets across the world, wherever demand is there. Hence, it is created due to the forces of colonialism, as a part of voyages to explore, colonise, and exploit newer geographical territories carrying definite economic potentials. It is considered as one of the oldest types of agriculture being practiced on large estates meant solely for commercial purposes. Hence, the specialised crops grown here were initially meant for export to the market centres of wealthier countries and now cover almost the entire world. It is facilitated to a great extent by the onset of the trio of liberalisation, privatisation and globalisation (LPG) drive. Prominently since 1990s, this drive has further opened up the channels of global trade, which has brought the world much closer in terms of the consumption of various agricultural commodities. Thereby, this aspect has substantially led to the shrinkage of the concept of distance in relative sense.

Most important crops grown in plantation agriculture can be clubbed under following categories:

- i. **Plantation Crops:** Cotton, copra, oil palm, rubber, sugarcane, jute and hemp, etc.
- ii. **Beverage Crops:** Tea, coffee and cocoa, etc.
- iii. **Fruit Crops:** Banana and pineapple, etc.

Besides these, certain other crops are also grown in sub-tropical and tropical lands across the continents of the world.

Geographical Location and Distribution

As stated earlier, plantation agriculture is primarily concentrated in the tropical regions covering both Northern and Southern Hemispheres or sides of the Equator as shown below in Fig. 9.4. In other words, we can say that it can be found wherever a tinge of tropical climate prevails. It is found and practiced in the following tropical regions:

- Broadly covers tropical regions of Latin America, Asia and Africa as well.
- However, among these, the oldest region of plantation agriculture is believed to be Latin America. Some of the prominent countries, where diverse varieties of specialised plantation crops are grown are as under:
- **Prominent Coffee Growing Countries:** It includes Bolivia, Brazil and Paraguay in Latin America and Tanzania and Kenya in Africa.
- **Prominent Tea Growing Countries:** It includes Indonesia, Sri Lanka and India in Asia.
- **Prominent Cocoa Growing Countries:** It includes Brazil, Ecuador and West Indies in Latin America, and Ghana and Nigeria in Africa.
- **Prominent Sugarcane Growing Countries:** It includes Brazil, Cuba, Peru and Puerto Rico in Latin America and Philippines in Asia.
- **Prominent Rubber Growing Countries:** It includes India, Sri Lanka, Thailand, Malaysia, Cambodia, Myanmar and Indonesia in Asia.

- **Prominent Banana Growing Countries:** It includes Mexico, Jamaica, Panama, Costa Rica, Columbia and Brazil in Latin America.

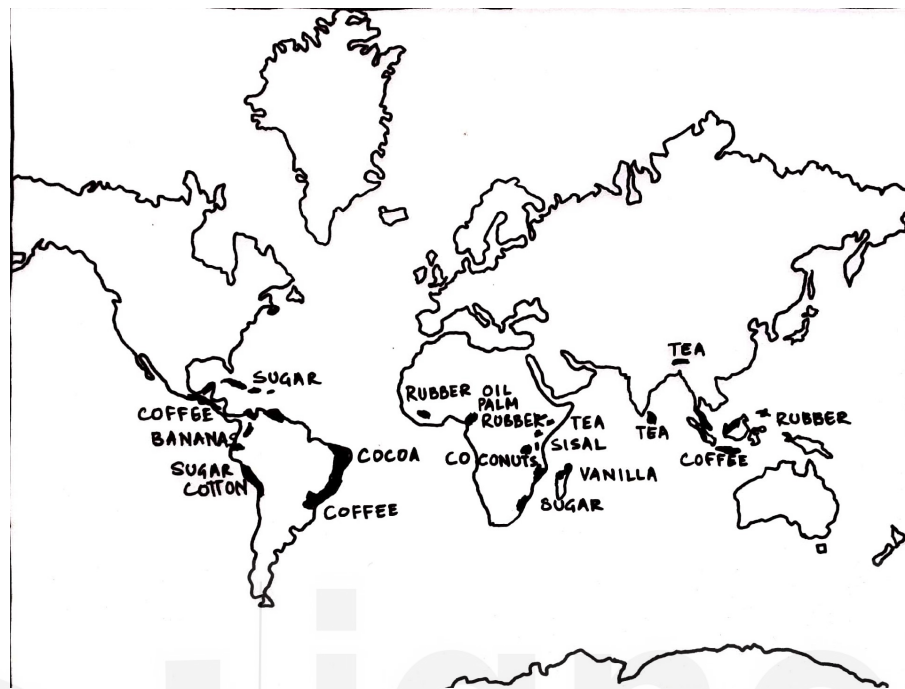


Fig. 9.4: Geographical Location and Distribution of Plantation Agriculture.

Salient Features:

In this type, besides highlighting the key characteristics, we will also try to focus on some key issues and problems being faced in the plantation agriculture or farming regions of the world. Let us begin our discussion on characteristics as under:

- i. **Mono-Cropping Pattern or Single Crop Specialisation:** As the name itself indicates, it is characterised by the cultivation of a single crop. It aims at high yields, high quality production and large output, most of which is exported.
- ii. **Longer Life Cycle:** Almost every type of crops being raised has more than two years of life cycle. Generally, all these tree crops have a long gestation period to mature and yield the produce. Subsequently, they keep on yielding the produce every successive agricultural season for a long period of time. The most prominent among these are tea, cocoa, coffee, oil palm, coconut and natural rubber etc.
- iii. **Large Estate Farming:** Usually, on an average, farm size in plantation agriculture is to the tune of more than 40 hectares, equivalent to 100 acres. However, small size farms being raised by small farmers also co-exist in parallel. They are inspired by the success of plantation crops, either by the large private companies or firms or by the autonomous government research institutions etc, as per the case prevalent on the ground. For example, i) In a few localised pockets of West Africa, smaller farm holdings hold more importance as compared to large estates. ii) The total production of rubber grown together by smaller farms far outweighs large estates.

- iv. **Foreign Origin Ownership and Local/Immigrant Origin Labor:** As the onset of plantation took place with the colonial expansion of foreign lands, many of the bigger plantation estates are owned by the company owners of foreign origin, primarily British and few others like French, Dutch and Spanish among the Europeans. However, the entire farming operations are carried out by both local and immigrant labourers. Of late, some American and Canadian capitalists have also ventured into plantation agriculture in tropical countries of America.
- v. **Capital Intensive Farming:** Because of its peculiar geophysical location, plantation agriculture necessitates very high capital investment, virtually into multiple spheres directly as well as indirectly. You are aware that such ideal locations in tropical countries are generally located in the interior parts, far away from nodal administrative and market centres. Therefore, capital is required not only to develop and maintain plantation estate. In many instances, the development of even a basic transport network becomes essential, to provide accessibility and connectivity with or without administrative assistance. In essence, we can say that overall cost of production is much higher as opposed to other farming systems, per se.
- vi. **Scientifically Managed Farming:** Lot of modern inputs is used to systematically and scientifically manage the plantation agriculture. These could include the specialised skills, application of fertilizers and use of machinery to optimize and minimize the labour demand wherever possible. Estate companies try to maximize their profit by increasing the yield, quality, and overall output with the help of scientific techniques.
- vii. **Export Oriented Farming:** Entire produce is meant for export in the international overseas markets. This aspect necessitates not only the development of good transport and communication network, but also sorting, processing, and packaging facilities of the final product such as cocoa, sugar, tea, palm oil, and sheet rubber etc. Therefore, it becomes mandatory to maintain the standards and specifications so as to maintain the quality of products as demanded by the consumers in the markets, which is often marred with stiff competition in recent times.
- viii. **Provision of Socio-Economic and Infrastructural Amenities:** One of the dissimilar features of plantation agriculture is arrangement of socio-economic and infrastructural amenities as opposed to other agricultural systems. Like well developed and scientifically managed farm estates, they are also required to develop housing, health and educational facilities, and markets etc., for the estate workers, allied people, diverse stakeholders and their families, who work and live there.
- ix. **Migration of Labour across Continents and Countries:** Farm labour requirement often necessitates the migration of workers from one place to other place both within a continent and across the continents. It happened on large-scale during the initial years of colonialism, when forced inhuman means were adopted to move the labour force. For example, labour requirement met with slavery system and later on indentured labour from India is well known (when Indian workers were taken to work in sugarcane plantations in different locations owned by

British Empire). Besides, Indian workers also migrated to rubber estates of Malaysia, tea estates of Sri Lanka, and sugarcane farms of West Indies.

Challenges and Recent Changes

Aside than the major advantages primarily confined to the profit seeking owners of estate companies, there are certain challenges as well.

- i. **Climatic Hazards:** Due to its location, tropical areas are characterized by high temperature, higher amount of relative humidity and very heavy rainfall throughout the year. These climatic conditions are not considered suitable for human activities, as these tend to deplete human energy and thereby reduce the output of human labour, as opposed to their counterparts. Besides, some local winds like harmattan, hurricanes and typhoons coupled with excessive rainfall may cause damage to the plantation crops. Production of coffee in sub-tropical region of Brazil often suffers due to the climatic hazard of frost.
- ii. **Attack of Diseases and Insects:** Peculiar characteristics of climate as already pointed out, may lead to the growth of insects and bacterial diseases. It can adversely affect both the crops as well as human labour. Some of the prominent crop diseases are blights and boll-weevil in the coffee plantations. Among the human diseases, fever, malaria, and dengue are notorious examples, which affect both the health and productivity of human labour.
- iii. **Soil Deterioration:** Due to heavy rainfall, diverse types of biological and chemical processes in the soil undergo a remarkable change. This often deprives the soil with oxygen content and facilitates the growth of certain compounds, which could be toxic in nature and hence may prove detrimental to the roots of plants. In addition, lot of soil nutrients such as magnesium, potassium and calcium also get washed away. Tropical regions known for red laterite soil, also become relatively infertile without crop rotation practices and overexploitation as well. It may eventually lead to soil erosion and decrease in soil fertility over time.
- iv. **Maintenance Hassles:** Due to excessive rainfall in tropical regions, growth of a variety of natural vegetation can often be seen in multiple layers. These may include tall trees of various species, diverse varieties of palm trees, diverse kinds of herbaceous, epiphytic and parasitic plants along with undergrowth of ferns, mosses and lichens etc. Natural vegetation cover virtually turns into a dense forest, which makes it difficult to maintain the farm estate structures and lines of communication and network. Therefore, such climatic factors in tandem with physical conditions often necessitate heavy expenditure on maintenance side. Moreover, a danger also keeps looming overhead from animal attacks, during the execution of such clearing and maintenance related estate operations.

SAQ I

- Name the five characteristics or functioning forms on the basis of which Derwent Whittlesey classified agricultural systems of the world.
- What is subsistence farming?
- What is commercial grain farming?

9.3 LAND USE PATTERN

You have learnt in Unit 6 of Block 2 of this course that land holds a special importance amongst the categories of natural resources. Others are soil, forest and water resources, which are of equal importance as far as survival and continued sustenance of human beings along with floral and faunal species on the planet Earth, are concerned. Land provides a basis or a kind of absolute platform for the smooth functioning of a range of activities such as tilling of land, animal husbandry, vegetation, settlement, factories and industries and infrastructural amenities (transport, electricity and telecommunication systems), etc. Land also denotes a valuable asset, which holds a great emotional and monetary value for its owner. As we are dealing with agriculture in this Unit, therefore, mere size of land is not only sufficient, but the quality of land is of utmost importance in terms of soil fertility to grow crops and obtain better productivity. Alongside, there are certain other factors, which invariably determine the agricultural productivity as discussed in the last Section 9.6.

Land use pattern denotes the various kinds of usages with standardised connotations, under which a piece or proportion of land has been put under to satisfy human requirements. One of the prominent agencies, which provide the statistics of land use pattern, is Food and Agricultural Organisation (FAO), of United Nations (UN).

Table 9.1: Area and Proportion of Land Use in Major World Regions - 2019 (Area in 000' Hectares).

Major Regions/ World	Total Land Area	Forest Land	Agricultural Land	Other Land
Africa	2990223.3 (100.00)	640608.6 (21.42)	1118601.3 (37.41)	1231013.4 (41.17)
Americas	3864917.6 (100.00)	1599319.3 (41.38)	1127759.8 (29.18)	1137838.5 (29.44)
Asia	3110087.9 (100.00)	621427.4 (19.98)	1667953.6 (53.63)	820706.9 (26.39)
Europe	2210304.7 (100.00)	1017238.7 (46.02)	462609.1 (20.93)	730456.9 (33.05)
Oceania	828283.8 (100.00)	185249.0 (22.37)	375187.0 (45.30)	267847.8 (32.34)
World	13003817.3 (100.00)	4063843.1 (31.25)	4752110.7 (36.54)	4187863.5 (32.20)

(Source: Computed from FAO, 2021. World Food and Agriculture - Statistical Yearbook 2021, Rome. <https://doi.org/10.4060/cb4477en>)

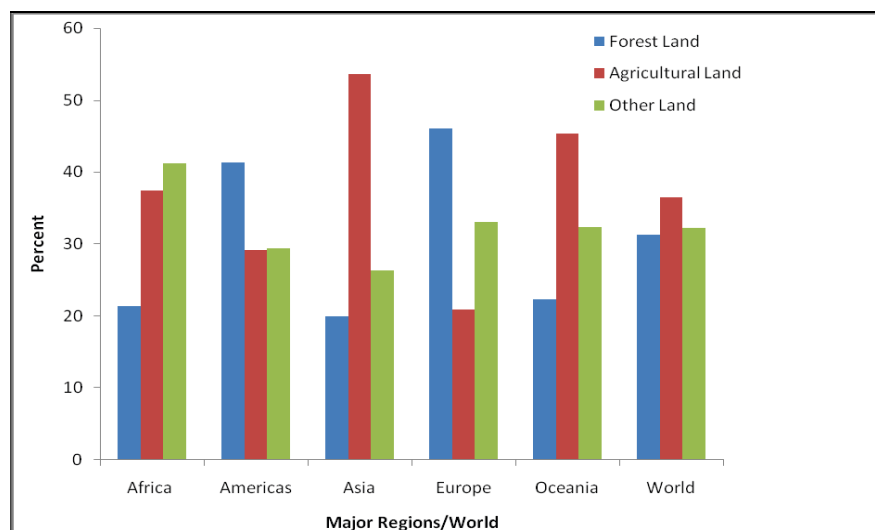


Fig. 9.5: Percentage of Land Use Area to Total Land Area by Diverse Types in Major World Regions, 2019.

Above Table 9.1 shows the land use area by diverse types for the major world regions in nutshell. Fig. 9.5 shows that out of total land area, Asia has the highest proportion of agricultural land to the tune of 53.63 percent whereas Europe has the lowest proportion i.e., 20.93 percent. It shows the necessity to feed an overwhelming number of human beings in Asia whereas moderately optimum number of human beings in case of Europe. As a whole, the proportion of agricultural land for the world is 36.54 percent. As far as parameter of ecological barometer i.e., forest land is concerned, highest proportion is found in Europe with 46.02 percent, whereas lowest proportion is found in Asia having 19.98 percent, which is much lower than the prescribed standard national level norms. The same figure for the entire world is 31.25 percent. The proportion of other land is highest in Africa having 41.17 percent, whereas lowest in Asia with 26.39 per cent. It is 32.20 percent in case of whole world.

Table 9.2: Area and Proportion of Agricultural Land Use in Major World Regions - 2019 (Area in 000' Hectares).

Major Regions/ World	Agricultural Land	Permanent Meadows and Pastures	Cropland
Africa	1118601.3 (100.00)	842870.2 (75.35)	275731.1 (24.65)
Americas	1127759.8 (100.00)	759561.9 (67.35)	368197.9 (32.65)
Asia	1667953.6 (100.00)	1077881.8 (64.62)	590071.8 (35.38)
Europe	462587.3 (100.00)	173792.9 (37.57)	288794.4 (62.43)
Oceania	375187.0 (100.00)	341923.0 (91.13)	33264.0 (8.87)
World	4752088.9 (100.00)	3196029.7 (67.26)	1556059.2 (32.74)

(Source: Computed from FAO, 2021. World Food and Agriculture - Statistical Yearbook 2021, Rome. <https://doi.org/10.4060/cb4477en>)

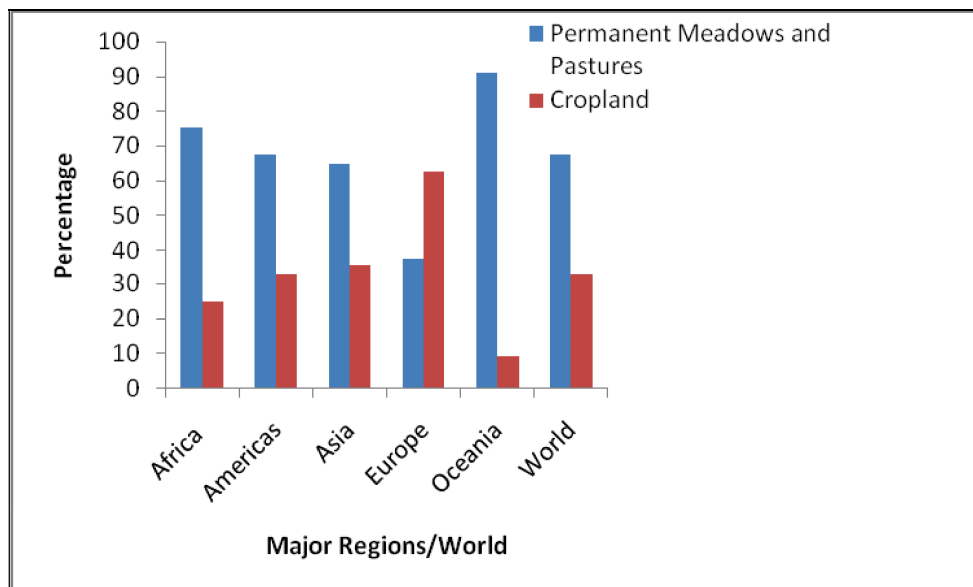


Fig. 9.6: Percentage of Agricultural Land by Different Usages in Major World Regions, 2019.

Above Table 9.2 and Fig. 9.6 shows the agricultural land by two different usages for the major regions of the world in nutshell. These two are known as a) permanent pastures and meadows and b) cropland or cultivated land. Out of total agricultural land, Europe has the highest proportion of cropland having 62.43 percent, whereas Oceania has the lowest proportion having 8.87 percent. The reasons for highest proportion could be highly developed form of scientifically managed agricultural practices, whereas in case of lowest proportion, it could be the uneven distribution of land and water bodies in Oceania. As a whole, the proportion of cropland for the world is 32.74 percent. As far as permanent meadows and pastures are concerned, highest proportion is found in the Oceania with 91.13 percent, whereas lowest proportion is found in Europe with 37.57 percent. The same figure for the entire world is 67.26 percent.

SAQ 2

What is land use?

