
UNIT 1 AGROBIODIVERSITY: CONCEPT, ORIGIN AND IMPORTANCE

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1.0 INTRODUCTION

Agrobiodiversity refers to the variety and variability of living organisms that contribute to food production systems and associated activities. Agrobiodiversity in its widest interpretation includes biodiversity of cropped areas as well as that of outside the farm boundaries which are beneficial for agriculture and which play a role in the regulation of ecosystem functions. Human civilization has been founded on the services provided by agrobiodiversity, the most obvious of which is the production of foods, fuels and fibres in agricultural landscapes. Such services have been and continue to be the basis for economic development for a large proportion of the human population.

We have already discussed about biodiversity and its importance in the Block 1 of this course. In the present unit we have given an overview of the concept of agrobiodiversity. While describing the scope or components of agrobiodiversity, the unit also explains the various aspects of its importance. Implications of agrobiodiversity for sustainability of agriculture and climate change have particularly been emphasized. While the present unit covers introductory aspects of agrobiodiversity, details about depletion, management and ongoing issues related to agrobiodiversity have been covered in Unit-2, Unit-3 and Unit 4 of this block respectively.

1.1 OBJECTIVES

After reading this unit, you will be able to:

- explain the concept and scope of agrobiodiversity.
- describe the importance of agrobiodiversity.
- discuss the implication of agrobiodiversity on climate change and sustainability of agriculture.

1.2 THE CONCEPT OF AGROBIODIVERSITY

Agrobiodiversity is a shortened form of agricultural biodiversity. Agrobiodiversity refers to the variety and variability of living organisms that contribute to food production, agriculture and associated activities in their largest sense. The fifth conference of parties to the Convention on Biological Diversity decided on the following definition: “the term agricultural biological diversity refers to, in a general fashion, all of the elements constituting biological diversity which relate to food production and agriculture, as well as all of the components of biological diversity which constitute the agroecosystem: the variety and variability of animals, plants, microorganisms, at the genetic, specific and ecosystem levels, necessary for the maintenance of the key functions of the agroecosystem, its structures and its processes”.

Agricultural biodiversity is a vital sub set of biodiversity. It is a use of life, i.e. ancillary biotechnologies, by mankind whose food and livelihood security depend on the sustained management of those diverse biological resources that are important for food and agriculture. Although the term agricultural biodiversity is relatively new as it has come into wide use in recent years, the concept itself is quite old. It is the result of the careful selection and inventive developments of farmers, livestock breeders, forest workers, fishermen and indigenous peoples throughout the world over millennia. In fact, agrobiodiversity is the result of the interaction between the environment, genetic resources and management systems and practices used by culturally diverse people. Thus, it encompasses the variety and variability of animals, plants and micro organisms that are necessary for sustaining key functions of the agroecosystem, including its structure and processes for, and in support of, food production and food security. Local knowledge and culture can therefore be considered as integral parts of agrobiodiversity, because it is the human activity of agriculture that shapes and conserves this biodiversity.

You should know that biodiversity is the basis for agricultural production. On one hand, it is the origin of all crops and domestic livestock and the variety within them. On the other hand, components of wild biodiversity in agricultural and associated landscapes provide and maintain ecosystem services that are essential to agricultural production (e.g. pollination). Similarly, on one hand agricultural biodiversity is the result of human activities and management; on the other hand human life is dependent on it for the immediate provision of food and other natural resources based goods, as well as for the maintenance of areas of land and waters that will sustain production and maintain agroecosystems and the wider biological and environmental services.

In the face of global environmental changes, there is growing need for scientific knowledge on the role of agrobiodiversity and human well-being. Worldwide

there is consensus among scientists that conservation and sustainable use of the diversity of cultivated plants and domestic animal breeds is the key to the attainment of Millennium Development Goals declared by UN.

