UNIT 4 PROMOTING GENETIC DIVERSITY: CHALLENGES AND OPPORTUNITIES

Structure

4.0 INTRODUCTION

Today's development and agriculture policies confront a difficult challenge to meet the demands of over 6.5 billion people around the world which is projected to grow to 9-10 billion by 2050. This implies that in order to meet the increased demand for food and fibre, more land would be converted to agriculture, and agricultural intensification would continue. This process is placing growing pressure on agricultural landscapes, thereby leading to unprecedented loss of agrobiodiversity and its services. The continued integration of international agricultural markets and the pressure from the agribusiness sector to shape agricultural landscapes into a more simplified and apparently manageable sector are also emerging as potential threat to agrobiodiversity. Associated to these challenges, there are opportunities which have potential to manage rich agrobiodiversity in agroecosystems. Recognition of traditional knowledge, participation of farmers in crop breeding programs, provision of gender sensitive policies and adoption of modern innovations are some of the potential options.

The present unit makes an attempt to analyze the implications of current global pattern of development on agrobiodiversity. While the previous three Units of the block have given a systematic account of introduction, depletion and conservation of agrobiodiversity, the present unit tries to analyze the complex socio-economic issues and identifies major challenges and opportunities which have potential role to decide the future scenario of agrobiodiversity. The main focus of the unit, however, remains to explore the alternative ways towards sustainable management of agrobiodiversity.

4.1 OBJECTIVES

After reading this unit, you will be able to:

- describe the implication of economic development on agrobiodiversity;
- explain the impact of genetically engineered crops on agrobiodiversity; and
- recognize the significance of women, traditional knowledge and participatory breeding for agrobiodiversity conservation.

4.2 CURRENT PATTERN OF ECONOMIC DEVELOPMENT AND AGROBIODIVERSITY

Present human society is living in the age of rapid ecological, social and economic changes, and the pace of this change will accelerate during the next several decades. The world's population of 6.5 billion people is projected to grow to 7.5 billion by the year 2020 and to 9-10 billion by 2050. By 2050, food consumption must double to meet human needs. To meet this increasing demand for food and fibre, production systems are expected to become increasingly dependent on inputs of fertilizers, pesticides and water and this imply that more land would be converted to agriculture, and agricultural intensification would continue. Irrigated lands will likely to increase by 1.9 fold by 2050. Pasture lands are also increasing, with an expected doubling in area by 2050. In 50 years, global agricultural land area is projected to increase by 18%, with a loss of 10^9 hectares of natural ecosystems.

This process is placing growing pressure on agricultural landscapes, thereby promoting species extinction in managed and constricted wild land habitats. Abandonment of already degraded fragile lands and agricultural encroachment on forest margins would most likely increase, with further loss of agrobiodiversity and its services. Added to this is the continued integration of international agricultural markets and pressure from the agribusiness sector to shape agricultural landscapes to a more simplified and thus apparently manageable sector, at an ever accelerating pace, especially in developing countries.

Simplifying agrobiodiversity translates in to disinvesting in natural capital and thus increasing the risks of already volatile agricultural commodity markets. Industrial countries with a highly developed financial sector may be able to substitute natural for financial capital to some extent. By contrast, in developing economies, when such financial markets exist, they are often rudimentary and incapable of insuring farmers against 'simplifying' choices. Managing a portfolio of capital without proper insurance mechanisms and well functioning markets is therefore a risky business.

Genetic vulnerability of our agroecosystems is one important aspect of our economic development. Such genetic vulnerability of today's global agricultural systems arises from a common dependence on relatively few crops and varieties. Each year, crop damage penalizes farmers in many of the world's villages, and for farmers who depend on their crops for their livelihoods, these penalties can be dire such as liquidation of assets, migration, and under nutrition. In intensive production systems, both the incidence of pests and plant diseases, and the potential for a large scale epidemic, are higher. Combating plant disease epidemics incurs costs for nations already strapped for funds, and these can involve unsafe use of chemicals. Coping with persistent crop damage and avoiding disastrous epidemics through maintenance breeding instead of chemical control requires long-term investments and access to a steady supply of diverse genetic resources.

Small scale farmers in developing countries are facing serious economic dilemma. For them the most profitable decision in agriculture is frequently to grow only a few crop varieties, and not to invest in conservation of the varieties that are less favoured by the market. In the case of genetic diversity, farmers who maintain *in situ* crop genetic diversity are essentially conserving a global public good and thus they can be seen as net subsidizers of modern agriculture and food consumers worldwide. However, global institutions are not in place to provide compensation for generating such global benefits. The net result is that global crop genetic diversity is rapidly being reduced, since the custodians of the global genetic portfolio are not compensated by current international markets, and there are no corrective policies or mechanisms in place.

4.3 TRANSITION FROM TRADITIONAL TO INTENSIVE AGRICULTURE

Nearly half of the world's population lives in rural areas and depends directly on agricultural systems. It is estimated that about 60% of the world's agriculture consists of traditional subsistence farming systems, in which there is a high diversity of crops and species grown and such as polycropping and intercropping. These systems encompass an enormous amount of the planet's agrobiodiversity, yet much of it has not been well documented in terms of species composition or function.