9.4 CROPPING PATTERN AND CHANGES

In simple words, cropping pattern refers to the proportion of area under various cultivated crops during a particular crop season. It is characterized by changes, both at spatial and temporal scale. Hence, it is more of a dynamic concept rather than static concept. There are numerous factors, which directly as well as indirectly govern the cropping pattern of a particular region. Some of such pertinent set of factors can broadly be clubbed under physical, climatic, social, economic, and political etc., with which you are familiar. On the basis of such factors either individually or jointly or in multiple combinations, cropping pattern varies from place to place, both within and across agricultural systems of the world. Some of the prominent diverse types of cropping pattern are discussed as under:

- a) **Mono-Cropping:** It simply means cultivation of a single crop in an agricultural year. Predominantly, commercial farms as well as small farms with relatively large landholdings are put under mono-cropping pattern, for example, cultivation of wheat.
- b) **Double-Cropping:** It indicates the cultivation and harvesting of two crops in succession in an agricultural year. For example, wheat in the spring season and soyabeans and mustard in the winter season.
- c) **Multi-Cropping:** It means the cultivation of more than two crops in a single agricultural year. For example, cultivation of wheat during the spring season and mustard during the winter season along with leguminous crops and vegetables.
- d) **Inter-cropping:** It refers to the practice of growing multiple crops simultaneously in the same field during an agricultural year. For example, cultivation of leguminous crops with maize.
- e) **Strip Cropping:** It denotes a kind of farming method, whereby agricultural fields are often divided into a combination of tapered and elongated strips. Then agricultural fields prepared in such a manner are put under crop rotation system in an alternating manner. This method becomes useful especially in case of hilly and mountainous areas with steeper slopes and also with an aim to arrest and prevent soil erosion.
- f) **Relay Cropping:** It also denotes a kind of method related to multiple cropping patterns, analogues to multiple cropping. Seed of next or second crop is sown well before the first crop attains maturity for harvesting under relay cropping pattern. It is believed to provide a solution to a few thematic issues concerned with the unproductive use of land and water resources, application of modern farm inputs and soil fertility, etc.

Changes

Change in cropping pattern is believed to be driven primarily by large-scale commercial profit-oriented ventures made possible by the unprecedented advancements in agro-technologies. Therefore, it has started witnessing an air of change, arising out of host of economic, environmental, health and commercial reasons. Among the prime economic reasons, it is the farmer's propensity to grow cash crops in lieu of better farm returns, instead of cultivation of centuries old ecologically sound traditional or coarse cereal crops. Environmental reasons may include the over-exploitation of land and water resources, causing ecological stress and imbalances, which may disturb a part or whole of the life providing giant Earth systems (driven by the energy of giant Sun and Oceans). Health reasons are also driving the cropping pattern changes in terms of organic and inorganic binaries as a result of the deep and disturbing concerns arising out of sedentary lifestyles and resultant life-threatening diseases. Organic farming denotes the farming done without the use of chemical and synthetic fertilizers and pesticides, insecticides etc., as an alternative to genetically engineered or modified crops. Its practice has started growing exponentially in developed parts of the world in recent times. Table 9.3 and 9.4 portrays the growing importance of

organic farming as evident from the proportion of area brought under organic farming across the major regions of the world, since 2010. However, it is still insignificant in terms of share of area under organic agriculture in total agricultural area. Organic farming is believed to give low yields against non-organic farming, besides other factors. Commercial reasons are driven by profits in the form of agri-businesses to cultivate specific cereal, non-cereal and medicinal crops on mega-scale, to meet the diverse needs of millions and billions of consumers. It is highly science and technology intensive form of agriculture known as bio-agricultural practices, prominently like green, white, yellow, and gene revolution etc. These revolutions brought a significant transformation to increase the agricultural yield and productivity per unit of land/farm worker/input cost. In addition, it has also helped to unleash a new chapter in the lives of both individual farmers as well as amongst the farm entrepreneurs.

One more insignificant form of cropping pattern i.e., rooftop (buildings and houses) and kitchen gardening (either in the front or rear side of a dwelling unit), to grow certain green vegetables has also started emerging among the urban households. However, this form is solely meant for self-consumption rather than commercial purpose.

Table 9.3: Area under Organic Agriculture in Major World Regions (in 000' Hectares)

Major Regions/ World	2010	2019	Percentage Change
Africa	1023.6	2018.5	97.20
Americas	10178.5	12056.9	18.45
Asia	3271.4	6462.9	97.56
Europe	9545.1	15793.9	65.47
Oceania	11785.2	35881.2	204.46
World	35803.8	72213.3	101.69

(Source: Computed from FAO, 2021. World Food and Agriculture - Statistical Yearbook 2021, Rome. <https://doi.org/10.4060/cb4477en>)

Table 9.4: Share of Area under Organic Agriculture in Total Agricultural Area in Major World Regions (in percentage)

Major Regions/World	2010	2019
Africa	0.1	0.2
Americas	0.9	1.1
Asia	0.2	0.4
Europe	2.0	3.4
Oceania	3.0	9.6
World	0.7	1.5

(Source: Computed from FAO, 2021. World Food and Agriculture - Statistical Yearbook 2021, Rome. <https://doi.org/10.4060/cb4477en>)

SAQ 3

What is cropping pattern? Discuss any two types.

9.5 PRODUCTIVITY

Productivity is used in many academic disciplines, especially in the economics and agricultural geography. The concept of productivity is more of a physical entity rather than a value concept. It is meant to describe the relationship between applied inputs and that of outputs. You may surmise the meaning of productivity, which is simply a measure of input-output ratio. In other words, inputs are generally taken as land, labour and capital in traditional parlance and output in terms of yield and production per unit of inputs or cropped area. And, the productivity is governed by multiple factors of production, like physical in unison with climatic, social, economic, institutional and technological, etc. For example, among physical factors, quality of land and soil, crucial climatic variables like temperature and rainfall are of greater importance. It is a kind of measure of efficiency, to see the agricultural production per unit of area in relation to the applied quantities of inputs. You may easily guess that all the agricultural regions or systems of the world as learnt in previous Section will not yield desired output uniformly. The variation across different agricultural systems may take place on account of the even and uneven interplay between physical and non-physical attributes of agriculture. Such attributes are known to provide a base for the operation of agricultural pursuits in the actual ground. For example, the crop productivity of a mountainous region (with skeletal soil cover) may be far below as compared to that of a river valley region in plains (covered with thick fertile soil and adequate humus content). Basically, agricultural efficiency is a function of the best possible choice and utilisation of input factors along with required skills and techniques to carry out such operations in a befitting manner. Besides, agricultural productivity never remains static, as it depends upon the interplay of changing nature of various factors of input. In essence, agricultural productivity is a function of interplay of various set of factors, primarily physical and cultural factors. Besides, the knowledge of crops and their timely, systematic, and scientific management on the part of a farmer or group of farmers is also of crucial significance. For example, if you happen to compare the agricultural productivity between a private farmer and that of institutional farmer, you will notice striking differences. The former may register relatively low productivity as compared to the later, on account of lack of proper scientific farming practices.

Many geographers and agricultural economists have developed various measures in terms of tools and techniques in order to measure the agricultural productivity. These are used to quantify the input-output ratio per unit area/time/farm workforce etc. It helps a concerned stakeholder or a beneficiary and planner to identify, address, and ameliorate the root causes of poor productivity pertaining to that agricultural system in comparison to areas with rich agricultural productivity. Nowadays, this task has been made much faster and easier with the penetration of latest state of the art conceptually and technologically enabled fields of communication and computational technologies coupled with rising academic acumen. There are around one dozen measures.

1. Output per unit area.
2. Production per unit of farm labour.
3. Assessment of agricultural production as grain equivalents.

4. Input-output ratio.
5. Ranking coefficient method.
6. Carrying capacity of land seen in terms of population.
7. Assigning weight to the ranking order of output per unit area with the percentage share under each crop.
8. Determination of index of productivity.
9. Computation of crop yield and concentration indices ranking coefficient.
10. Involvement of area, production, and price of each cultivated crop in each of the constituent areal unit of the crop.
11. Assessment of agricultural production in monetary terms.
12. Assessment of net income (in rupees), per hectare of cropped area.

All of the above-mentioned techniques are characterised by inherent strengths and weaknesses. Their application may yield a desired result at localised levels, but not at national as well as global levels. We will confine our discussion upto here only and not the detailed description on each measure as such, which seems beyond the scope of this Unit.

Table 9.5 provides the latest production data for the year 2019 in respect of primary crops by groups for major world regions. It is evident from Fig. 9.7 that for the world as a whole, the largest share of production is of cereals followed by sugar crops and oil crops, whereas lowest production share is of others along with roots and tubers out of the total production of primary crops by groups. It is clear that the largest share is occupied by roots and tubers followed by cereals, fruits and sugar crops, whereas lowest by others, oil crops, vegetables etc., in case of African region. In case of Americas, the largest share is of sugar crops followed by cereals, whereas lowest production share is of others, vegetables and roots and tubers. In case of Asia, largest share of production is of cereal crops followed by vegetables and sugar crops, whereas lowest share of production is of others and roots and tubers group of crops. In case of Europe, largest share of production is of cereals crops followed by sugar crops and roots and tubers whereas lowest share of production is of others and fruits group of crops. In case of Oceania, largest share of production is of cereal crops followed by sugar crops and oil crops, whereas lowest share of production is of others followed by vegetables group of crops.

Table 9.5: Production of Primary Crops by Groups in Major World Regions- 2019 (in 000' Tonnes)

Major Regions/ World	Cereals	Sugar Crops	Vegetables	Oil Crops	Fruits	Roots and Tubers	Others	Total
Africa	204,219 (21.59)	111,634 (11.80)	84,372 (8.92)	62,621 (6.62)	117,982 (12.47)	330,205 (34.90)	35,078 (3.71)	946,111 (100.00)
Americas	766,845 (30.42)	1,035,407 (41.07)	75,966 (3.01)	369,954 (14.67)	164,342 (6.52)	77,783 (3.09)	30,824 (1.22)	2,521,121 (100.00)
Asia	1,434,560 (30.62)	853,091 (18.21)	879,301 (18.77)	570,245 (12.17)	512,565 (10.94)	341,534 (7.29)	94,505 (2.02)	4,685,800 (100.00)
Europe	543,061 (48.84)	194,460 (17.49)	84,935 (7.64)	89,218 (8.02)	80,432 (7.23)	107,272 (9.65)	12,431 (1.12)	1,111,809 (100.00)
Oceania	30,296 (33.05)	34,109 (37.21)	3,353 (3.66)	9,268 (10.11)	8,094 (8.83)	4,249 (4.64)	2,293 (2.50)	91,664 (100.00)

World	2,978,982 (31.84)	2,228,701 (23.82)	1,127,927 (12.06)	1,101,307 (11.77)	883,416 (9.44)	861,042 (9.20)	175,131 (1.87)	9,356,505 (100.00)
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(Source: Computed from FAO, 2021. World Food and Agriculture - Statistical Yearbook 2021, Rome. <https://doi.org/10.4060/cb4477en>)

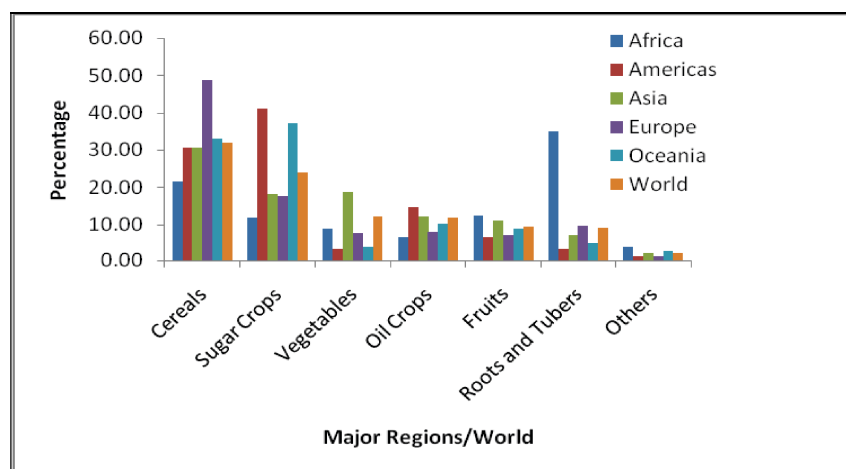


Fig. 9.7: Percentage Share of Production of Primary Crops by Groups in Major Regions of the World, 2019.

SAQ 4

What is productivity? Name any three measures of productivity.

9.6 SUMMARY

In this unit, you have learnt the following:

- Characteristics, location and salient features along with changes in a few important agricultural systems of the world, including subsistence farming, commercial grain farming and plantation agriculture.
- Land use pattern in major regions of the world.
- Cropping pattern and changes in major regions of the world.
- Productivity and production of primary crops in major regions of the world.

9.7 TERMINAL QUESTIONS

1. Briefly explain the commercial grain farming. Cite suitable examples.
2. Discuss land use pattern with suitable examples.
3. Describe cropping pattern and changes therein.
4. What is productivity? Explain with suitable examples.

9.8 ANSWERS

Self-Assessment Questions (SAQ)

1. a) The crop-livestock combinations, intensity of land use, processing, marketing and disposal of farm produce, degree of farm mechanisation, and the ensemble of buildings and other structures associated with agriculture.
b) Subsistence farming means the farming done at subsistence level by small scale farmers to satisfy the localised consumption and not for the trade.
c) Commercial grain farming refers to the cultivation of various cash crops solely for trade or commercial purposes.
2. Land use refers to the diverse kinds of usages, for which a piece of land is put under to meet diverse needs of human beings.
3. Cropping pattern means the proportion of area under various crops grown during a particular crop season.
4. In simple words, concept of productivity is used to describe the relationship between applied inputs and that of outputs. Three measures are input-output ratio, ranking coefficient method and carrying capacity of land etc.

Terminal Questions

1. Your answer should cover the brief explanation of commercial grain farming with suitable examples. Refer to Sec. 9.2.
2. Your answer should cover the discussion on land use pattern with suitable examples. Refer to Sec. 9.3.
3. Your answer should cover the description of cropping pattern and changes. Refer to Sec. 9.4.
4. Your answer should define the productivity and include the explanation with suitable examples. Refer to Sec. 9.5.

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UNIT 10

ANIMAL HUSBANDRY AND FISHING

Structure

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10.1 INTRODUCTION

You have studied about resources including natural resources, minerals and energy, and human resources in the previous Block 2. Block 3 explains the primary sector to you. In the primary sector, we have included agriculture, animal husbandry and fishing, forests, minerals and mining activities.

This Unit 10 of Block 3 will mainly focus on animal husbandry, dairying and fishing, which fall under the primary sector. Section 10.2 explains you the livestock and dairying under animal husbandry. You are introduced to livestock in Sub-Section 10.2.1, in terms of pastoralism, factors affecting livestock production, geographical distribution of grasslands and livestock, world livestock distributions, and India's livestock sector. Dairying is discussed in the Sub-Section 10.2.2 and Section 10.3 introduces the fishing sector of the world in general and India in particular.

Expected Learning Outcomes

After studying this unit, you should be able to:

- explain animal husbandry by including livestock and dairy farming;
- describe the favorable conditions for the livestock and their distribution;
- elucidate the importance of dairy farming and the growth of dairy sector; and
- explain the growth of fisheries sector, their distribution, and the significance of fishing activities.

10.2 ANIMAL HUSBANDRY

We all know that human life is closely associated with animal husbandry, dairying and fishing, as well as agriculture. These have remained vital elements since the beginning of civilisation. You might know that these actions have helped to maintain ecological equilibrium, food basket and draught animal power. In India, the animal husbandry, dairy and fishing sectors have played a significant socio-economic role because of its favorable geographical characteristics. The continuation of these activities has also been helped by traditional, cultural and religious beliefs. They also play a critical role in rural job creation, particularly for landless, small and marginal farmers and women, as well as bringing affordable and nutritious food to millions of people.

You all are well aware of India which mainly depends on agriculture dominated economy. Agriculture and livestock production are deeply intertwined, relying on each other and both being crucial to total food security. Livestock sector is a significant sub-sector of agriculture in India. It is a key source of revenue for most farmers, supporting agriculture with critical inputs, contributing to household health and nutrition, augmenting incomes and providing employment opportunities in times of need. It serves as a supplement and complement to the main business. From the standpoint of equality and livelihood, livestock wealth is more equitable than land. As a result, from the aspect of equity and livelihood, it is viewed as a vital component in poverty reduction programmes. Due to over growth of population, the demand for animal products has increased rapidly in recent times. Let us now understand the importance of livestock and its development.

10.2.1 Livestock

It is needless to say that every human being is acquainted with some or other animal on the planet Earth. It is also not correct to say that one has not used animal products like, milk or meat in the diet. **Livestock** including domesticated animals, and birds etc., have remained vital throughout human history and continue to play a vibrant role in the economies of many countries even today. This became possible only after **Pastoralism** was commercialised.

1) Pastoralism

Let us understand what is Pastoralism? And how is it important in human lives? **Pastoralism** is a type of animal husbandry in which animals are domesticated and released onto extensive vegetated outdoor fields (pastures) for grazing by **nomadic people** who roamed around with their herds during the historical era. The animals involved in pastoralism are cattle, camels, goats, reindeer, horses, yaks, and sheep, etc. These animals are commonly referred to as **livestock**. Pastoralism is generally classified according to the manner of movement, which is a crucial aspect of pastoralism. Different forms of pastoralism were practiced on diverse types of animals in different parts of the world. These are briefly explained below:

a) Nomadic Pastoralism

It is a type of pastoralism in which livestock are herded from place to place in search of new pastures to feed on. The true nomads follow an unpredictable pattern of travel. Cattle, water buffalo, yaks, llamas, sheep, goats, reindeer, musk-oxen, horses, donkeys and camels, as well as mixtures of species, are among the herded animals. Nomadic pastoralism is popular in areas with little arable land, such as the developing world and particularly in the steppe lands north of Eurasia's agricultural zone. Nomads reside throughout Africa, Asia, and Europe's dry and semi-arid regions, as well as Asia and Europe's tundra regions. For personal consumption as well as commerce, many nomads rely on their herds for meat, milk and hides.

b) Semi-Nomadic Herding

Semi-nomadic herders are less mobile than nomads. They nevertheless follow their herds for extended periods of time. For thousands of years, millions of **Mongolians** have been semi-nomadic herders. Sheep, goats, horses and Bactrian camels have all been herded in the past. Approximately, a quarter of Mongolia's population still practices semi-nomadic herding. Arctic herders of northern Norway, Sweden, Finland, and Russia also live semi-nomadic life. For centuries, they have relied on reindeer herding to maintain their income, which is augmented by fishing and trapping.

c) Transhumance

Transhumance is a different type of herding. Transhumance herders follow a seasonal rhythm, travelling to cooler highlands in the summer and warmer lowlands in the winter. These herders, unlike nomads, migrate between two areas where they establish permanent villages. Thousands of years of transhumance have changed foothill forests into alpine pastures in the European Alps, for example. Transhumance is still widely practiced by agricultural communities of Switzerland, Germany, Austria, Italy and Slovenia.

d) Livestock Ranching

Ranching is the process of raising huge herds of animals on huge acreage of lands. Cattle and sheep are commonly raised by ranchers. Ranching as an activity is growing at a greater rate compared to other agricultural sectors of the world. Examples are Africa's Savanna, Russia's Steppes, North America's Prairie, Argentina's Pampas, South Africa's Veld and Australia's Downs.

e) Commercial Livestock Rearing

Commercial livestock rearing is done in ranches, unlike in nomadic herding, and is highly organised and capital expensive. These ranches are huge and are parceled out into several lots, each of which is fenced to control grazing. Animals are shifted to another parcel when the grass on one parcel is grazed. This is a specialised activity that only raises one sort

of animal. Animal products are typically sold for both domestic and international markets. Associated activities like slaughtering, processing, and packaging are augmented due to commercial ranching. Transportation network, including roads and railways, is established to connect ranches and communities. Although, the ranches are enormous, the ranchers reside in permanent homes. The ranches are scientifically maintained, with high-quality animals raised through selective breeding and feedstuffs grown to replace grass shortages.