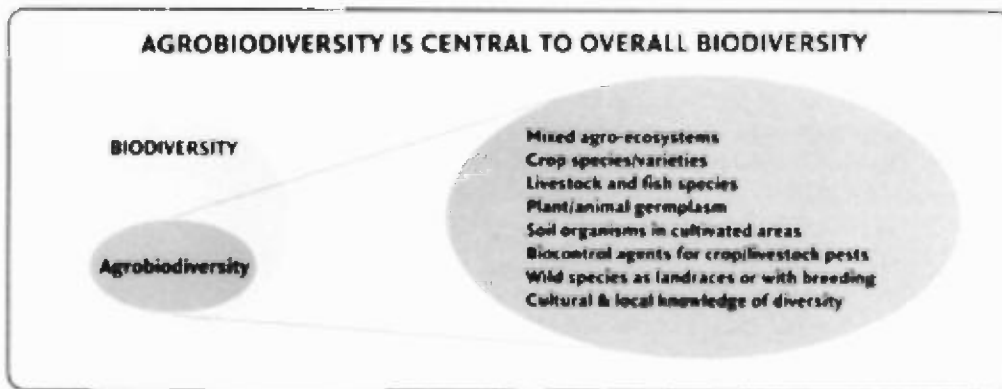


Fig. 1.1: Agrobiodiversity: A subset of biodiversity

1.3 SCOPE OF AGROBIODIVERSITY

Agrobiodiversity is a subset of general biodiversity. It further comprises genetic, population, species, community, ecosystem, and landscape components and human interactions with all these. Agrobiodiversity, in its widest interpretation includes biodiversity of cropped areas as well as that of outside the farm boundaries which are beneficial for agriculture and which play a role in the regulation of ecosystem functions. A distinction can be made between the planned or controlled biodiversity and the associated biodiversity. Planned agrobiodiversity is the crops and animal husbandry systems chosen by the farmer, while the associated biodiversity refers to organisms (soil fauna, weeds etc.) which colonise the agroecosystem without human support.

Planned biodiversity or harvested species include domesticated crop species (e.g., cereal, pulses, vegetables, fruits, spices etc.), wild relatives of crops, including woodland and aquatic plants (used for food and other natural resources based products etc.), domestic and wild animals (used for food, fibre, milk, hides, furs, power, organic fertilizer etc.), fish and other aquatic animals.

Associated agrobiodiversity or non-harvested species includes two categories. First category includes non-harvested species within production agroecosystems that perform supporting or regulating functions in agroecosystems. For example, it includes diversity of soil organisms, pollinators and pest predators. These play very important role in soil nutrient turnover, soil organic matter dynamics, pollination, biological pest control etc. Second category includes non-harvested species in the wider environment that support food production agroecosystems including species that are present in field margins, surrounding forest, rangeland, and aquatic ecosystem. For example, leaf litter produced by forest tree species add to soil fertility of agricultural fields: hence such forest trees can be included under agrobiodiversity.

In conventional studies on agrobiodiversity, major attention is given to cultivated varieties and to crop wild relatives. Cultivated varieties can be broadly classified into “modern varieties” and “farmers’ or traditional varieties”. Modern varieties are the outcome of formal breeding programmes and are often characterised as

'high yielding'. The short straw wheat and rice varieties of the Green Revolution are examples of modern varieties. In contrast, farmer's varieties (also known as landraces) are the product of breeding and selection carried out by farmers over the generations. Together, these varieties represent high levels of genetic diversity and are therefore the focus of most crop genetic resources conservation efforts. Aquatic diversity is also an important component of agricultural biodiversity. Fresh water fish, marine fish, prawn-fish and many aquatic plants provide much of the food supply as well as substantial income to the communities living in coastal areas or near water bodies.

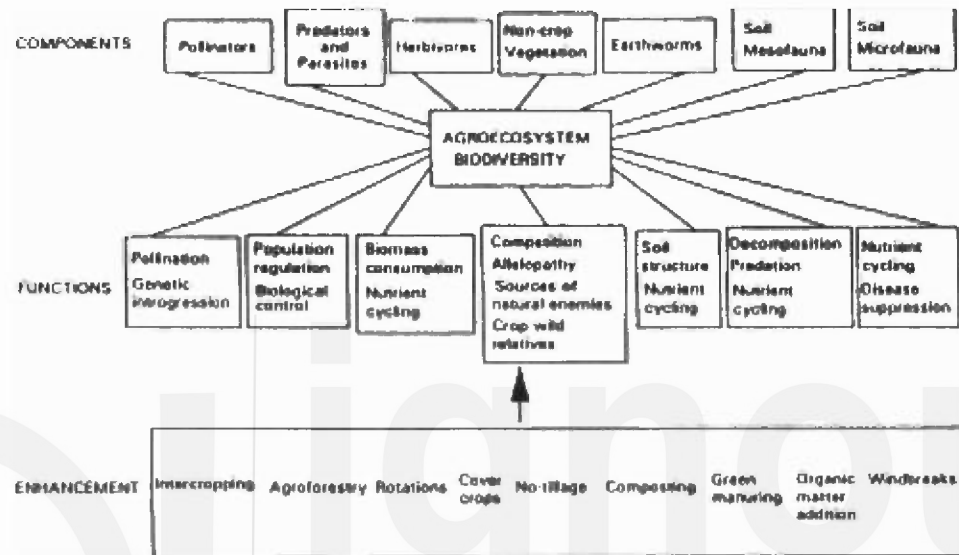


Fig.1.2: The components, functions, and enhancement strategies of biodiversity in agroecosystems (Altieri, 1994).