You have to remember that Pastoralism is currently practiced in more than 100 nations, covering over 25 percent of the Earth's land surface and supporting nearly 200 million households and herds of nearly a billion animals, including camels, cattle and smaller livestock, which account for about 10 percent of global meat output (FAO, 2001).

Let us now study the geographical factors that influence livestock production.

2) Factors Affecting Livestock Production

You will be surprised to know that livestock systems occupy nearly 30 percent of Earth's ice-free surface area. This sector is creating employability to roughly 1.3 billion people worldwide organised in long market chains. There are varieties of factors such as climate, topography, natural vegetation, economic conditions, nutrition, diseases and parasites which influenced the livestock production and productivity.

Let's have a look at the factors that have the most significant and widespread restricting effects on livestock production.

(i) Climate

Climate and location are undoubtedly the most important elements in determining the livestock productivity. Indeed, meteorological factors like atmospheric temperature and rainfall patterns have a significant impact on the availability of pasture and food resources throughout the year, as well as disease and parasite outbreaks in animal populations. Most important key aspects of livestock production, such as water availability, animal output, reproduction and health are affected by temperature. Variations in temperature and precipitation have an impact on forage quantity as well as quality and livestock illnesses.

(ii) Topography

Regions of the world where livestock farming occurs are relatively flat and rolling plains, which are ideal for grassland development and livestock ranching. Examples are Savannas and Steppes, etc.

(iii) Natural Flora

Grasslands and desert shrub lands are used commonly for livestock rearing. The grass types may vary from region to region. Marginal grasslands, such as desert environs adjacent to Steppes and grassland patches on the boundaries of forests adjacent to Steppes, are also used for ranching.

(iv) Economic Factors

The nature of the economy also impacts livestock ranching. For commercial cattle production to grow successfully, economic stability is required. The essential prerequisites for economic conditions are capital, transportation, and market demand. Nowadays, modern dairy farming, meat processing and other such businesses require a significant amount of capital. Because dairy and meat products are perishable, fast transportation infrastructures are essential.

Apart from the above discussed important factors that affect livestock development, one should also need to know the usage of grasslands and their distribution on the globe.

3) Geographical Distribution of Grasslands

Earth's ecosystems and people are intertwined in a vast and intricate relationship. Ecosystems are the planet's productive engines, providing us with everything from drinking water to food, fiber, clothing, paper and lumber. Despite this, nearly every parameter we use to evaluate ecosystem health shows that these ecosystems are deteriorating faster than ever before. There are several categories of ecosystems that exist on the Earth's surface for example coastal, forest, freshwater, agro, and grassland ecosystems.

Let us now particularly study about the grassland ecosystem, because grasslands are critical to the livestock industry.

Grassland Ecosystem: Grasslands are extremely dynamic ecosystems and supply commodities and services to support flora, animal, and human populations all over the world. Grasslands gave birth to many of our food grains, including wheat, corn, rice, rye, millet and sorghum, etc. These lands provide food for domestic livestock, which in turn provide meat, milk, wool, and leather. Breeding, migratory, and wintering birds use grasslands, which also provide optimal circumstances for numerous soil animals and rangeland for wild herbivores. The global distribution of livestock and the distribution of grasslands are interdependent.

The world's grasslands are divided mainly into two categories:

- (i) Temperate Grasslands and
- (ii) Tropical Grasslands

(i) Temperate Grasslands

Temperate grasslands are composed of a complex range of grasses and bushes and are supported by some of the world's richest soils. The mid-latitude zones of all continents except Antarctica have natural vegetation dominated by perennial grasses and bushes. **Temperate grasslands** can be observed in both hemispheres between 30° to 60° of North and South latitudes. Mid-latitude grasslands are also known as temperate or intermediate grasslands. The existence of grasslands in North America and Europe is due to their location in the midst of large continents, where precipitation is scarce and temperature extremes are common. The temperate grasslands are known as the Prairie in North America and the Steppe in

Eurasia, the Pampas in South America, the Veld in South Africa, and the Downs in Australia. The distribution of grasslands is presented in Fig. 10.1.

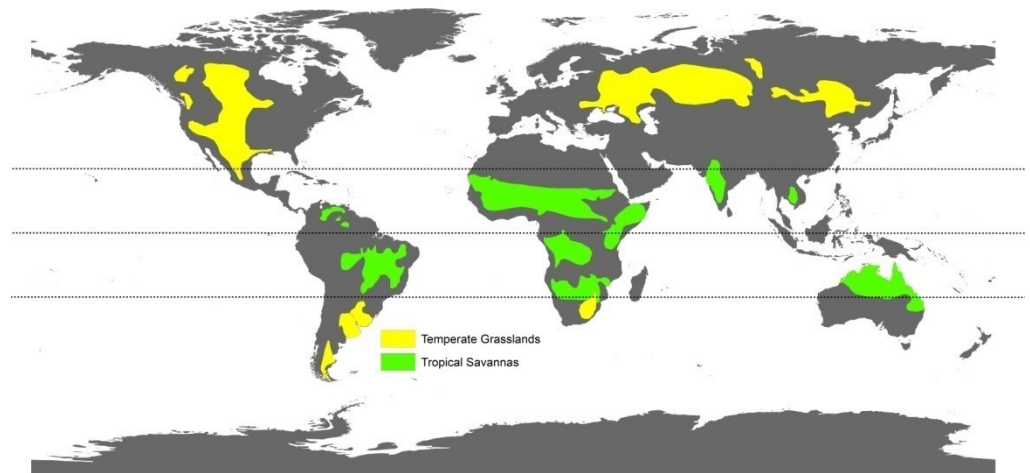


Fig. 10.1: Distribution of Grasslands in the World.

Semi-arid climates have given rise to temperate grasslands. These climate areas in the mid-latitudes receive 250-750 millimetre of annual precipitation. A large amount of snow falls throughout the winter months, for example, the regions of North America and Europe, also play a vital role in early spring soil moisture. Summers can be quite hot, and winters can be extremely cold. The most prevalent growth form in this temperate grassland is perennial grasses. However, a great number of other herbaceous plants, particularly perennial forbs, can also be found. Sunflower and legume family plants are particularly numerous.

In fact, in temperate grasslands, there is more living plant matter below ground than above. Roots are constantly growing, dying, and decaying, contributing organic matter to the soil in the form of humus. When rainwater percolates down through the soil, humus attracts certain ions that are crucial plant nutrients and prevents them from being taken from the root zone. The fine roots provide the soil a crumbly texture, allowing water and air to penetrate to depths of up to 12 feet in the biome's wetter areas, further improving the soil environment for plant growth.

We can find the highly developed livestock industries in New Zealand, the United Kingdom, Western Europe and humid regions of North America. Vast tracts of territory extend across Alberta, Saskatchewan, Nevada, and Texas states in Canada and the United States are ideal for grazing. Argentina is the leader in commercial livestock ranching among all South American countries. Argentina is the world's largest supplier of dairy products and wool. The world's largest steppe region, known as "the Great Steppe" is found in Eastern Europe and Central Asia, ranging from Ukraine in the west to Russia, Kazakhstan, Turkmenistan, and Uzbekistan, and on to China's Altai and other ranges. Sheep farming is popular in South African grassland, known as Veld. This area generates a significant amount of high-quality wool. Livestock ranching is a popular activity in Australia and New Zealand. Low population

density, land availability, wide grasslands, and traditional livestock ranching skills all aided commercial grazing on a large scale.

(ii) Tropical Grasslands

Tropical grasslands, commonly known as the **Savanna Biome**, are large open spaces dotted with small shrubs and trees. These biomes support some of the World's most recognisable species, such as lions, cheetahs, hyenas, elephants, giraffes and wildebeests, etc. The savannas are located approximately at the higher latitudes of the tropical rainforest and tropical dry forest biomes and serve as a transition between those woods and the sub-tropical deserts. Different types of Savanna may develop distinct zones as the distance from the equator increases, a pattern that occurs because of the longer dry seasons and less total yearly precipitation received.

The areas receive a lot of rain during the rainy season, results in more wet and humid. Hence, it is called the tropical humid climate also known as the tropical wet and dry climate, or simply the tropical savanna climate. Despite the fact that tropical savannas are strongly associated with tropical wet and dry climates, climate does not appear to be the fundamental reason for their distribution.

The grasses grow upto 2-4 feet tall and are drought resistant. Most of the savanna trees grow taller, upto 6 to 20 feet and rarely up to 40 feet. Some of the leaves have a thick, leathery feel, and although most trees and shrubs are deciduous, some drop their leaves at the same time as new buds form, giving them the appearance of being evergreen. Savanna trees are generally protected from fire by their thick bark.

Soils in humid tropical climates are subjected to high rates of leaching, which is the process of soluble chemicals dissolving and washing down into the soil column. Lateralisation is a common soil-formation process in these regions.

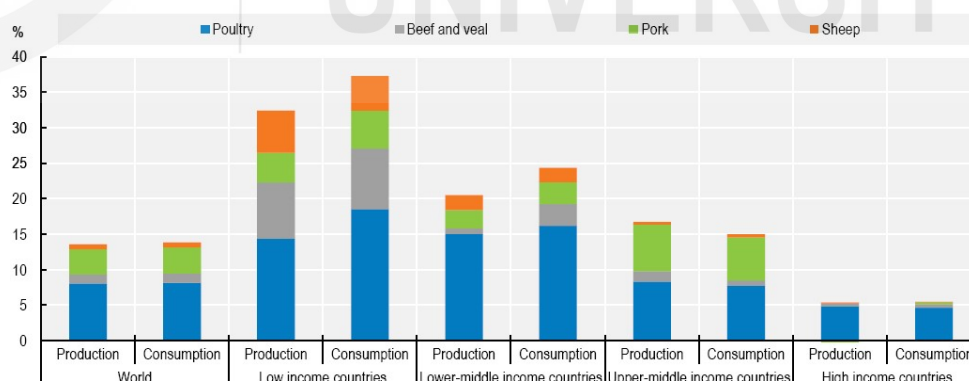
Savanna biomes cover half of Africa, as well as vast areas of Australia, South America, and India. The most popular Savanna biomes in Africa are the Serengeti Savanna biome in Tanzania and the Masai Mara Savanna biome in Kenya. Savannas in Africa have the greatest tropical grassland area on the planet. Except for the tropical forest on either side of the equator focused on the Congo Basin, it covers most of the continent between the Sahara in the north and the Kalahari and Namib Desert in the south. The Masai people of East Africa live in semi-arid and desert terrain along the Great Rift Valley in southern Kenya and northern Tanzania. The Masai rely on livestock such as cattle, goats and sheep for their livelihood.

American tropical grasslands are not as large and diverse as African grasslands. The Llanos and other smaller savanna patches can be found north of the Amazon rainforest in South America. The major grasslands are found in Venezuela, Bolivia, Brazil's Campos, and Argentina. Commercial grazing activities, such as cattle ranching, dominate the interior of the grasslands. The Australian grassland creates savanna landscape that is similar to that of the African savanna, although it is made up of distinct species. Most of Australia's vegetation and animal life are home to plants and species that are not found elsewhere.

4) World Livestock Distribution

The global livestock business has increased manifold in recent years due to the rising demand for animal-source foods by the growth of population. The rapid rate of urbanisation seen in many nations is not only linked to rising income, but it also leads to changes in people's dietary preferences. Rapid sector transformation and expansion are connected with many benefits and opportunities, but they are also associated with social, environmental, and public health hazards. Furthermore, there is a growing recognition that the livestock industry must operate in a carbon-constrained economy, resulting in increased competition for land and water resources as well as increased pressure on the industry to be managed cleanly, safely and sustainably.

Livestock has been one of the fastest-growing agricultural industries in developing countries. On a global scale, poultry, cattle, pig and to a lesser extent, sheep and goats, are the most common livestock varieties. However, the distribution of meat varieties varies widely around the world in some countries. More than 60 billion land animals are utilised for meat, eggs and dairy production around the world, and if current trends continue, the global livestock population might reach 100 billion by 2050, more than ten times the projected human population. In response to rising demand for livestock products, the global output of meat, milk, and eggs has exploded in recent decades. Growing populations, urbanisation and affluence have all contributed to this increase in demand, which has been particularly high in developing regions. In the developing world, global meat protein consumption is expected to rise by 14 percent by 2030, compared to the base period average of 2018–2020. Protein availability from beef, pork, poultry, and sheep meat is expected to rise 5.9 percent, 13.1 percent, 17.8 percent and 15.7 percent, respectively by 2030 (Fig. 10.2). In high-income countries, however, changes in consumer preferences, ageing populations and slower population growth will result in a plateau in per capita meat consumption and a shift toward higher-value meat cuts.



Note: The 38 individual countries and 11 regional aggregates in the baseline are classified into the four income groups according to their respective per-capita income in 2018. The applied thresholds are: low: < USD 1 550, lower-middle: < USD 3 895, upper-middle: < USD 13 000, high > USD 13 000.

Fig. 10.2: World Meat Production and Consumption.

(Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture Statistics (database), <http://dx.doi.org/10.1787/agr-outl-dataen>)

The consumption of meat has shifted to poultry. This reflects the cheaper price of chicken compared to other meats in low-income developing countries, while it demonstrates a greater preference for white meats in high-income

countries, which are easier to cook and seen as a healthier food choice. In 2030, poultry meat is predicted to account for 41 percent of total protein derived from meat sources worldwide, up 2 percentage points from the baseline period. Other meat products have smaller global shares: beef (20 percent), sheep meat (33 percent) and pig meat (34 percent).

5) India Livestock Distribution

The Indian economy relies heavily on livestock. A total of 20.5 million people rely on livestock for their survival. Small farm households earned 16.1 percent of their income from livestock, compared to 14 percent for all rural households. Two-thirds of rural communities rely on livestock for their livelihoods. It also employs approximately 8.8 per cent of India's population. India has an abundance of livestock. The livestock industry accounts for 4.11 per cent of overall Gross Domestic Product (GDP) and 25.6 percent of total agricultural GDP. India's livestock sector is one of the world's largest livestock sectors. Table 10.1 shows the population of animals by species in the livestock and poultry populations during the last two censuses (19th census in 2012 and 20th in 2019) of India. In 20th livestock census, there are 536 million animals in the country, including 192.5 million cattle, 109.8 million buffaloes, 74.3 million sheep, and 148.9 million goats. The data shows that about 36 percent cattle, 28 percent goat, 20.5 percent buffaloes, 13.9 percent sheep, and 1.7 percent pigs are in the country. Mithun, yaks, horses, ponies, mules, donkeys and camels taken together contribute 1.2 percent of the total livestock. The percentage share of the sheep and goat population has increased whereas cattle, buffalo, and pig population have marginally declined. The total poultry in the country is 851.81 Million in 2019, which increased by 16.8 percent over previous Census.

Table 10.1: Livestock and Poultry Population of India

Species	Population (in millions) 2012	Population (in millions) 2019	Growth Rate (%)
Cattle	190.9	192.5	0.8
Buffalo	108.7	109.9	1.1
Sheep	65.1	74.3	14.1
Goat	135.2	148.9	10.1
Pig	10.3	9.1	-12.0
Mithun	0.3	0.4	26.7
Yak	0.1	0.1	-25.0
Horses and Ponies	0.6	0.3	-45.6
Mule	0.2	0.1	-57.1
Donkey	0.3	0.1	-61.2
Camel	0.4	0.3	-37.1
Total Livestock	512.1	535.8	4.6
Poultry	729.21	851.81	16.81

(Source: Annual Report - 2019-2020, Department of Animal Husbandry and Dairying)

Animal production is primarily part of a mixed crop-livestock farming system in India, which is essential for the security and survival of a significant number of underprivileged people. Livestock offers money, employment, draught power

and manure in such a system. In the current environment of persistent economic expansion, growing affluence, expanding urbanisation and changes in tastes and preferences that have resulted in dietary changes and increased importance of milk, meat, eggs, and fish.

Some of the Important Contributions of Livestock Sector in India:

- Farmers in India practice mixed farming, which is a combination of crop and livestock production in which the output of one operation becomes the input of another, resulting in resource efficiency.
- India is the World's leading milk producer. Wool, hair, hides, and pelts are all produced as a result of livestock. The most important product with a strong export potential is leather. During the financial year 2020, India produced approximately 36.74 million kilogram of wool.
- Indian agriculture relies heavily on bullocks. Despite significant advances in the use of mechanical power in a variety of agricultural operations, many Indian farmers continue to rely on bullocks to curb expenses.
- In addition to bullocks, pack animals like camels, horses, donkeys, ponies, and mules are often utilised to transport products. Mules and ponies are the sole options for transporting products in the mountainous terrain. Likewise, the army also sometimes relies on these animals to transport various supplies in high-altitude places.
- In India, livestock are often referred to as "moving banks" as they serve as assets and are sold in the event of an emergency. Livestock provide security and self-esteem to their owners, particularly when they possess valuable animals such as bulls, dogs and high-yielding cows or buffaloes.
- Many Indian families, particularly the financially poor, who keep a small number of animals, rely on livestock as a secondary source of income. Livestock such as mulch cows and buffaloes provide a consistent source of income through milk sales. Sheep and goats are used as emergency revenue sources to cover costs such as weddings, medical treatment, children's education and house repairing, etc.
- Animal husbandry is an element of Indian culture. Animals are employed for a variety of social and religious purposes. Bulls and cows are worshipped on various religious occasions; rams, bucks and chickens are sacrificed during joyful seasons; and bulls and cows are worshipped during housewarming ceremonies. Many pet owners form attachments with their pets.
- Bullocks are used by farmers, especially the marginal and small, for ploughing, hauling, and transporting both inputs and outputs. Dung is utilised for a variety of things in rural settings, including fuel (dung cakes), fertilizer (farm yard manure) and plastering material.
- Recent advancements in animal breeding and genetics, combined with biotechnology, have created new prospects for raising animals with high genetic merit and efficiency. Using a genomic selection technique to improve our indigenous livestock breeds would pave the way for systematic improvement. This will provide a long-term, sustainable solution to India's 70 million farmers' challenges of livelihood and nutrition security.

SAQ I

- a) What is the meaning of pastoralism? Write different categories of pastoralism.
 - b) Note any five important livestock animals.
 - c) Write any two important factors that are affecting livestock production.
 - d) Highlight the role of grasslands in the development of livestock distribution.
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10.2.2 Dairy Farming

We all know that dairy farming is one of the significant activities of human culture and civilisation. **Dairy farming** is a part of agriculture that involves breeding, growing, and use of dairy animals, typically cows, for the production of milk and other dairy products. It has a long history in many parts of Europe and Africa, dating back to the early Neolithic age, approximately the seventh millennium BC. Milking was manually done on small farms prior to the twentieth century. Milking began on large-scale dairy farms in the early twentieth century, with commercially available innovations like rotary parlors, milking pipeline, and automatic milking systems. Since the introduction of refrigeration technology in the late 1800s, including direct expansion refrigeration and the plate heat exchanger, milk preservation methods have improved. Dairy farms were able to preserve milk by decreasing spoilage caused by bacterial growth and humidity using these cooling technologies. Many countries, including India, the United States, China and New Zealand, have large dairy sectors that act as key producers, exporters and importers of milk.

The cow and the buffalo are the primary producers of milk for human consumption. In China, India, and other Asian countries, as well as Egypt, goat is a significant milk producer. Goat rearing is a significant activity for livelihoods of India (Fig. 10.3). Goat's milk is also produced in Europe and North America, but it is somewhat unimportant in comparison to cow's milk. Some countries, particularly India, produce buffalo milk in commercial amounts. Buffalo milk is utilised in the same way as cow milk, and in certain locations, the community milk supply is made up of both.



Fig. 10.3: Goat Rearing - an Economic Asset.

Global milk production is anticipated to increase by 1.6 percent annually between 2020 and 2029, reaching 997 million tonnes in 2029. The rise in milk supply is strongly linked to the diet, according to this analysis. Milk production increases are largely related to the number of herds in countries where grazing-based livestock breeding is practiced, whereas output grows owing to productivity in countries where special feeding is used. Milk is produced by around 150 million households around the world. While most production takes place on tiny family farms in poor countries, the transition to large-scale industrial businesses continues apace in industrialised countries. The total annual milk production from all of these businesses is around 850 million tonnes. Cows, buffalo, goats, sheep, and camels provide nearly all of this production. Cows are responsible for more than 80 percent of the total milk production, particularly in wealthy countries.

Let us now discuss the distribution of dairy farming in the world in general and particularly in India.

1) World Distribution of Dairy Farming

Dairy farming has a wide geographic distribution over the world. However, there are three essential areas of commercial dairy farming. The first and foremost region is in Western Europe, with a belt stretching about 3,000 kilometre from the Atlantic coast to Moscow (Russia). The second dairy region, Anglo-America, is stretching from the Atlantic Coast to Canada's Prairie Provinces, the third region is the Australia-New Zealand region. The other dairy regions are in South Africa and South America and are smaller. Dairy farming has grown in Japan, South Korea, China, India, Pakistan and other Asian countries, however, majority of the output is consumed locally. Please refer to Fig. 10.4 for understanding the major dairy farming regions of the world.

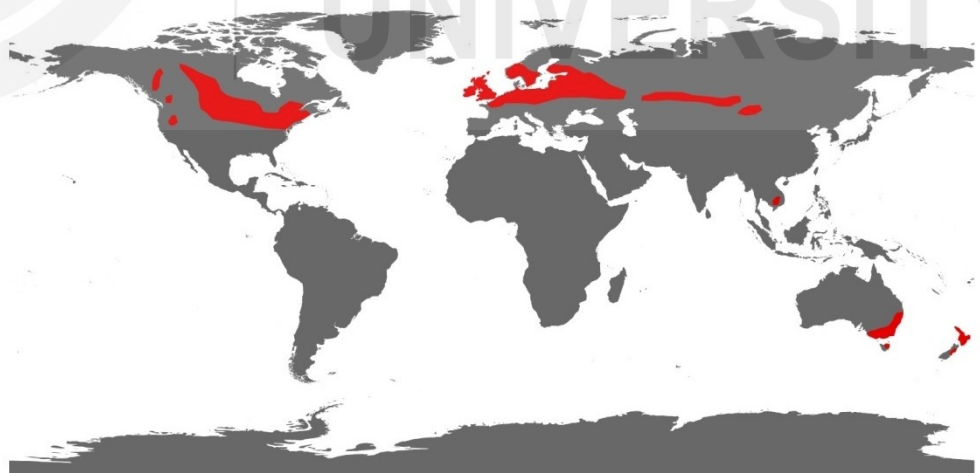


Fig. 10.4: Major Dairy Farming Regions of the World.

Food and Agriculture Organisation (FAO) reported that the world milk production has increased to 843 million tonnes (2018) from 530 million tonnes in 1988. India is the world's largest milk producer, with 22 percent of global production, followed by the United States of America, China, Pakistan and Brazil. The countries like China, Italy, the Russia, Mexico, Algeria and

Indonesia have the highest milk deficits whereas New Zealand, the United States of America, Germany, France, Australia and Ireland are recognised as the highest milk surpluses countries. World milk production by major region-wise during 2018-2019 is given in Fig. 10.5.

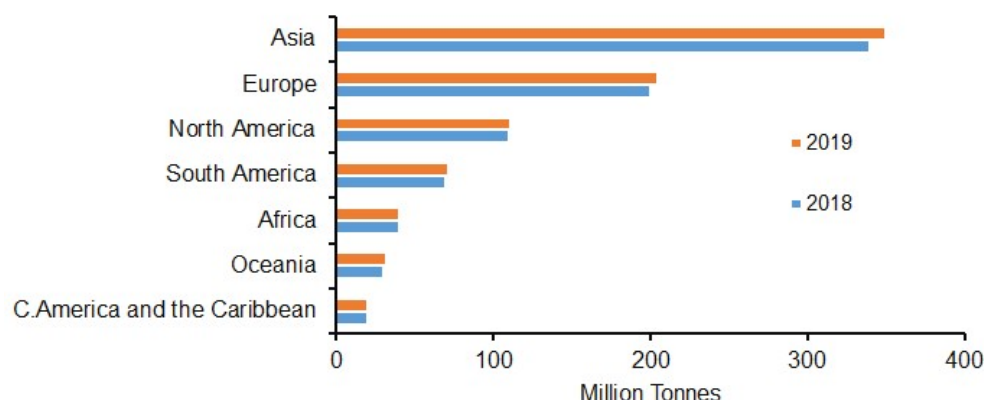


Fig. 10.5: Milk Production in Different Regions of the World during 2018-2019.

(FAO, Dairy Market Review, March, 2020)

The United States of America produces the most milk, cheese and butter in the world. Its internal demand for dairy products is high, and it only has a modest surplus to export. The south of the Great Lakes in Wisconsin, Minnesota, and sections of Dakota, are the primary dairying regions. Dairying is widely practiced along the Atlantic seaboard in the states of New York, New Jersey, Pennsylvania and some New England states. The dairy business in Canada has improved dramatically in recent years. The majority of milk and milk products are now produced in the Ontario and the Marine provinces of Canada.

Almost every European country has a significant dairy industry. France, Germany, Denmark, the Netherlands, the United Kingdom, Switzerland, and other countries are the top producers. France and Germany are the world leaders in milk, butter and cheese production. Dairy production is the most common agricultural activity in Denmark, and the country is a major exporter of butter. Denmark is a major exporter of bacon and mixes dairy production with pig farming. The Netherlands is a major producer of dairy products, with large milk outputs due to its lush pastures. It exports the most condensed, evaporated, and powdered milk. In Switzerland, dairy production occupies roughly 70 percent of accessible agricultural area, and transhumance is conducted in the harsh mountain valleys. Butter, milk, and cheese are all essential and dairy products are employed in the lucrative chocolate industry. The Central Lowlands of Scotland, south-west England, coastal areas in South Wales, and several sections of Northern Ireland are the primary dairying regions. Milk yields are high, and in addition to fresh milk, cheese, condensed and evaporated milk and chocolate production are well-developed. Formerly, the USSR was the world's largest producer of milk and butter, but as a result of its collapse, dairy production has decreased. Apart from Russia, other nations in this region have become dairy producers, including Estonia, Lithuania, and Latvia. Kazakhstan has a dairy industry as well. However, all of these countries' milk and other dairy products are produced solely for their own consumption.

With over 2 million dairy cattle, New Zealand is a significant dairy-farming country, but due to its small population, more than half of the milk produced is processed into butter or cheese for export. New Zealand is the World's largest exporter of butter. Australia is more known for ranching than dairying because much of the country experiences inconsistent rainfall, and 70 percent of the continent receives less than 510 millimetre per year. As a result, commercial dairy farms are limited to the more humid south-east, particularly in Victoria, New South Wales, and parts of Queensland. While much of Australia's milk is consumed in the country's major cities, a significant fraction is turned into butter for export.

Argentina and Uruguay are the leading dairy producers in South America. However, their output is restricted to the local market. The dairy sector in Argentina has grown in the La Plata region. Uruguay also produces a limited amount of dairy products. The dairy cows in this area graze on alfalfa and fodder crops that have been sown. Only South Africa and Zimbabwe have considerable dairy farming output in Africa, but it is quite tiny in comparison to the rest of the World.

2) Dairy Farming in India

You might have observed dairy farming and related activities in almost everywhere in rural India. Dairy farming has become an essential supplementary source of income for millions of rural people of India, and it has played a key role in generating revenue, particularly for marginal and female farmers. The majority of milk is produced by animals raised by marginal farmers and landless labourers.

Since 1998, India has ranked top among the World's milk producers. The National Programme for Bovine Breeding and Dairy Development, the National Dairy Plan (NDP), and the Dairy Entrepreneurship Development Scheme etc., are being used by the Indian government to boost the dairy sector. NDP Phase-I assists in meeting predicted National demand by improving productivity and strengthening and expanding village-level infrastructure for milk procurement, as well as providing producers with market access. These government initiatives have taken many steps to boost the productivity of dairy cows, resulting in large gains in milk production. India produces 7.2 percent of all milk produced worldwide. Despite having the World's highest number of dairy cattle, India's production is quite low. In India, the dairy business does not run scientifically, and the majority of milk produced is consumed locally (Fig. 10.6). The key milk-producing states in India are Punjab, Haryana, Gujarat, Maharashtra, western Uttar Pradesh, Andhra Pradesh, Rajasthan and Madhya Pradesh. About 46 percent of milk produced is consumed by farmers or sold to non-farmers in rural areas. There are mainly six milk cooperatives and/or unorganised players such as milkmen and contractors account for 54 percent of total milk output.



Fig. 10.6: Small Scale Commercial Dairy Farming.

Uttar Pradesh is the top one state producing milk with 16 percent of country's total milk production, followed by Rajasthan (13 percent), Madhya Pradesh (9 percent), Andhra Pradesh (8 percent) and Gujarat (8 percent). These are India's five major milk-producing states, account for more than half of the country's milk production. When compared to water buffalo milk, cow milk is becoming more prevalent which account nearly 48 percent of total milk production.

The production of dairy cattle is mostly concentrated in a few states. West Bengal, Uttar Pradesh, and Madhya Pradesh account for over 30 percent of National dairy cattle production. Bihar (8 percent), Maharashtra (7 percent) and Rajasthan (7 percent) are the next most populous states. These six states account for more than half of India's dairy cattle population. Water buffalos, indigenous water buffalos, and non-descript buffalos (i.e., animals not selected or bred for milking purposes) produce 49 percent, 35 percent, and 14 percent, respectively, of India's milk. Uttar Pradesh is home to 33 percent of India's water buffalos followed by Rajasthan (12.5 percent), and Madhya Pradesh (10 percent) states. You can refer to Fig. 10.7 for understanding the top milk producing states of India.

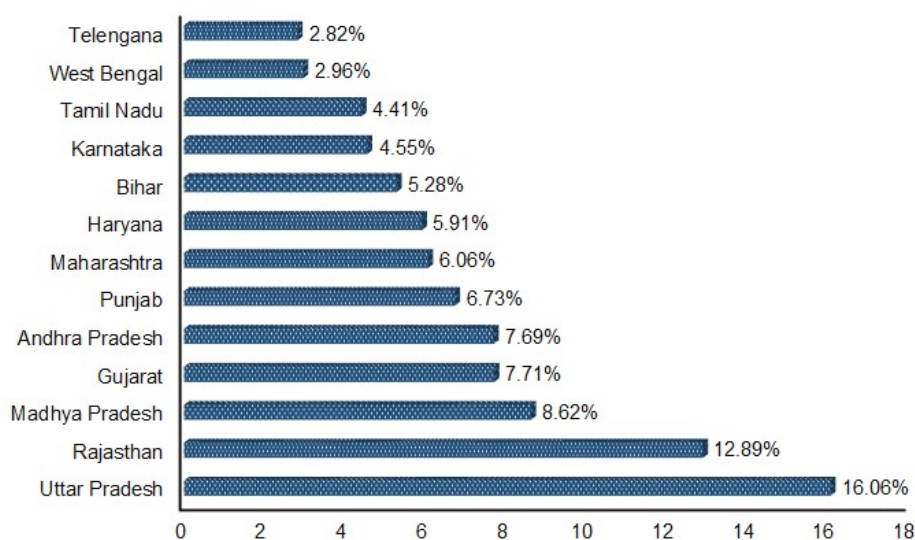


Fig.10.7: Milk Production from various States of India during 2019-2020.

(Source: Department of Animal Husbandry and Dairying - Animal Husbandry Statistics, 2020)

a) Factors Affecting Milk Productivity in India

The low genetic potential of Indian bovines, limited nutritious and balanced feed diets, and insufficient veterinary services are all factors restricting dairy cow productivity. The average milk yield by various species like exotic cows (11.88 kilogram/day), crossbred cows (8.09 kilogram/day), indigenous cows (3.9 kilogram/day) non-descript cows (2.57 kilogram/day), indigenous buffalo (6.43 kilogram/day), non-descript buffalo (4.51 kilogram/day) and goat (0.44 kilogram/day) are very low when compared to other countries. The yield rate per animal per day in India is significantly lower than in the United States (30 kilogram/day) and the United Kingdom (22 kilogram/day) as per the data of 2019-20. The supply of fodder is a major limitation in India's dairy industry. Access to higher-quality feeds and fodders would assist dairy animals produce more milk. According to the Indian Grassland and Fodder Research Institute, India is lacking 23.4 kilogram of dry fodder, 11.2 kilogram of green fodder, and 28.9 kilogram of concentrated feed for every 100 kilogram of feed required. India's demand for fodder is expected to increase by 24 percent by 2050. For the cattle and dairy industries to continue to thrive, access to high-quality green fodder will become increasingly important.

The National Livestock Mission on Fodder and Feed Development, launched by the Indian government, aims to eliminate the feed and dry fodder shortages that farmers face. Only 4 percent of India's total cultivated land is dedicated to forage production. However, due to competing uses of the land for the growth of food and other cash crops, this region is not likely to grow in the near future. Compound cattle feed utilisation is limited to 8-10 million metric tonne due to lack of fodder production area, although the total dairy feed need is 80 million metric tonne.

b) Dairying Trade

India's fluid milk exports are nearly 10,000 metric tonne/year, accounting for negligible proportion in the world trade. Despite its large production, India does not export significant fluid milk. State-level dairy cooperatives establish the benchmark rates for private dairies by offering farm gate prices to dairy producers. Dairy cooperatives consider increases in feed and fodder costs, as well as other input costs, when calculating farm gate prices. Several state governments in India provide financial assistance to dairy cooperatives, allowing producers to achieve more profitable milk prices.

The organised sector handles around 40 percent of the sales of the 52 percent of dairy production that is processed, with 20 percent going to cooperatives and producer businesses and 20 percent to private dairies. The unorganised sector, which includes small private dairy, milkmen, and local producers, handles the remaining 48 percent. Packaged milk is one of the fastest-growing segments in the dairy industry, followed by other value-added dairy products. Pasteurized milk, either as a blend of cow and buffalo milk or in its purest form, is sold in varying fat content percentages.

Concerns about milk safety and quality are driving a surge in demand for packaged, ultra-high temperature (UHT) milk marketed in sterilized packaging with a longer shelf life. The National Action Plan for Dairy Development of the Indian Government seeks to double the organised milk output. Cooperative

milk handling is expected to rise from 10 to 20 percent, while private sector milk handling is expected to rise from 10 to 30 percent. If these objectives are met, Indian dairy farmers would have more access to organised milk processing and, as a result, higher incomes.

c) Dairy Farming and Employment Opportunities

India has a modest percentage of the global milk trade, and only a small portion of the total milk produced is processed. Milk sellers acquire milk from local producers and sell it in urban and semi-urban regions in the informal sector. Around 65–70 percent of the entire milk production is handled by these milk merchants. The growth of the human population has a direct impact on food demand. However, as the World's cultivable lands dwindle, the livestock sector's role becomes even more critical, not just in terms of nutritional security but also in terms of job creation. In India, the Agricultural and Processed Food Products Export Development Authority (APFEDA) regulates dairy import and export. The demand for Indian milk desserts will continue to rise in the future because of the presence of Indian population in various countries, it increases export possibilities.

In terms of global dairy product production economics, nations with low milk production costs, such as India, are likely to benefit the most from the burgeoning dairy boom. As a result of the evolving picture in the dairy industry, both nationally and internationally, it is clear that the dairy sector has a lot of potential for job creation and entrepreneurial activities.

SAQ 2

- a) Discuss the importance of dairy farming?
 - b) Describe three important regions in the World that are known for commercial dairy farming.
 - c) Note the top three major milk producing states of India?
-

10.3 FISHERIES SECTOR

You will be surprised to know that during the last five decades, global fish and seafood production has quadrupled. It indicates towards the incremental average daily consumption of seafood and fish by the rising population globally. Since 1980s, the proportion of fish stocks that are overexploited has more than doubled, implying that current levels of wild fish catch are unsustainable. Food security has long been acknowledged as one of the world's most pressing issues in international forums. And, with a worldwide population anticipated to exceed roughly 10 billion by 2050, sustainable supply of fish products is a critical component of this problem. You will now study the fisheries production at world level.

10.3.1 World's Production of Fisheries

Fishing, both in capture fisheries and aquaculture, can play an essential role in producing jobs and feeding the globe if it is managed responsibly. In 2018, the worldwide fish export trade reached \$151 billion, a figure that is expected

to climb. Fish consumption per capita has increased dramatically, from 10 kilogram in the 1960s to more than 20 kilogram in 2018, with projections of 21.5 kilogram in 2030. And in certain Pacific countries, like as Tuvalu, the per capita rate is as high as 80 kilogram per year. The fish now accounts for about 17 percent of worldwide protein consumption, with certain coastal and island countries reaching as high as 70 percent.

Fisheries play an important role in providing livelihoods, jobs, and income in coastal communities of developing countries. Fisheries and aquaculture support the livelihoods of 10 to 12 percent of the world's population. The millions of people are directly involved in capture, also from harvesting to distribution of fisheries and aquaculture. Employment in the fisheries and aquaculture sectors has increased at a greater rate than the global population and traditional agriculture.