1.4 DISTINCTIVE FEATURES OF AGROBIODIVERSITY

We know now that agrobiodiversity is a subset of biodiversity. As discussed easiest that while general biodiversity includes diversity of all life forms, agrobiodiversity refers to the diversity that relate to food production and agriculture, as well as all of the components of biological diversity which constitute the agroecosystem. General biodiversity is represented by about 1.8 million species of plants and animals on the earth. This is the number of species that have been described till date. Agrobiodiversity, on the other hand, is represented by about 40,000 species of plants and animals. These species are used by human society for different purposes in different parts of the world.

According to FAO (1999) the agrobiodiversity is defined as the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems.

There are several distinctive features of agrobiodiversity that makes it different from other components of general biodiversity. Some of these features are described as below:

- While the evolution of general biodiversity is a natural process, that of agrobiodiversity is largely facilitated by human intervention in form of farming, breeding and selection of different crops. Many components of agrobiodiversity would not survive without such human interference.
- Many economically important agricultural systems are based on 'alien' crop or livestock species introduced from elsewhere for example, horticultural production systems or Friesian cows in Africa. This creates a high degree of interdependence between countries for the genetic resources on which our food systems are based.
- While the general biodiversity is often described at the level of species, agrobiodiversity is generally described at both the levels: genetic diversity (or diversity within species) as well as species diversity.
- Conservation of agrobiodiversity is inherently linked to its sustainable use in agroecosystems and has close relationship with livelihood of farmers' community. Local knowledge and culture are integral parts of agrobiodiversity management.
- Preservation through establishing protected areas is less relevant for agrobiodiversity. In industrial type agricultural systems, however, much of the crop diversity is now held *ex situ* in gene banks or breeders' materials rather than on farm.

1.5 CENTRES OF ORIGIN OF CULTIVATED PLANTS

Agrobiodiversity is the outcome of thousands of years of effort by farmers' communities. Selection and breeding created species, breeds and varieties that are adapted optimally to the conditions in their regions of origin and best match the needs of their breeders. The origin of crop plants is now basic to plant breeding in order to locate wild relatives, related species, and new genes (especially dominant genes, sources of disease resistance). Knowledge of the origins of crop plants is vitally important in order to avoid genetic erosion due to the loss of germplasm as well as loss of habitat. Germplasm preservation is accomplished through gene banks and preservation of natural habitats (especially in centers of origin).

There are eight centres of origin of agrobiodiversity which are known as Vavilov's centres of origin of cultivated plants. They were first described by Dr. Nikolai Ivanovich Vavilov. All the crop varieties used at present originated from one of these centres. These areas continue to be home to the largest pool of agricultural biodiversity. A glimpse of the centers of origin of major crops shows that no country is self-sufficient in crop genetic resources and there is high degree of inter-dependency across the world. For example, nearly half of India's main crops have been introduced from abroad. Same is the case with other nations.

Brief descriptions of these centres along with sequence of centres and subcentres and names of crop varieties that originated there are given below. These centres have also been depicted in the given world map according to the sequence code described in the text.



Fig.1.3: World map showing location of eight centres of origin of cultivated plants

Source: http://en.wikipedia.org/wiki/Center_of_origin

1) South Mexican and Central American Center

Includes southern sections of Mexico, Guatemala, Honduras and Costa Rica.

- Grains and Legumes: maize, common bean, lima bean, tepary bean, jack bean, grain amaranth
- Melon Plants: malabar gourd, winter pumpkin, chayote
- Fiber Plants: upland cotton, bourbon cotton, henequen (sisal)
- Miscellaneous: sweetpotato, arrowroot, pepper, papaya, guava, cashew, wild black cherry, chochenial, cherry tomato, cacao

2) South American Center

62 plants listed; three subcenters

2) Peruvian, Ecuadorean, Bolivian Center:

- Root Tubers: Andean potato, Other endemic cultivated potato species. Fourteen or more species with chromosome numbers varying from 24 to 60, Edible nasturtium
- Grains and Legumes: starchy maize, lima bean, common bean
- Root Tubers: edible canna, potato
- Vegetable Crops: pepino, tomato, ground cherry, pumpkin, pepper
- Fiber Plants: Egyptian cotton
- Fruit and Miscellaneous: cocoa, passion flower, guava, heilborn, quinine tree, tobacco

2A) Chiloe Center (Island near the coast of southern Chile)

- Common potato(48 chromosomes), strawberry.

2B) Brazilian-Paraguayan Center

- manioc, peanut, rubber tree, pineapple, Brazil nut, cashew, purple granadilla.

3) Mediterranean Center

Includes the borders of the Mediterranean Sea. 84 listed plants.