Every year, the world produces over 200 million tonnes of fish and seafood. This is a result of a blend of wild-caught and farmed fish. Excluding aquatic plants, overall world fisheries, and aquaculture production increased by 41 percent from 2000 to 2019, reaching 178 million tonnes in 2019, just shy of the previous high of 179 million tonnes set in 2018. In comparison to 2000, this is a 52-million-tonne increase. The minor drop in production between 2018 and 2019 is attributable to a 5 percent fall (or 3.8 million tonnes) in marine fish production owing to lower catches. This happened due to the El Nino phenomenon.

Many changes occurred as a result of the enormous increase of fisheries and aquaculture production, including changes in the source of production, which became increasingly reliant on aquaculture. Aquaculture has been the main engine of increased fisheries and aquaculture production over the last three decades, with an average annual growth rate of 5.2 percent from 2000 to 2019, reaching a record 85.3 million tonnes in 2019 (Fig. 10.8).

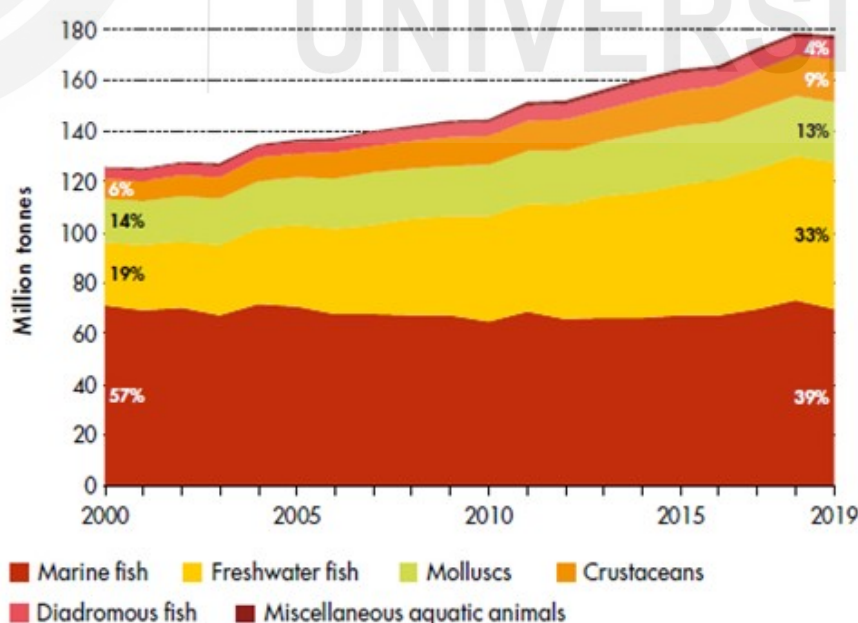


Fig. 10.8: The Capture Fisheries and Aquaculture Production by Species Group in the World.

(Source: The State of World Fisheries and Aquaculture 2020; Food and Agriculture Organisation of the United Nations)

Capture fisheries production has remained relatively consistent at roughly 90 million tonnes since the early 1990s, after several decades of strong expansion, with occasional inter annual swings in the range of 3 to 6 million tonnes. Variations in fish catches in South America, which are notably affected by climatic change variability, influenced these oscillations, but they also depended on ecosystem productivity, fishing intensity control and fish stock management.

Asia contributed significantly to overall growth in fisheries and aquaculture productivity, accounting for around 70 percent of total production in 2019 compared to 57 percent in 2000. The Americas had a 12 percent share in 2019, followed by Europe (10 percent), Africa (7 percent) and Oceania (7 percent). China is by far the largest producer of both capture fisheries and aquaculture accounting for 36 percent of overall production in 2019, up from 30 percent in 2000. Refer to the Table 10.2 for understanding the world statistics of capture fisheries and aquaculture production.

Other major producers in 2019 were Indonesia and India, which together accounted for slightly more than half of overall fisheries and aquaculture production. These three countries also dominated the catch fisheries and aquaculture industries. In 2019, the top three producers controlled 73 percent of aquaculture and 30 percent of capture fish. Despite this concentration of production, aquaculture has grown at different rates around the world, reflecting variances in local policy, management aims, site options and environmental conditions.

Table 10.2: Capture Fisheries and Aquaculture Production in the World

Country/ Region	Marine Fish	Freshwater Fish	Molluscs	Crustaceans	Diadromous Fish	Miscellaneous Aquatic Animals	Total
World	69794.3	58066.9	23971.6	16589.2	7863.9	1548.1	177834.0
Africa	6793.0	5072.1	260.8	231.7	25.9	1.6	12385.1
America	13759.9	1563.1	2483.4	2280.0	1669.3	114.6	21870.3
Asia	35798.2	50832.8	19935.1	13370.3	3416.5	1397.3	124750.3
Europe	11910.5	584.2	1114.2	659.4	2674.9	32.1	16975.4
Oceania	1518.3	14.7	178.1	47.7	77.3	2.5	1838.5
Afghanistan	-	10.1	-	-	-	-	10.1
Albania	7.7	2.3	1.5	1.5	1.9	-	15.0
Algeria	98.8	2.4	1.5	2.1	0.1	-	104.9
Angola	381.4	25.4	1.7	2.6	0.0	-	411.2
Antigua and Barbuda	1.3	-	1.6	0.3	-	-	3.2
Argentina	463.7	26.8	118.9	218.1	1.2	-	828.7
Armenia	-	2.2	-	0.6	15.4	-	18.3
Australia	133.8	1.8	25.1	39.0	61.5	0.1	261.4
Austria	-	1.5	-	-	3.1	-	4.6
Azerbaijan	0.1	0.7	-	-	0.9	-	1.7
Bahamas	0.5	0.0	3.1	6.3	-	-	9.9
Bahrain	7.1	0.0	0.2	7.5	0.3	-	15.0
Bangladesh	459.8	3139.7	-	251.9	532.8	-	4384.2
Barbados	1.5	-	-	-	-	-	1.5
Belarus	-	9.7	-	-	0.5	-	10.3

Belgium	17.1	0.3	2.3	1.7	0.1	-	21.4
Bolizo	208.9	0.1	4.3	0.5	-	-	213.7
Bonin	45.0	29.0	0.0	3.2	2.0	-	79.2
Bhutan	-	0.2	-	-	0.0	-	0.2
Bolivia	-	9.8	-	-	1.6	-	11.4
Bosnia and Herzegovina	0.2	0.6	-	-	3.5	-	4.3
Botswana	-	0.1	-	-	-	-	0.1
Brazil	423.5	746.5	26.9	110.9	2.1	0.2	1309.9
Brunoi Darussalam	10.5	0.0	0.1	3.1	0.9	-	14.6
Bulgaria	5.5	8.9	7.7	0.0	4.7	-	26.8
Burkina Faso	-	25.2	-	-	-	-	25.2
Burundi	-	21.9	-	-	-	-	21.9
Cabo Vardo	17.1	-	-	-	-	-	17.1
Cambodia	105.8	813.7	26.9	19.6	1.0	0.2	967.1
Cameroon	221.6	33.5	0.0	43.9	0.5	-	299.5
Canada	345.7	20.5	155.8	251.8	155.5	15.9	945.2
Central African Republic	-	29.1	-	-	-	-	29.1
Chad	-	107.1	-	-	-	-	107.1
Chile	1782.2	-	496.9	52.0	989.5	35.8	3356.5
China	10970.5	26525.3	16324.8	7906.9	550.5	1132.8	63410.8
Colombia	73.6	161.5	1.0	9.9	26.5	-	272.4
Comoros	17.6	-	-	-	-	-	17.6

(Source: The State of World Fisheries and Aquaculture 2020; Food and Agriculture Organisation of the United Nations)

Let us now understand the fisheries sector of India.

10.3.2 Fisheries Sector of India

India's coastline stretches for 7,516 kilometre covering 2.02 million square kilometre Exclusive Economic Zone (EEZ), with 3,432 fishing villages and 1,537 fish landing centres. Nearly 1, 95,210 kilometre of rivers and canals, 2.9 million hectares of minor and large reservoirs, 2.4 million hectares of ponds and lakes and around 0.8 million hectares of flood plain wetlands and water bodies make up India's fresh water resources. India has significant Continental Shelf comprising with 5.30 square kilometre.

The fishing industry plays a crucial role in the country's socio-economic development. Figure 10.9 gives a glimpse of fishing activities in a coastal region of India. It has been recognised as a significant source of income and employment, as it encourages the creation of a number of subsidiary businesses and serves as a cheap and healthy food source in addition to earning foreign exchange. Most importantly, it provides a source of income for a substantial portion of the country's economically disadvantaged population. Accurate data on fishery resources and their potential in terms of fish production, development of sustainable technologies for fin and shell fish culture, yield optimization, harvest and post-harvest operations, landing and berthing facilities for fishing vessels, and fishermen welfare are among the main challenges faced by the country's fisheries development.

The aquaculture industry is known as India's "sunshine" sector of agriculture. It aids in the increase of food supply, the creation of adequate employment, and the improvement of nutritional levels. It has a large export potential and is the country's main source of foreign exchange revenues. Freshwater aquaculture in India has progressed from its 1950s confinement to the East Indian states to the current thriving industry that spans the entire country.

Fisheries and aquaculture sectors in India are an important part of the food production chain, providing nutritional security to the food basket, contributing to agricultural exports, and employing over 14 million people in various occupations. The country has exhibited constant and sustained increases in fish output since independence, with various resources ranging from deep seas to highland lakes and more than 10 percent of global biodiversity in terms of fish and shellfish species.



Fig. 10.9: Fishing Activities in the Coastal Areas by Fisherman (fish catch).

You will be astonished to know that fishing sector accounts for 1.07 percent of India's total GDP, employing 14.5 million people, which is one of the largest employment sectors in India. India is the world's second-largest producer of aquaculture after China and third-largest producer of fisheries accounting 7.96 percent of the global production. The fisheries industry earned Rs.43, 717 Crores export revenue during 2020-21, despite the market uncertainties raised by the COVID-19 pandemic. Total fish production of the country is 14.73 million metric tonne including Inland sector (11.25 million metric tonne) and Marine sector (3.48 million metric tonne). This is an increase from the

previous year's total of 14.16 million metric tonne. The statistics ranged from 14.73 million metric tonne in 2020-21 to 8.67 million metric tonne in 2011-12 (Fig. 10.10).

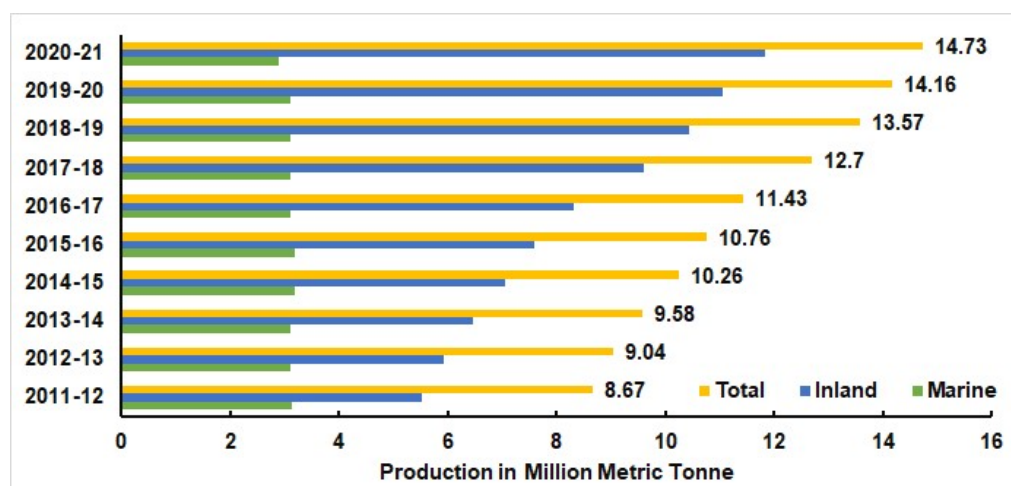


Fig. 10.10: Fish Production in India during 2011-2021.

(Source: Annual Report 2021-22, Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India)

The continuous yearly growth rate of 6 to 7 percent seen over the last three decades has been critical in closing the demand-supply imbalance in the domestic market as well as raising exports to exceptional levels. Aquaculture production is expected to increase in the future. Andhra Pradesh has long been the most important state for aquaculture, both freshwater and coastal shrimp production. Given the recent growth tendency, it is expected that brackish water aquaculture production (shrimp) will continue to expand in Odisha, West Bengal, and Gujarat. In Andhra Pradesh, there is clear commercial potential in the manufacturing of fish feed, post-harvest processing and quality testing laboratories, etc.

The Central Institute for Fisheries Nautical and Engineering Training (CIFNET), Kochi; National Institute for Fisheries Post-Harvest Technology and Training (NIFPHATT), Kochi; Fishery Survey of India (FSI), Mumbai; Central Institute of Coastal Engineering for Fisheries (CICEF), Bengaluru; National Fisheries Development Board (NFDB), Hyderabad and the Coastal Aquaculture Authority (CAA), Chennai are the major institutions/organisations working under the Department of Fisheries (DoF), Ministry of Fisheries, Animal Husbandry and Dairying for charting of fishing grounds, focusing on training and the skill development, planning and capacity building, providing technical support to the maritime States/UTs, promoting sustainable exploitation and management of fishing and coastal aquaculture.

There are several important measures suggested to improve the aquaculture activities as follows:

- a) The value-chain approach should be strengthened, because there is a need for better inputs and infrastructure for post-harvest processing in both brackish and fresh water aquaculture.

- b) The creation of awareness and promotion of better agricultural management methods are critical and state governments must recognise this requirement.
- c) Market access is hampered by a lack of infrastructure and processing facilities, particularly in the domestic market, which accounts for the majority of demand for freshwater aquaculture goods.
- d) The country's area must expand horizontally while also addressing vertical productivity growth. However, due to decreasing per capita land holdings and rising water demand, additional allocation of large areas for aquaculture to overcome the fish production deficiency will necessitate a deliberate action plan for effective and efficient resource utilisation.
- e) As a result, there is a pressing need to raise both research and development activities in order to improve the productivity of existing water bodies by expanding vertically and enhancing water use efficiency.
- f) In addition to aquaculture output, maintaining capture fisheries, both marine and inland, and focusing on culture-based fisheries in reservoirs and other large open-water bodies in inland areas will be equally important.
- g) To keep up with the pace of aqua farming firms, the sector must develop effective human resources with necessary knowledge and skills, as well as receive much-needed policy support from the government, as well as improved institutional credit facilities.

SAQ 3

Write a note on aquaculture.

10.4 SUMMARY

In this Unit, you have learnt the following:

- In the current World, animal husbandry plays a prominent role in the economies of several countries.
- Pastoralism is a type of animal husbandry practiced by nomadic people in many parts of the world during the historical era. The livestock involved in pastoralism are cattle, camels, goats, reindeer, horses, yaks and sheep, etc.
- It is classified according to the manner of livestock movement in various forms including nomadic pastoralism, semi-nomadic pastoralism, transhumance and livestock ranching, etc.
- There are several factors such as climate, relief, natural vegetation, and economic affecting livestock production.
- Grasslands provide food for domestic livestock, which in turn provide meat, milk, wool, and leather for human consumption. We get food grains such as wheat, corn, rice, rye, millet and sorghum from grasslands.

- The distribution of livestock is mainly observed in two important types of grasslands namely temperate grasslands and tropical grasslands.
- Livestock has been one of the fastest-growing agricultural industries in developing countries.
- India has an abundance of livestock. Nearly two-thirds of India's rural population relies on livestock for their livelihoods.
- Animal production is primarily part of economic activity in India, which is essential for the security and survival of a significant number of underprivileged people. Livestock offers money, employment, draught power, and manure in a mixed crop-livestock farming system, which is practiced by people in India.
- Dairy farming is essential supplementary source of income for millions of rural people of India and the majority of milk is produced by animals raised by marginal farmers and landless labourers.
- The nations like India, the United States, China, and New Zealand have large scale dairy sectors that act as key producers, exporters and importers of milk. The key milk-producing states in India are Punjab, Haryana, Gujarat, Maharashtra, western Uttar Pradesh, Andhra Pradesh, Rajasthan and Madhya Pradesh.
- Fisheries and aquaculture sector support the livelihood of more than 10percent of world's population.
- Fisheries and aquaculture sectors in India are an important part of the food production chain, providing nutritional security to the food basket, and agricultural exports.

10.5 TERMINAL QUESTIONS

1. Explain the geographical distribution of grasslands in the world.
2. Write a note on India's livestock distribution and its importance.
3. Discuss the distribution of dairying industry across the globe.
4. Fishing and aquaculture activities are important in the economic growth of India. Explain.

10.6 ANSWERS

Self-Assessment Questions (SAQ)

1. a) Pastoralism is a type of animal husbandry in which animals are domesticated and released onto extensive vegetated outdoor fields (pastures) for grazing. Nomadic and semi-nomadic pastoralism, transhumance and livestock rearing, etc. are identified as different categories of pastoralism
b) The animals are cow, buffalo, camel, goat, and horse.
c) Temperature and rainfall pattern, topography and flora etc., can affect the production of livestock.

- d) Grasslands provide perennial grasses and great number of herbaceous plants, shrubs and trees etc., thus helping the sustenance of large scale livestock in the world.
2. a) Dairy farming is involved in the breeding, growing, and use of dairy animals, for example cows, for the production of milk and other dairy products.
- b) (i) the Atlantic Coast to Moscow (Russia), (ii) the Atlantic Coast to Canada's Prairie Provinces, (iii) the Australia-New Zealand region.
- c) Uttar Pradesh (16.06 percent), Rajasthan (12.89 percent) and Madhya Pradesh (8.62 percent).
3. Aquaculture is recognised as major economic activity and has been the main engine of increased fisheries. The aquaculture production has recorded 85.3 million tonnes in 2019.

Terminal Questions

1. Your answer must be covering the distribution and characteristics of temperature grasslands and tropical grasslands of the world. You may refer to Section 10.2.
2. Your answer should be covering the livestock species and their percentage distribution in India by including the important contributions of livestock sector in India. To this information, you please refer to Sub-Section 10.2.1.
3. Explain the importance of dairy industry and its geographical distribution across the globe by including India's dairy industry. Refer to Section 10.2.2.
4. Your answer must be covering the importance of fisheries and aquacultural activities in India. For this information, you may refer to Section 10.3.

10.7 REFERENCES AND FURTHER SUGGESTED READING

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UNIT 11

FORESTRY |

Structure

11.1	Introduction	11.5	Tribal and Forest rights
	Expected Learning Outcomes	11.6	Summary
11.2	Concept of Forestry	11.7	Terminal Questions
11.3	Forest Products	11.8	Answers
	Timber	11.9	References and Further
	Non-timber		Suggested Reading
11.4	Forest and Livelihoods		

11.1 INTRODUCTION

In this Block, till now you have studied three major primary sector activities namely agriculture, animal husbandry and fishing. You have also realised that these are essential for human lives and livelihoods. We cannot imagine sustenance of human being without these activities. In this Unit, we will discuss another important primary activity i.e., forestry. You might have read that in the beginning of human history, human beings were wanderer in the forest and derived everything from the forest for their sustenance. Though human civilisation has moved from a primitive economy based society to an advanced economy based society, the role of forest for human beings is still extremely crucial and important. It encompasses our lives in terms of economy, ecology and social aspects. In this Unit, we will discuss various dimensions of forestry as economic activities.