- Cereals and Legumes: durum wheat, emmer, Polish wheat, spelt, Mediterranean oats, sand oats, canarygrass, grass pea, pea, lupine.
- Forage Plants: Egyptian clover, white clover, crimson clover, serradella
- Oil and Fiber Plants: flax, rape, black mustard, olive.
- Vegetables: garden beet, cabbage, turnip, lettuce, asparagus, celery, chicory, parsnip, rhubarb.
- Ethereal Oil and Spice Plants: caraway, anise, thyme, peppermint, sage, hop.

4) Middle East

Includes interior of Asia Minor, all of Transcaucasia, Iran, and the highlands of Turkmenistan. 83 species.

- Grains and Legumes: einkorn wheat, durum wheat, poulard wheat, common wheat, oriental wheat, Persian wheat, two-row barley, rye, Mediterranean oats, common oats, lentil, lupine.
- Forage Plants: alfalfa, Persian clover, fenugreek, vetch, hairy vetch.
- Fruits: fig, pomegranate, apple, pear, quince, cherry, hawthorn.

5) Ethiopia

Includes Abyssinia, Eritrea, and part of Somaliland. 38 species listed; rich in wheat and barley.

- Grains and Legumes: Abyssinian hard wheat, poulard wheat, emmer, Polish wheat, barley, grain sorghum, pearl millet, African millet, cowpea, flax, teff.
- Miscellaneous: sesame, castor bean, garden cress, coffee, okra, myrrh, indigo.

6) Central Asiatic Center

Includes Northwest India (Punjab, Northwest Frontier Provinces and Kashmir), Afghanistan, Tadjikistan, Uzbekistan, and western Tian-Shan. 43 plants.

- Grains and Legumes: common wheat, club wheat, shot wheat, peas, lentil, horse bean, chickpea, mung bean, mustard, flax, sesame.
- Fiber Plants: hemp, cotton.
- Vegetables: onion, garlic, spinach, carrot.
- Fruits: pistacio, pear, almond, grape, apple.

7) Indian Center

Two subcenters.

7) ***Indo-Burma***: Main Center (Hindustan): Includes Assam and Burma, but not Northwest India, Punjab, nor Northwest Frontier Provinces, 117 plants.

- Cereals and Legumes: rice, chickpea, pigeon pea, urd bean, mung bean, rice bean, cowpea.
- Vegetables and Tubers: eggplant, cucumber, radish, taro, yam.
- Fruits: mango, orange, tangerine, citron, tamarind.
- Sugar, Oil, and Fiber Plants: sugar cane, coconut palm, sesame, safflower, tree cotton, oriental cotton, jute, crotalaria, kenaf.
- Spices, Stimulants, Dyes, and Miscellaneous: hemp, black pepper, gum arabic, sandalwood, indigo, cinnamon tree, croton, bamboo.

7A) ***Siam-Malaya-Java***: statt Indo-Malayan Center: Includes Indo-China and the Malay Archipelago, 55 plants.

- Cereals and Legumes: Job's tears, velvet bean.
- Fruits: pummelo, banana, breadfruit, mangosteen.
- Oil, Sugar, Spice, and Fiber Plants: candlenut, coconut palm, sugarcane, clove, nutmeg, black pepper, manila hemp.

8) Chinese Center

A total of 136 endemic plants are listed in the largest independent center.

- Cereals and Legumes: e.g. broomcorn millet, Italian millet, Japanese barnyard millet, Koaliang, buckwheat, hull-less barley, soybean, Adzuki bean, velvet bean.
- Roots, Tubers, and Vegetables: e.g. Chinese yam, radish, Chinese cabbage, onion, cucumber.
- Fruits and Nuts: e.g. pear, Chinese apple, peach, apricot, cherry, walnut, litchi.
- Sugar, Drug, and Fiber Plants: e.g. sugar cane, opium poppy, ginseng camphor, hemp.

1.6 ANIMAL GENETIC DIVERSITY

Livestock or animal genetic diversity constitutes the vital part of agrobiodiversity. The 40-plus livestock species contributing to today's agriculture and food production are shaped by a long history of domestication and development. Selection pressures resulting from environmental stress factors, and the controlled breeding and husbandry imposed by humans, have combined to produce a great variety of genetically distinct breeds. This diversity, developed over thousands of years, is a valuable resource for today's livestock keepers. Genetically diverse livestock populations provide a greater range of options for meeting future challenges, whether associated with environmental change, emerging disease threats, new knowledge of human nutritional requirements, fluctuating market conditions or changing societal needs.

The State of the World's Animal Genetic Resources for Food and Agriculture is the first global assessment of livestock biodiversity. Drawing on 169 Country Reports, contributions from a number of international organizations and twelve specially commissioned thematic studies, it presents an analysis of the state of agricultural biodiversity in the livestock sector; origins and development, uses and values, distribution and exchange, risk status and threats and of capacity to manage these resources institutions, policies and legal frameworks, structured breeding activities and conservation programmes.

Thousands of years of animal husbandry and controlled breeding, combined with the effects of natural selection, have given rise to great genetic diversity among the world's livestock populations. High output animals intensively bred to supply uniform products under controlled management conditions coexist with the multipurpose breeds kept by small scale farmers and herders mainly in low external input production systems.

Effective management of animal genetic diversity is essential to global food security, sustainable development and the livelihoods of hundreds of millions of people. The livestock sector and the international community are facing many challenges. The rapidly rising demand for livestock products in many parts of the developing world, emerging animal diseases, climate change and global targets such as the Millennium Development Goals need to be urgently addressed. Many breeds have unique characteristics or combinations of characteristics i.g. disease resistance, tolerance of climatic extremes or supply of specialized products that could contribute to meeting these challenges. However, evidence suggests that there is ongoing and probably accelerating erosion of the genetic resource base.

1.7 THE ROLE OF AGROBIODIVERSITY

Over millennia, human well being has been founded on the services that biodiversity provides, the most obvious of which is the production of foods, fuels and fibres in agricultural landscapes. Such services have been and continue to be the basis for economic development for a large proportion of the human population. In a wider context, biodiversity in agricultural landscapes serves critical functions that enhance the environmental base upon which agriculture depends. These functions include regulating and supporting services such as water purification, nutrient cycling, and soil formation.

Experience and research have shown that agrobiodiversity can:

- Increase productivity, food security, and economic returns
- Reduce the pressure of agriculture on fragile areas, forests and endangered species
- Make farming systems more stable, robust, and sustainable
- Contribute to sound pest and disease management
- Conserve soil and increase natural soil fertility and health
- Contribute to sustainable intensification of agriculture
- Diversify products and income opportunities
- Reduce or spread risks to individuals and nations

- Help maximize effective use of resources and the environment
- Reduce dependency on external inputs
- Improve human nutrition and provide sources of medicines and vitamins, and
- Conserve ecosystem structure and stability of species diversity.

1.8 AGROBIODIVERSITY AND FOOD SECURITY

FAO (2005) estimated that at least 852 million people worldwide suffer from hunger and malnutrition; 80% of them live in rural areas. Tackling hunger has for many years been one of the issues at the heart of international cooperation. Eradicating extreme poverty and hunger by achieving food security is one of the eight Millennium Development Goals.

As per the World Food Summit of 1996 in Rome “Food security is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”. There are three core determinants of food security: availability, access and utilization. Availability involves the production of a sufficient quantity of food that is available at the right time and in the right place. Access concerns the demand side, in particular the problems of people who cannot buy enough food even if it is available. Utilization involves the correct storage, processing and combination of foods.

Humans use at least 40,000 species of plants and animals. People around the world depend on these species for their food, shelter, clothing and energy requirement. Food is obtained from various food crops and animal species. Genetic resources are particularly relevant for food sector. There are several thousand species of edible plants, but only 20 kinds of plants are cultivated to produce about 80% of world’s food. The three major crops wheat, rice and maize contribute about two third of total food production. There is enormous untapped potential for increasing the range of food products suitable for human consumption.

Higher yields of major food crops achieved through the “Green Revolution” have contributed to food security in many countries. But even where “high-tech agriculture” predominates, greater species diversity could in the long term help to develop new products, stabilize yields and optimize the utilization of resources such as fertilizers or water for irrigation. Regions such as deserts or mountainous areas that are disadvantaged by their natural situation have seen very little rise in yields over recent decades. It is in these very areas that local plant species and animal breeds are often advantageous, since they are optimally adapted to the local conditions. Together with traditional knowledge and practices, they help farmers make the best use of limited resources.

Filling one’s belly is often not enough. People who live on the brink of poverty often lack a varied diet. Yet the appropriate use and combination of foods can contribute to long-term health, particularly among children. Leafy vegetables, fruits, legumes, roots, tubers, spices, and herbs are essential for human nutrition and complement staple crops such as rice or maize. Many leguminous crops, such as cowpea and winged bean, are excellent sources of protein and

m micronutrients. Home gardens often accommodate a particularly rich diversity of crops. As home gardens are usually run by women, most of the production is directly used for cooking, benefiting all the family. The establishment and appropriate support of home gardens is therefore a promising option for improving the nutritional status of poor people both in rural and periurban areas. They also serve to raise awareness of the importance of the diversity of traditional food plants.

1.9 IMPORTANCE OF WILD VARIETIES AND SPECIES

The reservoir of genetic traits present in wild varieties and traditionally grown landraces is extremely important in improving crop performance. Important crops, such as the potato, banana and coffee, are often derived from only a few genetic strains. Improvements in crop species over the last two centuries have been largely due to harnessing genes from wild varieties and species. Interbreeding crop strains with different beneficial traits has resulted in more than doubling crop production in the last 50 years as a result of the Green Revolution.