We begin our discussion by explaining the concept of forestry in the Section 11.2. After discussing the concept of forestry, an attempt has been made to describe various forest products in Section 11.3. In Section 11.4, we have elaborated the relationship between forest and livelihood. Finally, we have discussed tribes and their forest rights in Section 11.5.

Expected Learning Outcomes

After studying this Unit, you should be able to:

- describe the concept of forestry;
- list various forest products and their uses;
- explain the relationship between forest and livelihoods; and

- highlight the need and significance of forest rights for tribal communities.

11.2 CONCEPT OF FORESTRY

Forestry has been regarded as a separate branch of science. This is mainly considered as an applied science. This is grouped as a primary land-use science comparable with agriculture. With this brief background, can you describe what forestry is? In simpler terms, it refers to the science and craft of creating, managing, planting, using, conserving and repairing forests, woodlands and associated resources for human and environmental benefits. Therefore, it is practiced in plantations as well as in natural stands also. Forests or tree plantations, those whose primary purpose is the extraction of forest products, are planned and managed utilizing a mix of ecological and agro-ecological principles. In many regions of the world there is considerable conflict between forest practices and other societal priorities such as water quality, watershed preservation, sustainable fishing, conservation and species preservation.

At present, we have a strong body of research regarding the management of varieties of species found in the diverse forest ecosystem existing all over the world. Apart from this, forestry studies also include the development of better methods for the planting, protecting, thinning, controlled burning, felling, extracting and processing of timber. One of the applications of modern forestry is reforestation, in which trees are planted and tended in a given area. Till now, you might have also realised that forestry involves more resources than just trees. That is why you will find that foresters are concerned not only with trees, but also animals, soils, water, insects, diseases, and human beings. Foresters manage for a broad spectrum of benefits that humans desire from their forests.

You might be thinking that why is forest so important? Yes, it is. It has many direct and indirect benefits. Forests help us to minimize the impacts of storms and floods by controlling soil erosion as tree roots make the soil stronger. We have about 80 percent of the world's biodiversity that are found in forests. Have you ever imagined how life without forests would be? Not only for the over 1 billion people who live in or close to forest need it to survive, but also it is equally important for the ones living in cities and urban areas. We take and transform forests' raw materials like wood and timber, and make several useful commodities such as toilet paper, napkins, corks or notebooks, heavier items like tables and chairs. Many essential and expensive fruits and seeds namely avocados, acai, cacao, coffee and mangos to name a few initially came from the forests later on grown commercially in large farms and estates.

Therefore, to derive maximum benefits from the forest on one hand and maintaining sustainable forest cover on the other is possible by adopting best forestry practices as listed in the introductory paragraphs of this section. You might know that there is a need to maintain one third land all over the world under forest cover. In other words, we can say that former is the short term goal whereas the later one is the long term goal.

Maintaining sustainable forest cover is a challenge and responsibilities of global communities in general and for a forester in particular. This is the reason for which forestry emerged as an important applied science branch all over the world.

You will have more clear ideas after reading the following Section in which a detailed discussion is presented about forest products. You would also realise how important forest is as far as lives and livelihoods are concerned. Before reading the next Section, try to answer the questions that are given below.

SAQ I

Fill in the blanks with suitable words.

- (i) Forestry is an _____ science.
 - (ii) One of the applications of modern forestry is _____.
 - (iii) Maintaining sustainable forest cover is a challenge and responsibilities of _____ in general and for a _____ in particular.
 - (iv) There is a need to maintain _____ land all over the world under forest cover.
-

11.3 FOREST PRODUCTS

Forest is one of the largest available renewable resources on the planet Earth. It provide us a wide variety of commodities such as timber, fuel wood, fodder, fiber, fruits, herbal drugs, cosmetics and many types of raw materials used by the industries. A great variety of animals and birds which live in the forest, serve as useful living resources. Forest plays a great role in the soil formation, water conservation and regeneration of oxygen. Trees fix CO₂ in their biomass and through transpiration (loss of moisture to atmosphere) they moderate the climate. Can you imagine what would happen if forest does not exist in the world. As mentioned above, it performs certain functions which can be directly observed. But there are certain functions which cannot be directly observed like purification of air and carbon sink etc. Functions performed by the forest as a resource can be categorised under three major headings namely economic, ecological and social. Ecological functions include stabilising global climate, protecting biodiversity and supporting global ecological system and processes. Forest has also socio-cultural significance in terms of providing ethical, spiritual, recreational and tourism value. But, the functions which catch our attention are economic functions. This is because these satisfy immediate needs of human beings. Let us discuss economic functions in detail.

Forest products can be classified into various categories by using various bases. One of the popular classifications of forest products are wood and non-wood products. In many literatures, we divide the forest products as timber and non-timber products. However, there is a minor difference between wood products and timber products. Can you guess what the difference is? Major difference between the two is that Wood Products **include all wood products namely fuel wood, charcoal, small woods,**

artisanal use of wood etc., whereas Timber Products include only timber and exclude other uses of wood.

About 60 percent of the world's forests – approximately 2.4 billion hectares – are primarily or partially used for the production of wood and non-wood forest products (FAO, 2016:3). The below given figure 11.1 depicts the schematic classification of forest products suggested by Food and Agriculture Organisation (FAO).

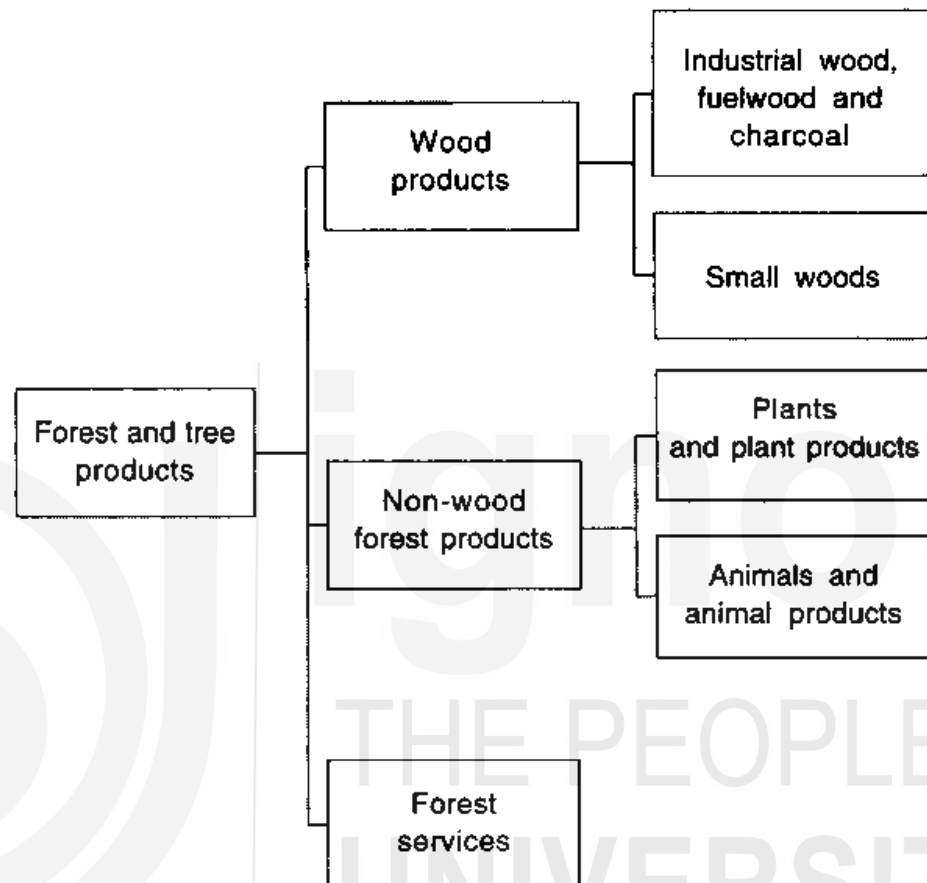


Fig. 11.1: Classification of Forest Products.

(Source: <https://www.fao.org/3/x2450e/x2450e0d.htm>)

Let us now discuss wood and non-wood products in the below given sub-Sections 11.3.1 and 11.3.2, respectively.

11.3.1 Wood Products

In simpler terms, we can say these are the products which are derived from wood. As discussed earlier, timber products are also a part of wood products. You all are aware of various uses of wood. Can you name some of these uses? Yes, wood is used for various purposes namely making houses, furniture, matches, ploughs, bridges and boats etc. Wood and bamboo pulp are also used for manufacturing paper and rayon. Let us discuss some of these uses of wood.

Uses of Wood and Timber: Though, there are numerous uses of wood, we will discuss only four major uses namely wood as fuel, construction material, pulp and paper and rayon. Let us discuss them one by one.

- (i) **Wood as a Fuel:** You must be aware of use of wood as fuel. This is still very common among low income households in the rural areas of developing countries of Asia, Africa and South America. It has been estimated that about 40 percent of the total timber removed from forests all over the world is used as fuelwood. However, the proportion of timber production used as fuel differs from region to region in different parts of the world. Do you know what are the major factors responsible for this? Major factors responsible for the variations are availability of other fuels, the degree of control exercised over the forests by governments and the fuel requirements of the various countries. Those countries in which forest industries are most highly developed, generally use least timber for fuel, while in those areas where forestry is little developed, fuel is the major use. Let us discuss this with examples.

Most of the developing countries in the African, South American and Asian continents consume a very large proportion of their timber as fuel, both for domestic and industrial purposes. However, there are some notable exception to this pattern namely in Malaysia. In Malaysia, though timber is a major product of the country, the proportion used for fuel is very small. This is partly because a rather higher standard of living than in many developing countries that enables many people to use kerosene, gas or electricity rather than wood as the major domestic fuel. For example, in Europe and North America people use relatively little wood for fuel. Besides, the countries which are short of timber but have ample supplies of coal and gas, use very little wood for fuel. Contrarily, in many Latin American countries, due to less availability of coal or oil, wood has traditionally been used to power industries.

- (ii) **Construction Material:** After fuel, the most important use for timber is in the building and constructional industries. It has traditionally been used to build houses or parts of houses. Despite the use of steel and concrete for a wide range of building purposes, nowadays, wood still continues to be used as building and construction material. Although, the development of newer materials has reduced the proportion of total timber used for construction. However, the continual growth of population in the world and growth of the construction industry has increased the amount of timber used for this purpose.

Apart from house-building, timber is also used for shipbuilding in many areas. Timber is also the basis of a wide range of woodworking industries producing furniture, boxes, crates and matches. While most of the timber used for fuel is hardwood from tropical forests, the situation in the industrial use of timber is the reverse. Most of the timber is used for construction, pit props and matches and so on is softwood. Timber is used in the construction industry in three main ways namely sanwood, plywood and fiber board.

- (iii) **Pulp and Paper:** As far as extensive use and economic value is concerned, the most important use of timber is in the pulp and paper industry. This industry is constantly expanding and it creates an ever-increasing demand for timber. This is one of the major reasons for deforestation. Wood contains two substances, lignin and cellulose and

the object of pulping is to extract the cellulose from which paper are made. Both hardwoods and softwoods can be used for pulping, but the greater ease of dealing with softwoods and the predominance of softwoods in the developed world has led to the dominance of softwoods in this industry.

Wood is not the only substance from which paper can be made and a wide variety of vegetable fibres have been used in different parts of the world for many hundreds of years. Apart from wood, banana trees, sugar bagasse, paddy straw and old rubber trees are also important sources of pulp. However, these raw materials are being experimented with and they have not yet been used on a large scale. Temperate hardwoods, however, are being increasingly used for pulp production. Rags and wastepaper can also be converted into pulp for re-use as newsprint, though high quality paper cannot be made, and this practice is becoming more and more important in the major paper-consuming countries. At present, however, 90 percent of pulp is derived from wood.

There are three processes namely mechanical, chemical and semi-chemical by which wood is converted into pulp and the method used depends on the type of wood and the type of paper to be produced. The pulp produced by the above processes has to be processed in various ways in order to produce the wide range of papers and cardboards, which are in everyday use.

Paper is not the only product of the pulp industry. Of growing importance is the manufacture of a wide variety of fiber boards and particle boards for constructional purposes. These are made from pulp, saw mill waste, such as sawdust or forest waste, such as chips and off cuts. These board products have only become important in the twentieth century. Fiber board is made mostly from mechanically or semi-chemically processed pulp and both softwoods and hardwoods can thus be used. Sawmill residues are also used to a large extent, especially in Europe. The leading producers are Russia, U.S.A. and Sweden. Particle board can be made from a wide range of materials, not necessarily pulp and consists of a mass of small particles of lignocelluloses bonded by resinous material to form a board. Much forest waste is utilised in its production. Both fiberboard and particle board production are increasing and should be encouraged because they can make use of hitherto wasted timber materials and at the same time can ease the demand for sawn-timber in the construction industry.

(iii) Rayon for Synthetic Textiles: Many of you might have heard about rayon. Do you know from where it is derived from? Yes, it is derived from wood cellulose, which is the basic ingredient of the synthetic textiles known as rayon. The chief source of cellulose for the textile industry is spruce wood pulp but cellulose is also extracted from cotton linters. The rayon filaments may be used to produce 'artificial silk' or may be cut into staple lengths and then spun, woven, dyed and finished in the same way as ordinary textiles. They may thus be given the properties and appearance of the traditional textiles such as cotton or wool. Do you know which are the leading rayon producing countries?

Major rayon producing countries are USA, Japan and Italy to name a few.

SAQ 2

Fill in the blanks with suitable words.

- Countries in _____ and _____ use relatively little wood for fuel.
- Timber is used in the construction industry in three main ways namely _____, _____ and _____.
- Wood contains two substances _____ and _____.
- The chief source of cellulose for the textile industry is _____.

11.3.2 Non-Wood Forest Products

As the name suggests, it includes everything provided by the forest other than wood or timber. Non-Wood Forest Products (NWFPs) are defined as ***"all biological materials, other than wood, which are extracted from forest for human use."***

Non-Timber Forest Products (NTFPs) include fruits, nuts, fungi, fibers, medicinal and ornamental plants, mosses, dyes, resins, gums, fuel-wood, charcoal, leaves as fodder, poles for local construction, honey, syrup, fish, and game, as well as other animal products. These products are vital resources for various groups of people around the world. Till date, it is vital for communities of those areas where basic infrastructure and market access are not available. Therefore, these above mentioned products are essentials not only for their subsistence but also meeting the sources of daily nutrition. The flora and fauna of the forest also holds the key to numerous life sustaining products such as pharmaceuticals, insecticides and pesticides. These substances should be harvested sustainably so that it could enhance the long term resource value of the forest. In the Section given below, let us discuss some of the major uses of NWFPs.

Uses of Non-Wood Forest Products: As mentioned above, besides producing timber and conferring certain other economic benefits, forest provides a wide range of other products. Some of the most important NWFPs are discussed below.

- Rubber and Gum:** We are using rubber in our daily life and also being used by various industries. But, most of them are synthetic rubber. But this was not the scenario six to seven decades back. We were heavily dependent on natural rubber. If we look historically, rubber was originally a forest product collected from the Amazon forests of Brazil. Today natural rubber is grown as a plantation crop. Rubber and similar gums, such as balata and guttapercha are still collected, but production of this kind is now of little importance. Many other natural gums are still essentially forest products however, especially chicle, from the Central American forests and jelutong from South-East Asian forests, which are used in the manufacturing of chewing gum.

- (ii) **Resin and Turpentine:** Non-Wood products like resin, pitch, tar and turpentine that are derived from the resinous material exuded from coniferous trees, is collected or systematically tapped and processed in a variety of ways. Today, they are used in the chemical industries. Turpentine, the distilled form of resin, is used in paint.
- (iii) **Cork:** Cork is the thick bark of the cork oak. This variety of Oak tree is found in southern Europe and North Africa. These trees generally grow in the wild. However, nowadays these trees are grown in plantations. The bark can be stripped from the tree in such a way that it won't harm the main trunk. Most of the world's cork comes from Spain, Portugal and North Africa.
- (iv) **Tannin:** Tannin is a substance, found in the bark of certain trees, which is used in the conversion of raw hides into leather. It is found in a number of trees including the hemlock of North America and Europe, the oak and chestnut of the temperate hard wood forests, the quebracho of South America and the wattle of Africa. It may be cut in the forest or grown as plantation crop in Kenya, South Africa, Brazil and Sri Lanka. Mangrove species from the tropical coastlands also provide tannin.
- (v) **Palm and Creeper Products:** Oil palm is sometimes a forest product, though it is now mainly produced on plantations and smallholdings. The leaves and fruits of a number of other palms are also harvested for various purposes, e.g., the pandanus palms and the raffia palms, which are used for weaving mats and baskets. Bamboo and vines or creepers such as rattan are much used for furniture, basketry and weaving.
- (vi) **Medicinal Plants.** A wide variety of medicinal plants is found in the forests, and forest dwellers extract both beneficial drugs and harmful narcotics from the plants and trees around them. Some of the important medicinal plants are cinchona, from the bark and wood of which the drug quinine is extracted, and the coca shrub, from the leaves of which the drug cocaine is extracted. Both were originally native to the Andes, and coca is in daily use among the Andean Indians, but both are now mostly grown for world markets in plantations in Indonesia. Camphor, oil distilled from the camphor tree, originally had mainly medicinal uses. Nowadays, it is used in the manufacture of cosmetics, soaps, explosives and plastics as well as ointments.
- (vii) **Fruits, Nuts and Spices:** A wide variety of fruits is collected either for use by forest dwellers or for international trade. Brazil nuts, ivory nuts and betel nuts are among the most important. Spices may also be produced from cultivated trees or bushes.
- (viii) **Waxes, Honey, Musk, and Hides:** Apart from the above mentioned non-wood products, waxes, honey, musk and hides are some of the important non-wood forest products derived from the forest.

Till now, you might have realised that gathering and extraction of forest products have been carried out at two levels namely subsistence and commercial. Forest products are generally used for subsistence in the regions, where people are heavily dependent on primary sector of economy.

In other words, it includes hunter-gatherer and agrarian society. On the other hand, it has been used for commercial purposes mostly in the developed countries of Europe and North America. In the following Section, we shall discuss in detail about the forest-based livelihoods.

Before that let us pause for a while and answer the questions that are given below.

SAQ 3

Fill in the blanks with suitable words.