Wild plants serve as supplement to human food in many parts of the world. This greatly helps to reduce human pressure on agriculture, particularly in the region where agricultural production is challenged by many constraints like population, land degradation etc. For example, throughout the West African Sahel, rural women carefully collect the fruit, leaves and roots of native plants for use in the families' diet. These supplement the agricultural grains (millet, sorghum) that provide only one part of the nutritional spectrum and may fail in any given year. More than 800 species of edible wild plants have been catalogued across the world. In addition to supplying calories and protein, wild foods supply vitamins and other essential micro-nutrients. However, in some areas, pressure on the land is so great that wild food supplies have been exhausted. The term 'wild-food' is used to describe all plant resources that are harvested or collected for human consumption outside agricultural areas in forests, savannah and other bush land areas. For instance, fruits and berries, from a wide range of wild growing plants, are typically referred to as 'wild-food'.

1.10 AGROBIODIVERSITY AND LIVELIHOOD OF FARMERS

Many farmers, especially those living in environments where high-yield crop and livestock varieties do not prosper, rely on a wide range of crop and livestock types. This helps them maintain their livelihood in the face of pathogen infestation, uncertain rainfall and fluctuation in the price of cash crops, socio-political disruption and the unpredictable availability of agro-chemicals. So called minor or underutilized crops or companion crop are frequently found next to the main staple or cash crops. They often grow these minor crops along with the major crops. Their importance is, however, often misjudged. In many cases, from a livelihoods perspective, they are not minor or underutilized as they can play a disproportionately important role in food production systems at the local level. Plants that will grow in infertile or eroded soils, and livestock that will eat degraded vegetation, are often crucial to household nutritional strategies. In

addition, rural communities, and the urban markets with which they trade, make great use of these companion crop species.

Fallow fields and wild lands can support large numbers of species useful to farmers. In general, poor households rely on access to wild foods more than the wealthier. Wild foods are incorporated into the normal livelihood strategies of many rural people, pastoralists, shifting cultivators, continuous croppers or hunter-gatherers. Wild food is usually considered as a dietary supplement to farmers' daily food consumption, generally based on their crop harvest, domestic livestock products and food purchases on local markets.

One of the causes of food insecurity is chronic or temporary shortage of money. Even if food is available in sufficient quantity and quality, not everyone has the resources to buy it. Improving the income situation of such people is an essential part of improving food security. Special, often little known plant varieties and livestock breeds offer potential for income generation. This may involve processing to food, medicines, cosmetics and craft products, or developing new markets and market niches for such products. The organic and fair trade markets provide potential for long-term initiatives in these areas.

Check Your Progress 1

Note: a) Use the space given below for your answer.

b) Compare your answers with those given at the end of the unit.

1) How does agrobiodiversity differ from general biodiversity?

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2) How is agrobiodiversity related to livelihood of smallholder farmers?

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1.11 AGROBIODIVERSITY AND ECOSYSTEM SERVICES

In general, the Millennium Ecosystem Assessment (MA) aimed to promote understanding of the value of biodiversity to human society, and conversely costs associated with actual and projected biodiversity losses. In addition to an inventory of global biodiversity, this international assessment implemented and widely publicized the concept of ecosystem services. The report also provided a general

methodology to quantify the consequences of changes in biodiversity on ecosystems and on different components of human well-being.

Goods and services provided by biodiversity are numerous in number and there are several ways in which they can be studied. As stated in the block of this course, the Millennium Ecosystem Assessment, undertaken under CBD framework, identified 24 ecosystem services that are directly or indirectly related to biodiversity and that make a direct contribution to human well-being. We know from previous section that the Assessment was intended to examine the changing status of these services so as to devise conservation strategy for future. We know that these 24 goods and services can be described in four categories: goods, cultural services, regulating services and supporting services. Besides these there are some unknown benefits from biodiversity.

In the context of agrobiodiversity, these services have further been redistributed into three categories which signify different aspect of food production system:

- First category includes sustainable production of food and other agricultural products emphasizing both strengthening sustainability in production systems at all levels of intensity and improving the conservation, sustainable use and enhancement of the diversity of all genetic resources for food and agriculture, especially plant and animal genetic resources, in all types of production systems
- Second category includes biological or life support to production emphasizing conservation, sustainable use and enhancement of the biological resources that support sustainable production systems, particularly soil biota, pollinators and predators.
- Third category includes ecological and social services provided by agro-ecosystems such as landscape and wildlife protection, soil protection and health (fertility, structure and function), water cycle and water quality, air quality, CO₂ sequestration, etc.