- a) Rubber was originally a forest product collected from the _____ of Brazil.
 - b) Tannin is a substance which is used in the conversion of _____ into _____ leather.
 - c) _____ and _____ palms are used for weaving mats and baskets.
 - d) Cinchona, from the bark and wood of which the drug _____ is extracted.
-

11.4 FOREST AND LIVELIHOODS

After learning about uses of wood and non-wood products, I am sure you can very well think about the linkages between forest and livelihoods. If you closely observe various types of people engaged in primary and secondary occupations in your region, then you might find many people either directly or indirectly dependent upon forest for their livelihoods. It plays an important role particularly in developing countries of Asia, Africa and South America as far as subsistence based livelihoods are concerned. Forest is a major source of timber, fire wood, fodder, food and medicinal plants to name a few, and it also provides employment and livelihoods to a large section of rural population and forest dwellers. Let us discuss some direct as well as indirect connection between forest and livelihoods in the following paragraphs.

Some of the direct connections between forest and livelihood are as follows:

- a) Forests provide work opportunities to maintain vocation through timber industry.
- b) The forest supply with firewood and food to support living.
- c) The forest supply medication to the human populace.

Hundreds of millions of people particularly in the developing world rely on forests to earn their living. About two billion people use fuel wood and charcoal as their main source of energy for cooking and for heating their homes. Rural households in developing countries collect food, fuel, medicinal plants and construction materials directly from the forest. Tens of millions of people supplement their cash incomes by collecting and selling such materials. Others sell timber from their own traditional land areas to logging companies or make and sell furniture and handicrafts, just so they have enough income to support themselves and their families. And industrial

logging provides millions of full-time jobs and steady earnings for people in developing countries, especially in Brazil, China, India and Indonesia. Here, we will discuss two major forest-based livelihood activities on which millions of people depend for their sustenance. Let us discuss them one by one.

(i) Lumbering: Do you know what does this mean? In simple terms, lumbering refers to the procedure of systematic cutting and felling of trees for timber and extraction of other forest produce for commercial gains. There are three stages of lumbering namely preparation, felling and extraction. Preparation is the initial stage in which a detailed survey of the area is conducted for searching best timber. Felling is the second stage in which trees are cut with the help of powered saws and axes for ease and speed of felling. Extraction is the final stage in which the extracted logs are moved to collection points. This is one of the major forest based livelihood activities both in tropical and temperate forested regions of the world. Lumbering is most significant in terms of economic value and volumes manufactured. However, if we compare between tropical and temperate forest regions, lumbering is better developed in temperate regions than tropical regions. This is because of considerable stands of single species, mechanical extraction, steady demand, sound forest practices, better living conditions and transportation facilities and access to markets.

(ii) Livelihood based on Minor Forest Products: Do you know the things or substances included under minor forest product? Minor Forest Products (MFPs) is a subset of non-timber forest produce of plant origin and includes bamboo, brushwood, stumps, canes, tusser, cocoon, honey, waxes, lac, tendu/kendu leaves, medicinal plants and herbs, roots and tuber, etc. The table 11.1 given below describes about various MFPs collected by forest dwellers in India during different seasons.

Table 11.1: MFPs Collected by Forest Dwellers in India in Different Seasons

Seasons	MFPs collected	Economy
January-March	Lac (resin), mahuwa, flower and tamarind	Over 75 percent of tribal households in Odisha, Madhya Pradesh and Andhra Pradesh collect mahuwa flower and earn Rs.5,000 a year. 3 million people are involved in lac production.
April-June	Tendu leaves, sal seeds, and chironji	30 million forest dwellers depend on seeds, leaves and resins from sal trees; tendu leaf collection provides about 90 days of employment to 7.5 million people, a further 3 million people are employed in bidi processing.
July-September	Chironji, mango, mahuwa fruits, silk cocoons and bamboo	10 million people depend on bamboo for livelihood; 1,26,000 households are involved in tussar silk cultivation only.
October-November	Lac, kullu gum and resins used in incense sticks	3 lakh person days of employment from collection of gums.

(Source: <https://trifed.tribal.gov.in/non/timber/msp-mfp>)

Before moving to the next Section, let us undertake the exercise given below.

SAQ 4

State whether the following statements are true or false.

- a) Hundreds of millions of people particularly in the developing world rely on forests to earn their living.
 - b) Lumbering is one of the major activities in the equatorial region of Africa.
 - c) Majority of tribal communities in India living in the forest earn their livelihood by selling minor forest products.
-

11.5 TRIBES AND FOREST RIGHTS

Till now, you might have realised how forest is very important for livelihoods for millions of people across the world either directly or indirectly. However, there are significant number of tribes and forest dwellers whose livelihoods are directly connected to forest. You might know that tribal communities across the world have been living in the forest since ages. If we look it in the context of the tribal livelihood, it is significant to emphasize that tribes depend on their surrounding natural resources for their livelihood. If we analyse the main source of livelihood of tribes across the globe, it can be observed that most of these people are either dependant on agriculture or MFPs collected by them. In the previous Section, we have already discussed the meaning of MFP. In the context of India, some of the examples of minor forest products are Sal, Mahua, Amla, Char, Harra, Bahera, Tamrind, Tendu leaves, Mehul leave, Honey and variety of roots to name a few. From this list, you can imagine the diversity of MFPs all over the world.

Majority of tribal population in our country as well as in different parts of the world has been living in the forest. If you closely observe tribal dominated areas of our country as well as in different parts of Africa, South America and South East Asia, have rich forest cover, mineral bearing areas and significant number of watersheds of key rivers. Forest provides food, medicine and other products needed by tribal people and plays a vital role in the life and economy of tribes living in the forest. Developmental activities like construction of dams, mining and establishment of mineral based industries, etc. alienated tribal people from their own land. This alienation deprived them from their livelihoods. Most of them are dependent upon natural resources based informal economy. Their natural resource based informal economy is mostly dependent on agriculture both settled and jhum, and on the other NTFPs, such as medicinal herbs, edible flowers, leaves and fruits. They also get their small timber and firewood from the forest.

Hence, development is bound to affect their agricultural and forest land which is the primary source of their livelihood. The development process pushes them from an informal to a formal economy that is new to them without any preparation. They had depended on agricultural land and forests, both of which they lose to the project. When they receive compensation it is monetary with which most communities living in the informal economy are not familiar. As mentioned above, in most cases the Common Property Resources (CPR)

are not compensated. Therefore, there was a need to address these problems.

Government of India passed an act in the Parliament titled 'The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006' to address this anomaly. The Act empowers the forest dwellers to access and use the forest resources in the manner that they were traditionally accustomed, to protect, conserve and manage forest, protect forest dwellers from unlawful evictions. It also provides for basic development facilities for the community of forest dwellers to access facilities like education, health, nutrition and infrastructure.

The major objectives of this Act are:

- (a) To undo the historical injustice done to the forest dwelling communities;
- (b) To ensure land tenure, livelihood and food security of the forest dwelling Scheduled Tribes and other Traditional Forest Dwellers.
- (c) To strengthen the conservation regime of the forests by including the responsibilities and authority on Forest Rights holders for sustainable use, conservation of biodiversity and maintenance of ecological balance.

With the above mentioned objectives, the act will ensure that people get to manage their forest resources on their own and minimise the exploitation of forest dwellers.

SAQ 5

State whether the following statements are true or false.

- a) Tribal dominated areas of our country as well as in different parts of Africa, South America and South East Asia, have rich forest cover, mineral bearing areas and significant number of watersheds of key rivers.
 - b) There are significant number of tribes and forest dwellers whose livelihoods are directly connected to forest.
 - c) Developmental activities like construction of dams, mining, establishment of mineral based industries etc., do not alienate tribal people from their own land.
 - d) 'The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, came into effect in the year 2004.
-

11.6 SUMMARY

In this Unit, you have learnt the following:

- Forestry refers to the science and craft of creating, managing, planting, using, conserving and repairing forests, woodlands and associated resources for human and environmental benefits.
- Forest products can be classified into various categories by using various bases. One of the popular classifications of forest products are

wood and non-wood products. In many literatures, we divide the forest products as timber and non-timber products.

- Wood-Forest Product includes wood as fuel, construction material, pulp and paper and rayon for synthetic textile.
- Non-Wood Forest Products (NWFPs) are defined as *"all biological materials, other than wood, which are extracted from forest for human use."*
- Forest-based livelihoods include lumbering, timber industry, pulp and paper industry and selling of minor forest products.
- The tribes depend on their surrounding natural resources for their livelihood. Developmental activities like construction of dams, mining, establishment of mineral based industries etc., alienated tribal people from their own land. To address this anomaly, the Government of India passed an act 'The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.

11.7 TERMINAL QUESTIONS

1. What is forestry? Explain major areas covered by forestry as a subject.
2. Describe the uses of timber with suitable examples.
3. Explain the uses of non-timber forest products with examples.
4. Discuss the importance of forest as livelihoods.
5. How does a forest right support the tribal communities? Explain.

11.8 ANSWERS

Self-Assessment Questions (SAQ)

1. (a) applied; (b) reforestation; (c) global communities, forester; (d) one third
2. (a) Europe and North America; (b) sanwood, plywood and fiber board; (c) lignin and cellulose; (d) spruce wood pulp
3. (a) Amazon forests; (b) raw hides, Leather; (c) Pandanus, Raffia; (d) quinine
4. (a) True; (b) False; (c) True
5. (a) True; (b) True; (c) False (d) False

Terminal Questions

1. You should describe the meaning of forestry and explain major areas covered by forestry as a subject. Refer to Section 11.3.
2. In your answer, you will include the description on the uses of timber with suitable examples. Refer to Section 11.3.
3. To answer this question, explain the uses of non-timber forest products with suitable examples. Refer to Section 11.3.

4. You should include the discussion on the importance of forest as a source of livelihoods with apt examples. Refer to Section 11.4.
5. In your answer, you should explain that how forest right support the tribal communities. Refer to Section 11.5.

11.9 REFERENCES AND FURTHER SUGGESTED READING

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MINERALS AND MINING ACTIVITIES

Structure

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	Expected Learning Outcomes		
12.2	Metallic and Non-Metallic Mineral Resources		
	Minerals and their Characteristics	12.5	Harmful Effects of Mining on Different Spheres of Earth
	Classification of mineral Resources	12.6	Harmful Effects of Different Mining Methods on Landscape and Environment
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12.4	Effects of Mining on Landscape and Environment	12.8	Terminal Questions
			Answers
			References and Further Suggested Readings

12.1 INTRODUCTION

In this course so far, you have studied about the basic concepts in economic geography. You have also learnt about the resources needed for economic activities. In Block 3 which is on primary sectors of economy, you have already got acquainted with primary activities like agriculture, animal husbandry, fishing and forestry. You have also studied about mineral resources in the course on Geography of India in the fifth semester and in Block 2 of this course on Economic Geography. In this Unit, we are more concerned about the economic importance of minerals. Therefore, focus is more on the mining activities related to minerals, different methods of mining and their consequences.

Section 12.2 will give you a brief recap to mineral resources and their types. According to Zimmermann, "**resources are not, they become**". This means it exists in the environment as a neutral stuff. When its utility is realised and used by humans, it is transformed into a **resource**. So it must be evident to you that utilisation of mineral resource through effective mining methods is of utmost importance. Section 12.3 gives a detailed description of different methods of mining. With the help of latest mining techniques, harnessing of minerals has increased, due to which many are on the verge of depletion.

Section 12.4 of this unit is dedicated to the effect of mining on landscape and environment. In this section we have two sub-sections. In the first sub-Section, we will study the harmful effects of mining on different spheres on earth, that is, harmful effects on land, water, air, and biosphere (exhibiting the living organisms). In the latter sub-Section of 12.4 we will study the harmful effects of different mining methods on the landscape and environment.

In next Unit, you will learn about factors affecting the location of industries.

Expected Learning Outcomes

After studying this unit, you should be able to:

- define minerals and explain its characteristics;
- classify minerals and distinguish between them;
- analyse various methods related to the mining of minerals;
- assess the impact of mining on landscape and environment; and
- compare the impact of different mining methods on landscape and environment.

Let us first have a little bit of recap about minerals and its types, which you have already studied in Unit 9 of 5th semester course on Geography of India and Unit 7 of this course on Economic Geography

12.2 METALLIC AND NON-METALLIC MINERALS

So far you have learnt that minerals are naturally occurring substances with a definite chemical composition and recognisable physical properties. We cannot imagine our life without minerals. It is so much embedded in our daily activities. Can we start our day without brushing our teeth or can we eat our food without salt? Even the houses we live in are made of a variety of minerals. Our entire body is made up of so many minerals. The fruit and vegetables we eat contain so many important minerals needed for our growth and sustenance. So minerals are a core part of our lives as we are very much dependant on it. Let us have a quick recap of some of the basic properties of minerals.

12.2.1 Minerals and their Characteristics

Mineral are supposed to have five basic characteristics. These are naturally occurring, inorganic, solid substances with definite chemical composition and crystalline structure.

Minerals occur naturally. That means, minerals are not created by scientists in a laboratory. However not all substances occurring naturally are minerals, as they might be lacking other characteristics of minerals. Though minerals occur naturally, they are not made up of any living organisms. They are in fact inorganic. They do not belong to any class of organic compounds like carbohydrates, proteins and fats. So, they may contain carbon but carbon here does not bond with hydrogen to form long chains as in other organic compounds. Another important property of minerals is that, these are solids at standard temperature and pressure. In a mineral, the particles are not free to move like in liquid and gaseous substances. Minerals also have a crystalline

structure where atoms are arranged in a systematic and repeating pattern giving it a crystalline shape. Most of the minerals have cubic or tetrahedral shape. This crystal structure is attributed to intense heat and pressure which minerals undergo. Apart from crystalline structure, minerals also have a definite chemical composition where a particular number of atoms are bonded together in a definite crystalline structure. This is supposed to be specific for a particular mineral. Take for example mineral “halite” or common salt has a chemical composition of NaCl. Thus, it is made up of equal number of sodium and chlorine atoms which are electronically charged ions (in this case) bonded together in a repeating pattern in all directions which is actually cubic in case of NaCl.

12.2.2 Classification of Mineral Resources

You may recall that on the basis of chemical and physical properties, minerals may be grouped into two types, that is metallic and non-metallic minerals.

Metallic Minerals are those minerals that contain metal and so are the source of metals e.g. Iron ore, copper, manganese, gold etc. **Non- Metallic minerals** on the other hand, are those minerals which do not contain any metal in it e.g. fossil fuels, mica and limestone, etc.

Metallic minerals are further divided into **ferrous** and **non-ferrous** minerals. You may recall that the word “**Ferrous**” refers to iron. So, all those minerals which have iron content in them are referred to as ferrous minerals e.g. iron ore, manganese, tungsten, nickel and cobalt, etc. Metallic minerals which do not have iron content are called **non-ferrous metallic minerals** e.g. gold, silver, copper, lead, bauxite, tin and magnesium.

Non-Metallic minerals are also divided into **organic** and **inorganic** minerals. Organic minerals are those minerals which contain organic matter. Examples of this type include fossil fuels as they are derived from organic remains of plants and animals. So fossil fuels like coal, petroleum etc fall under this category. Inorganic minerals are those minerals that do not contain any organic matter, for example mica, limestone, graphite etc.

The **United Nations Framework Classification (UNFC)** for fossil energy and mineral reserves and resources prescribes a standard mineral classification based on three fundamental criteria, that is, **economic viability, feasibility assessment**, and also **geological assessment**. You may go through the unit 9 on ‘mineral resources’ in the course on ‘Geography of India’ to know more about this.

Before we proceed further let us check your understanding through a SAQ.

SAQ I

Match List 1 with List 2:

List 1	List 2
Ferrous	Mica
Non-Ferrous	Bauxite
Organic	Manganese
Inorganic	Petroleum

Now let us learn about the various methods of mining in the next section of this unit.

12.3 METHODS OF MINING

You all know that mineral resources are non-renewable and their distribution is not uniform around the world. It is evident that mining of the minerals should be done in a sustainable manner so that little waste is generated and the resources are not depleted. So, methods of mining and its efficiency forms an important part of study while studying minerals and you should know about it. First let us understand what is mining.

In simple words mining is the process used to:

- extract valuable resources from the earth;
- acquire any resource that cannot be grown or fabricated through artificial means; or
- used to extract those resources which are non-renewable just like fossil fuels and minerals, etc.

To sum up, mining is the extraction from the earth of valuable minerals or other geological materials, usually from a deposit of ore, lode, vein, seam, reef or placer. These deposits form an economically interesting mineralised package for the miner.

There are four main methods of mining. They are:

- Surface Mining
- Underground Mining
- Placer Mining
- In-Situ Mining

Let us get acquainted with these.

12.3.1 Surface Mining

As the name suggests, surface mining is done to extract minerals that are close to the surface of earth. Thus, it is done for those minerals which are fairly shallow deposits and can be easily exploited. Due to this the mining of these minerals involves less expenditure and so the minerals have lesser value or are non-precious. Some of the common minerals extracted using surface mining are coal, iron and bauxite. Surface mining involves removal of plant life, soil and potential bedrock to be able to access resource deposits. It is done in two different methods of which one is *open-pit mining* and the other one is *strip mining*.

Open pit mining involves digging out rocks to form an open pit or borrow pit, from which resources are then extracted. However, in this case, the sides of the pits are generally terraced or stepped so as to reduce the risk of collapse of side walls. Refer to Fig. 12.1 to see an open pit mining. You will notice that in the picture the side walls of the mine is terraced as mentioned. Besides, since these mines are open, they may face the problem of temporary flooding

due to rainwater accumulation and may turn into a lake. So to avoid any such problems, proper water management has to be done. Open-pit mines are workable till they are economically profitable, that is either it is having ample mineral. Various factors make the mine non-profitable. When this occurs, the open pit is often modified to become a landfill for solid wastes.



Fig. 12.1: An Open Pit Mining.

(Source: <https://www.pxfuel.com/en/free-photo-xxsus>)

Strip mining is mostly used to extract shallow, "bedded" deposits, where a mineral layer is covered by a layer of soft topsoil and weathered rocks. The relatively soft top layer of earth is stripped off either by a dragline or industrial shovel so as to expose the deposit. It is generally stripping off surface layers to reveal ore or seams below. For example, sometimes coal mining involves removal or stripping off the top of a mountain to reach deposits of ore at depth. Refer to Fig. 12.2 to get an idea about strip mining.



Fig. 12.2: Strip Mining.

(Source: https://commons.wikimedia.org/wiki/File:Strip_mining.jpg, Allen Arthur, U.S. Fish and Wildlife Service)

12.3.2 Underground Mining

Underground mining as the name suggests is sub-surface mining and is used to reach the mineral deposits located deep under the surface of the earth. It involves digging down into the earth and creating tunnels and shafts that reach the deposits of resources. So, this method of mining is relatively expensive compared to the previous one. Underground mining can also be classified according to the type of shaft used, the method of extraction or the technique used to reach the deposit. Take for example; if tunnels are horizontal, it is called ***drift mining***, while if the shafts or tunnels are diagonal, it is called ***slope mining***. However, the type of underground mining depends very much on the geology of the area. It requires different techniques in hard and soft rock formations. Some of the expensive minerals extracted through underground mining are gold, lead and silver. The relative depth of the deposit and economic value of the mineral play a key role in determining which method of mining has to be used. It could be shallow having depth only up to 300 metres or very deep with depth above 3 kilometres. For example, earth's deepest underground mine, ***Mponeng Gold Mine***, located in South Africa, has an operating depth beyond 3.1 kilometre. Refer to Fig. 12.3 to get an idea about underground mine shaft.



Fig. 12.3: An Underground Mine Shaft.

(Source: <https://pixabay.com/photos/mine-mine-shaft-tunnel-underground-215907/>)

12.3.3 Placer Mining

Placers are actually unconsolidated deposits of resources formed due to weathering via water or wind action. So, they are found as sediments in river channels, beach sands or other similar environments. So placer mining often takes place in riverbeds, sands and environments where there is a natural accumulation of sediments. Common minerals gathered using placer mining are gold, platinum, tin and diamonds. You may refer to Fig 12.4 to see how gold descends on a riffle box which is made up of rough plank, placed on an

incline. In this manner, gold and a few of the heavier materials find their way to the bottom and rest there by aid of the riffle bars. At least 50 percent of the world's titanium comes from this type of mining operation. It involves sifting valuable materials from sediments. The extracted sedimentary material is then rinsed and sluiced to pull out the desired minerals.

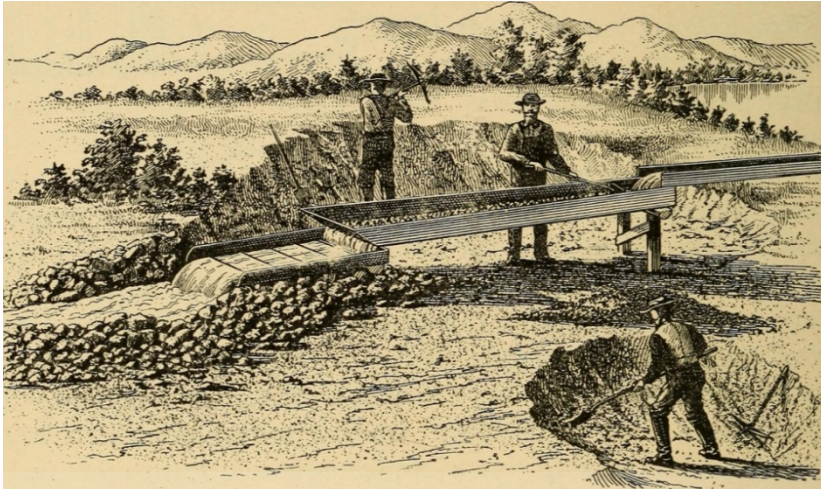


Fig. 12.4: Placer Mining.

(Source: [https://commons.wikimedia.org/wiki/File:Placer_mining._A_hand-book_for_Klondike_and_other_miners_and_prospectors._\(1897\)_ \(14765410565\).jpg](https://commons.wikimedia.org/wiki/File:Placer_mining._A_hand-book_for_Klondike_and_other_miners_and_prospectors._(1897)_ (14765410565).jpg))

12.3.4 In-Situ Mining

In situ mining is also referred to as solution mining. It does not involve removing intact ore from beneath the earth's surface. Instead, it involves pumping chemicals under the ground to dissolve the resource-containing ore in place and then pumping what is known as the "pregnant solution" back up to the surface. Then processing is done at the surface where the mineral is recovered. In this case you must have noticed that mineral is recovered without moving the rock from the ground. Thus in this technique very little rock waste is produced and the surface remains intact. This type of mining is primarily used in mining of uranium. Refer to Fig. 12.5 to see an example of in-situ mining.



Fig. 12.5: In-situ Mining.

(Source: [https://commons.wikimedia.org/wiki/File:In-situ_recovery_mining_in_Crow_Butte,_Neb._\(14675701681\).jpg](https://commons.wikimedia.org/wiki/File:In-situ_recovery_mining_in_Crow_Butte,_Neb._(14675701681).jpg), cc-by-2.0)

SAQ 2

Differentiate between:

- a. Surface mining and underground mining
 - b. Open-pit mining and strip mining
 - c. Placer mining and In-situ mining
-

12.4 EFFECTS OF MINING ON LANDSCAPE AND ENVIRONMENT

While going through different methods of mining, you might have got an idea that mining takes a heavy toll on landscape and environment. Mining can pollute air and drinking water, harm wildlife and habitat and induce loss of biodiversity. It may lead to soil erosion and contamination of surface water, groundwater and soil and permanently scar natural landscapes. Let us first study the effects of mining on landscape and environment and then we will summarise the effects caused due to different methods of mining.

12.4.1 Harmful Effects of Mining on Different Spheres of Earth

Both current mines as well as abandoned mines are responsible for significant damage to the different spheres on earth. Let us get acquainted with them.

A. Damage to Land

Mining generates a lot of rock wastes and surface mining can lead to removal of the fertile top soil which supports the natural flora and fauna of the region. Various surface features may disappear permanently due to mining. Creation of shafts and tunnels, in case of underground mining may destabilise the ground which may lead to subsidence and collapse of overlying structures. Besides, restoration and reclamation of abandoned mining area usually takes a longer period of time. Some of the species are also permanently lost.

B. Damage to Air

Mining releases unrefined materials which deteriorates the quality of air. Rock wastes and bare soil are exposed to wind action which erodes them and leads to suspension of particulate matter in air. Lead, arsenic, cadmium and other toxic elements are often present in such particles. This has a detrimental impact on the health of population living nearby. They may suffer from several respiratory diseases as well as eye infection or skin allergies due to this. Air pollutants also have a damaging effect on plants. It affects the leaves especially its metabolism. Air pollutants once deposited on the ground affects the roots of plants and interferes with the resource capturing ability of the plants and hampers its growth.

C. Damage to Water

Mining affects both surface and groundwater bodies in its vicinity its terms of metal contamination, increased sediment levels in streams and acid mine drainage. Untreated wastes released from processing plants or underground

mines act as the primary sources of water pollution. It might increase the concentration of arsenic or mercury in the surrounding surface as well as underground water. The dumping of contaminated waste water produces a devastating effect on water bodies and destroys the surrounding vegetation as well as poses a threat to aquatic flora and fauna and all species dependent on them for food.

Acid mine drainage is another term used to denote water pollution through mining. Mining unearths large amounts of ore that contains precious metals, such as gold and silver, as well as iron and other sulphides. When sulphides in the ore are exposed to water and air, sulphuric acid is created, which can seep from mines and waste rock piles into streams, rivers and groundwater. This seepage is called acid mine drainage. Acid mine drainage can be 20 to 300 times more acidic than acid rain and can burn human skin and kill fish and aquatic organisms e.g. water recovered from Richmond mine in California was found to be more acidic than that of a battery acid. Acid mine drainage also leaches toxic metals, such as arsenic, cadmium, chromium, lead from ore and waste rock, causing additional water pollution.

There are certain chemicals which are required to separate precious metals and minerals from ore. These may sometimes leak into rivers or other water bodies. Some of these chemicals like mercury persist in the environment for decades. Although no longer used in mining, mercury continues to contaminate waterways. Cyanide, which is widely used in modern gold mining, is another potentially deadly chemical that can get into water supplies.

Siltation is another problem which the water bodies adjoining to mines face. It adversely affects activities like irrigation, swimming, fishing, domestic water supply related to water bodies.

D. Damage to Biodiversity

Mining activities lead to a massive habitat loss for a variety of flora and fauna ranging from soil microorganisms to large mammals. Wildlife even gets dislocated. Several endemic species face the risk of extinction due to perturbations in their habitat. Various toxic materials released through mining can wipe out an entire population inhabiting an area. Exposure of water bodies to heavy metals resulting due to mining can interfere with the metabolism of aquatic flora and fauna and result in their stunted growth. Increase in sedimentation can limit light penetration into the water bodies thus affecting several aquatic organisms. Adverse effect on biodiversity decreases with increasing distance from mining areas.

One example of water pollution due to mining activities occurred in Minamata Bay where methyl mercury was released from a nearby chemical industry in Kumamoto, Japan. It poisoned and killed the aquatic fauna in the bay by a disease which was named as minamata disease. It even infected the people who ate them.

Polluted water conditions like high zinc concentration, change in pH, even have an adverse effect on the microorganisms like algae, phytoplanktons or diatoms.

Since we are studying the damage to biodiversity due to mining activities, let us also study the impact on human beings here. Humans inhabiting or

working near mines are also affected adversely. There are several occupational hazards associated with mining activities like asbestosis, silicosis or black lung disease. Several other diseases like chronic asthma, pulmonary insufficiency and cardiovascular mortality are resulted due to long term exposure to mining activities. Even the abandoned mine sites can show long term impacts as the chemical effluents released by them can be carried by fishes and other animals for a long time and affect the humans. This effect was reported near an abandoned Dabaoshan mine in China where the impact of mining activity was seen years after the mine was inactive. A huge percentage of population was affected by esophageal cancer and liver cancer which was due to untreated wastes released from the mine.

Let us now study the effects caused due to employment of different methods of mining.

12.4.2 Harmful Effects of Different Mining Methods on Landscape and Environment

Each mining method has a bearing on environment related to biodiversity, air, water and land. Let us study the harmful effects of mining on landscape and environment in terms of different mining methods in this sub-section.

A. Surface Mining and its Effects

This is highly destructive form of mining as it requires clearing of large forest areas and agricultural land. This depletes the forest cover, results in loss of wildlife habitat and erosion of the topsoil. According to the Amnesty International Report 2016, more than 397 hectares of forest land have been destroyed in the region of Korba coalfield of Chhattisgarh. The land becomes barren and desolate, and reclamation and rehabilitation of such degraded land takes a lot of time.

Open-pit mining exposes the hard rock that has been unexposed for geological eras. It might expose radioactive elements while crushing. The residual rock slurries can pollute the bedrock as well as pollute the neighbouring water bodies. This can lead to serious deterioration to river ecosystem. The eroded topsoil would sediment in the streams and cause siltation, disfiguring of the river channels and streams and deterioration of the river ecosystem. The damaged and contaminated land left behind after mining, stays barren for a long period of time making land reclamation difficult. Surface mining also has a greater impact in polluting the air as it operates in the open and can spread over large areas. In the open cast mining areas of Dhanbad in Jharkhand, air pollutants like oxides of sulphur and nitrogen, PM_{2.5}, PM₁₀ and trace metals like lead, arsenic and nickel have been observed which is extremely high than the air quality standard levels.

Let us now study the harmful effects of underground mining

B. Underground Mining and its Effects

You may recall that underground mining is done to explore the mineral resources which are located deep beneath the surface of earth, so it requires removal of huge chunks of rock materials from beneath the earth while constructing tunnels or shafts to reach the minerals. So there is always a fear

of subsidence of overlying earth into the underground mine. Apart from this, minerals like coal catch fire easily and the fire becomes uncontrollable. Take for example Jharia coal field in Jharkhand, India has been burning for more than a century and about 37 million tonnes of reserves have been lost. Refer to Fig. 12.6 to see the burning coal seams of Jharia. Coal mines also release greenhouse gases like methane.

Underground mining exposes huge amount of rock materials which may release toxic compounds into the air and water. As water takes on harmful concentrations of minerals and heavy metals, it becomes a contaminant.



Fig. 12.6: Jharia Coal Seams burning for about 100 Years.

(Source: https://en.wikipedia.org/wiki/Coal-seam_fire#/media/File:Coal_Mine.jpg, Author: Tripod Stories- AB -, Tripod Stories- AB, CC BY-SA 4.0)

C. Placer Mining and its Effects

As you have read earlier that mercury is used to maximise the extraction of precious metals like gold etc. through placer mining. With the implementation of proper method, mercury can be recovered. However, there is chance of mercury leaking into the water body as well as land and air causing serious health hazards to all living organisms exposed to it. Also since placer mining is done on stream bed through digging, there is always a problem of siltation which threatens the fish habitat and results in their stunted growth and affects their metabolism including reproductive cycles. Placer mining involves moving massive amounts of soil and rock, which can be detrimental to the surrounding wildlife habitat.

Before we proceed further, consider answering an SAQ.

SAQ 3

What are the problems associated with coal mining on landscape and environment?

Now let us study the effects of In-Situ mining method on the landscape and environment.

D. In-Situ Mining and its Effects

You have read earlier that in-situ mining is much better than the conventional surface and underground mining methods as much less rock waste is produced. However, this method causes some detrimental effects on the environment. You may recall that in this case, the mineral is dissolved with the help of strong acids which is actually pumped inside the earth to reach the mineral and dissolve it. These strong acids apart from dissolving the mineral ores dissolve the host rock as well which may contain certain radioactive substances. The fluids remaining after the leaching process commonly contain elevated concentrations of metals and radioactive isotopes and the situation gets hazardous when they penetrate into underground or neighbouring surface water sources.

Let us now recapitulate what we have learnt so far in this unit.

12.5 SUMMARY

In this unit, you have learnt the following:

- Minerals are naturally occurring substances with a definite chemical composition and recognisable physical properties. Minerals are unevenly distributed and non-renewable resources.
- Minerals are classified as metallic and non-metallic mineral based on the presence and absence of metal content in them respectively.
- Metallic minerals are further classified as ferrous and non-ferrous minerals based on the presence and absence of iron content in them respectively.
- Non-Metallic minerals are divided into organic based on the presence of organic content or derivation from organic matter and inorganic minerals based on the absence of organic matter in them.
- There are four types of Mining methods: Surface Mining, Underground mining, Placer mining and in-situ mining
- Surface mining is done to extract minerals that are close to the surface of earth. It is divided into Open pit mining and Strip mining. Open Pit mining involves digging out rocks to form an open pit from which resources are then extracted. Strip mining is mostly used to extract shallow, "bedded" deposits, where a mineral layer is covered by a layer of soft topsoil and weathered rocks.
- Underground mining is sub-surface mining and is used to reach the mineral deposits located deep under the surface of the earth.
- Placer mining is done on riverbeds, sands and environments where there is a natural accumulation of sediments.
- In situ mining is also referred to as 'solution mining' and is considered the most effective form of mining compared to the above methods. It involves pumping chemicals under the ground to dissolve the resource-containing ore in place and then pumping what is known as the "pregnant solution" back up to the surface.
- Mining has an adverse effect on the different spheres on Earth, that is land, water, air and biosphere.

- Different methods of mining are also responsible for damaging landscape and environment and should be studied separately.

12.6 TERMINAL QUESTIONS

1. Explain different mining methods with suitable sketches.
2. Explain briefly the impact of mining on different spheres on earth.
3. What are the harmful effects of different mining methods on landscape and environment? Explain giving examples.

12.7 ANSWERS

Self-Assessment Questions (SAQ)

1. Ferrous- Manganese
Non-Ferrous- Bauxite
Organic- Petroleum
Inorganic- Mica
2. (a) Surface mining is done to extract minerals that are close to the surface of earth while underground mining is done to reach the mineral deposits located deep under the surface of the earth.
(b) Open pit mining involves digging out rocks to form an open pit or borrow pit, from which resources are then extracted while strip mining is done where a mineral layer is covered by a layer of soft topsoil and weathered rocks which is stripped off to uncover the mineral deposit.
(c) Placer mining is done on riverbeds, sands, and environments where there is a natural accumulation of sediments while in-situ mining involves pumping of chemicals under the ground in order to dissolve the resource-containing ore in its place and then pumping the solution containing mineral back up to the surface.
3. Coal mining is done both through surface mining (opencast and strip mining) and through underground mining. So in case of surface mining, it involves removal of vegetation and forests and also generates a lot of rock wastes. Besides there is also a risk of collapse of side walls or water flooding the mines. The rock wastes may contain radioactive materials which may pollute the adjoining land, water or air masses, and have a detrimental effect on living organisms.

In case of underground mining of coal, there is a risk of subsidence of overlying rocks into the mine. Besides this, coal seams catch fire very easily which may be uncontrollable. In this case also rock wastes are generated and toxic materials released may leak into the neighbouring water bodies, soil or air and affect the living organisms inhabiting there.

Terminal Questions

1. First of all define mining and list all the different methods of mining. You can elaborate all the different methods and draw rough sketches as given in the figures. Refer to Section 12.3 of this unit.

2. Just elaborate on the effects of mining on land, air, water, and biodiversity as given in Section 12.4.1 of this unit.
3. Refer to Section 12.4.2 of this unit where the effect of different mining methods on landscape and environment is given separately. You have to answer that way.

12.8 REFERENCES AND FURTHER SUGGESTED READING

- <https://wman-info.org/resource/environmental-impacts-of-mining/>
- <https://www.worldatlas.com/articles/what-is-the-environmental-impact-of-the-mining-industry.html>
- <https://www.oecd.org/env/1830307.pdf>
- <https://web.mit.edu/12.000/www/m2016/finalwebsite/problems/mining.html>
- <https://geographyandyou.com/mining-and-environment/>



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GLOSSARY

Commercial grain farming	: It means just opposite of subsistence farming.
Cropping pattern	: It refers to a farming practice, in which a variety of cropping practices like mono-cropping, double-cropping, multiple-cropping, mixed cropping, relay cropping etc., are practiced over the surface of the Earth in a geographical region.
Ferrous minerals	: Those metallic minerals which have iron content in them.
Inorganic minerals	: Those non-metallic minerals that do not contain any organic matter.
In-situ mining	: It is also referred to as 'solution mining'. It involves pumping chemicals under the ground to dissolve the resource-containing ore in place and then pumping what is known as "pregnant solution" back up to the surface.
Landuse pattern	: It refers to the diverse categories of uses for which a piece of land has been put under like agriculture, residential, mining, industry, transport and other uses etc.
Minerals	: A naturally occurring substance with a definite chemical composition and recognisable physical properties.
Metallic minerals	: Those minerals which contain metal.
Non-ferrous metallic minerals	: Those metallic minerals having no iron content.
Non-metallic minerals	: Minerals which do not contain any metal in it.
Open pit mining	: It involves digging out rocks to form an open pit or borrow pit, from which resources are then extracted.
Organic minerals	: Those non-metallic minerals which contain organic matter.
Placers	: These are actually unconsolidated deposits of resources formed due to weathering via water or wind action.
Placer mining	: It takes place in riverbeds, sands, and environments where there is a natural accumulation of sediments.
Plantation	: It refers to a large-scale farming organised to raise cash crops, a kind of estate owned either by an entrepreneur, enterprise family and corporation, etc. Plantation agriculture is mostly concentrated in the tropics. Recently, a trend towards the organisation of small size plantation estate has also emerged to cater

	to the needs of niche markets and clienteles.
Productivity	: It simply refers to output in relation to any economic activity corresponding to the provided inputs in absolute terms.
Strip mining	: It is mostly used to extract shallow, "bedded" deposits, where a mineral layer is covered by a layer of soft topsoil and weathered rocks.
Subsistence farming	: It refers to a kind of farming, primarily carried out by subsistence level small scale farmers to satisfy the localised consumption and hence not for the purpose of business or trade. It was a kind of norm in the human history characterised by the absence of technological and modern inputs to augment the farm yield, per se.
Surface mining	: It is done to extract minerals that are close to the surface of earth.
Underground mining	: It is sub-surface mining and is used to reach the mineral deposits located deep under the surface of the Earth.
UNFC	: United Nations Framework Classification.