1.12 AGROBIODIVERSITY AND CLIMATE CHANGE

The implications of climate change for agriculture have opened a new window in the discussion of agrobiodiversity. Environmental change is one of many factors that are responsible for reducing the diversity of crops and livestock. Five climate change related factors can be identified: the rise in temperatures, changes in precipitation patterns, the rise of sea levels, higher incidence of extreme weather events and the increase of greenhouse gases, especially carbon dioxide in the atmosphere. The rise in temperature commonly known as global warming, is probably the most obvious phenomenon of climate change. It is expected that the increases will be highest in the tropics and subtropics, and there will be large-scale extinction of species, lower agricultural yields and a major change in cropping systems. Indirect temperature effects will also be significant, including the increased evaporation of water from the soil, the accelerated decomposition of organic matter, and the increased incidence of pests and diseases affecting both animals and plants.

Dramatic implications are expected for agriculture and food supply, although with large regional differences. It is predicted that the 40 poorest countries, located

predominantly in tropical Africa and Latin America, may lose 10 - 20 percent of their grain growing capacity due to drought by 2080. It is also argued that many rain fed crops in some areas are already near their maximum temperature tolerance, and their yield may fall sharply with a further temperature rise. By contrast, yield increases are expected in temperate regions; a country like China could experience a 25 percent rise in production. Tragically, these changes are likely to hit the world's poorest people hardest.

Combating such changes requires a two pronged strategy of mitigation and adaptation. On the one hand all possible efforts must be made to reduce greenhouse gas emissions and to slow climate change. On the other, fast and appropriate action is needed to enhance capacity to adapt to irreversible changes already inherent in the system but not yet fully visible. Agrobiodiversity provides potential option to combat against the challenges posed by climate change. Agricultural genetic resources are not only a victim of climate change; they are of fundamental importance for adaptation to this change and are crucial to coping with the problems it poses. There are a number of plants and animals which presently have no economic value, but these can cope with the changing climatic situation.

However, climate change requires not only that genetic resources should be conserved, but also that they should adapt to climate change. Plants, animals and ecosystems have the capacity to adjust to changes in factors such as heat, drought or salinity, and this enables us to cope with the consequences of changing environments. This capacity is an outcome of genetic diversity. Adaptation is a dynamic process brought about through an organism's interaction with its environment. It is not a matter of, for example, deep freezing a drought resistant strain of millet for many decades in a gene bank, but rather of continuing to grow and breed the seeds in the fields, where they are exposed to a wide range of agricultural and ecological conditions. The resistance of plants to environmental stress (e.g. drought tolerance) is a multigenetic characteristic. It is difficult to achieve through genetic engineering and best developed through classical breeding under *in situ* conditions.

The social dimension of these adaptive processes is no less important. The poor sectors of the population, in particular, must be enabled to adapt to changing environmental conditions; traditional knowledge and social organization must be strengthened and developed. Climate change induced environmental stress may in fact exceed the adaptive capacity of animals and plants to cope with it. Nevertheless, the *in situ* approach offers a genuine chance to shape a future worth living.

1.13 AGROBIODIVERSITY FOR SUSTAINABILITY OF AGRICULTURE

For more than 10,000 years, farmers have been selecting plants to develop varieties that produce higher yields, are less susceptible to diseases, and that show a certain degree of uniformity in germination and ripening, which makes harvesting easier. Through this selection of crop plants and by cultivating them under various, in some cases harsh environmental conditions, over the millennia a rich diversity of agricultural crop species has developed. In India, for instance, until a few decades ago up to 30,000 rice cultivars were grown.

During the past 150 years this trend has reversed. The biological diversity of crop plants has since been dwindling. Fewer and fewer species are being used for agriculture, and no more than three of them (rice, maize and wheat) supply 60 percent of the world's food. Not only are fewer and fewer plant species used for agriculture, but genetic diversity within species is also declining. Plant breeding and commercial seed production have contributed substantially to the reduction of genetic diversity within individual species. The number of varieties of any given crop is constantly decreasing and the varieties are becoming increasingly uniform, while certain characteristics are being lost during the process. In view of the necessity of adapting to climate change and of ensuring global food security, this "genetic erosion" threatens the existence of the global population. In order to meet these and future challenges, some of which are still unknown, humanity needs whatever genetic diversity still exists. At the same time, conservation of biological diversity must be reconciled with agricultural intensification.

In the 50 years from 1950 to 2000, global grain production almost tripled. This increase was mainly made possible through progress in plant breeding, intensive nitrogen fertilisation and effective herbicides for weed control. This productivity increase, however, was mainly achieved on fertile soils, under optimal growing conditions, and only a small percentage of farmers benefited. A large proportion of all farms are still smallholdings. These mostly involve no external inputs such as fertilizer and pesticides, because the classic intensification strategies are not suitable for such farms. In the 1980s, around 60 percent of all agricultural land was still being farmed in this manner. Even though this figure is probably smaller today, traditional agriculture still contributes substantially to world food production and is fundamental to food security.

In order to feed the increasing world population, further agricultural intensification is required. The world population is expected to grow to approximately 9 billion people by 2050. The potential to expand agricultural land to feed this population, however, is very limited. In order for intensification to be sustainable, agriculture must start using nutrients and energy more efficiently, it must sustain ecosystems and their functions while conserving biodiversity and it has to be climate-friendly. One possibility for increasing the yield potential of traditionally farmed lands is increasing on-farm species diversity. But crops and their varieties that are expected to produce higher yields on poorer sites must have traits different to the high yielding varieties used on agriculturally favourable sites.

The search for alternatives started 50 years ago and led to today's method of evolutionary plant breeding. In order to generate new varieties,, breeders systematically utilize farmers' local varieties that are genetically diverse and have adapted ecologically. This involves bringing together seed from different origins and recombining them through crossbreeding. Evolutionary breeding with composite crossbred populations is a very promising method for agricultural intensification, particularly under ecologically disadvantageous conditions, and for adapting crops to climate change-induced environmental changes. Participatory plant breeding is one good approach to ensure agrobiodiversity conservation as well as agricultural sustainability. In contrast to classical approaches, breeding is not done by breeders alone, nor does it take place only in experimental fields or in laboratories. Farmers are involved throughout the entire breeding process and most of the breeding takes place in their fields. This helps

to ensure better ecological adaptability of the crops towards the conditions of farmers' field.

Check Your Progress 2

Note: a) Use the space given below for your answer.

b) Compare your answers with those given at the end of the unit.

1) How is agrobiodiversity related to global climate change?

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2) How does agrobiodiversity contribute in sustainability of agriculture?

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1.14 LET US SUM UP

- Agrobiodiversity refers to the variety and variability of living organisms that contribute to food production systems and associated activities.
- Agrobiodiversity is the result of the careful selection and inventive developments of farmers, livestock breeders, forest workers, fishermen and indigenous peoples throughout the world over millennia.
- The 40-plus livestock species contributing to today's agriculture and food production are shaped by a long history of domestication and development.
- Agrobiodiversity provides means of livelihood to small holder farmers across the world particularly to those who are living in harsh environment or less industrialized regions.
- As per Millennium Ecosystem Assessment identified and assessed 24 ecosystem goods and services associated to biodiversity.
- Climate change may lead to erosion of several crop varieties. A number of crop varieties will be able to cope up with changing climate.
- Agrobiodiversity helps to maintain essential ecosystem functions. It helps agroecosystems to cope up with uncertainties posed by climate change, market risks and socio-economic disruption.

1.15 KEY WORDS

Agroecosystems	: Ecosystems represented by agriculture or similar food production system
Varieties	: Taxonomic units represented by genetic variation within a species
Planned Biodiversity	: Species or varieties of crops, or breeds of animals which perform certain production function
Associated Agrobiodiversity	: Agrobiodiversity other than planned biodiversity that performs supporting or regulatory functions in agroecosystems
Smallholder Farmers	: Farmers with small landholdings and belonging to low or middle income group
Malnutrition	: Health disorders caused by consumption of food which lack one or more ingredients of balanced diet like protein, vitamins etc.
Genetic Erosion	: Loss of genetic diversity within a species.

1.16 REFERENCES AND SUGGESTED FURTHER READINGS

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Relevant Websites:

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- <http://en.wikipedia.org/wiki/Agrobiodiversity>
- <http://www.cbd.int/agro/>
- <http://www.icar.org.in/node/1333>
- <http://www.agrobiodiversity-diversitas.org/>
- <http://agrobiodiversityplatform.org/>
- <http://www.fao.org/biodiversity/en/>

1.17 KEY TO CHECK YOUR PROGRESS

Check Your Progress 1

- 1) Your answer must include the following points:
 - Agrobiodiversity include biodiversity that is related to agroecosystems
 - Unlike general biodiversity, human intervention has been the integral part of agrobiodiversity
- 2) Your answer must include the following points:
 - Several indigenous crops are particularly grown by smallholder farmers and these are source of income
 - Agrobiodiversity helps farmers to maintain their livelihood in the face of ecological, climatic and socio-economic uncertainties

Check Your Progress 2

- 1) Your answer must include the following points:
 - Climate change may lead to erosion of several crop varieties
 - A number of crop varieties will be able to cope up with changing climate
- 2) Your answer must include the following points:
 - Agrobiodiversity helps to maintain essential ecosystem functions
 - It helps agroecosystems to cope up with uncertainties posed by climate change, market risks and socio-economic disruption