Modernization of agriculture is due to many factors including rapid population growth, breakdown of traditional institutions, and stronger market forces, exacerbated by the role of agribusiness and international trade pressures. An immediate effort must be made to conserve the biodiversity and human knowledge from traditional agroecosystems, so that it is available for solving agricultural problems, now and in the future, and to support human societies that rely on its cultural services.

Agricultural intensification and expansion of agriculture adversely impacts the biodiversity on and off-farm, thereby promoting species extinction in managed and constricted wild land habitats. Abandonment of degraded lands, desertification, and agricultural encroachment on forest margins will increase, with further loss of biodiversity and its services. Agricultural intensification, as defined here, refers to the use of nonrenewable, purchased inputs, such as pesticides and fertilizers, substitution of mechanization and fossil fuels for human labor, and high capital invested per unit of land.

Modern agriculture is currently one of the greatest extinction threats to biodiversity in both agroecosystems and in wildlands. Ironically, since the advent of agriculture, biodiversity has provided the raw material for new innovations in agriculture, critical ecosystem services, and options for an uncertain future. Yet at this time in human history, we face the prospect of agricultural landscapes that are biodiversity poor, with increasing threats to wild biodiversity. Humanity faces a challenge of meeting its growing needs for food and fiber from a resource that it is threatening to destroy.

4.4 SUSTAINABLE AGRICULTURE AND ROLE OF AGROBIODIVERSITY

To combat the adverse impacts of agricultural intensification and expansion, a transition has been set into motion worldwide toward sustainable agriculture, which is one that "will over the long term: satisfy human food and fiber needs, enhance environmental quality and the natural resource base upon which the agricultural economy depends, make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls, sustain the economic viability of farm operations, enhance the quality of life for farmers and society as a whole.

Biologically, there is much potential for increasing the utilization of agrobiodiversity for sustainable agriculture. The agricultural sciences have shown for decades that plant breeding can introduce genes to increase the quality of agricultural production, though recent advances with genetically modified organisms are very controversial. Crop diversity can clearly enhance nutrient use efficiency, and a diverse soil community may govern tighter nutrient cycling, control pests and diseases and improve soil structure. Ecological research has shown that biodiversity can increase the productivity of ecosystems. The structure of agricultural landscapes, i.e. mosaics of agricultural and nonagricultural ecosystems, now is recognized as important for the utilization and conservation of both on farm and off farm biodiversity.

Research that integrates the natural and social sciences is needed to explore the importance of agrobiodiversity for sustainable agriculture, its services, and the socioeconomic trade offs involved in its use and conservation. The challenge is to find ways to meet our immediate needs for food, fuel, and fiber while conserving sufficient biodiversity to assure our capacity to respond to climate and other anthropogenic environmental change. Moreover, to alleviate poverty in a rapidly growing world population using a finite set of rapidly eroding biological assets, we need to be able to identify the trade offs involved in alternative land uses much more effectively than has been done in the past. This requires a scientific approach that is driven by human needs, recognizes the interdependence between human behavior and ecosystem processes, and delivers a deeper understanding of the role of biodiversity in satisfying those needs.

4.5 INTEGRATION OF ECOLOGIC AND ECONOMIC PERSPECTIVE ABOUT AGROBIODIVERSITY

For an economist, agrobiodiversity is part of natural capital, and the flow of services that it provides is the 'interest' on this capital. Just as investors choose a portfolio of produced capital to maintain the return on capital over a range of market risks, so society needs to choose the mix of genes, species, communities, and ecosystems to maintain the flow of ecosystem services over a range of environmental and social risks. In order to design agricultural, development and conservation policies that maintain an ecologically acceptable and economically optimal level of biological diversity in agricultural landscapes, an understanding of the risk implications of changes in the mix is required. Economics can offer insights for decision makers by identifying the 'social opportunity costs' that result from agrobiodiversity loss. Such opportunity costs have to do with complex trade off among food production, biodiversity conservation, ecosystem services and human wellbeing.

Economists have shown, how investment in agrobiodiversity reduces both the environmental and market risks faced by agricultural producers, and so enhances well-being. But the economic value of changes to enhance agrobiodiversity and its services is rarely reflected in current market transactions, and is not taken into account by decision-makers. In many countries, users of biological resources in agroecosystems have little incentive to maintain sufficient diversity to meet the needs of agricultural production because markets for agricultural inputs and outputs do not reflect the full social opportunity costs. Economists refer to this as the problem of market failure, and to the resultant loss of biodiversity as an external effect of agricultural markets that creates excessive social costs. Ecological economics, however, offer potential solution to such policy dilemma. It calls for the evaluation of all the environmental costs and benefits associated with different modes of agriculture and thereby can succeed to identify the relative economic benefit associated with maintaining high agrobiodiversity.

Further research is needed to address the issues where ecologists and economists fail to build consensus in terms of appreciating the value of biodiversity. This can be done by identification of the key functional (ecological and socioeconomic) roles played by biodiversity, with evaluation of possible scenarios for improving the management of these key functions in agroecosystems in response to environmental or economic stress.

Resilience, for example, appears to be a useful concept which is can be valued by both ecologists and economists. Resilience refers to the capacity of a system to adapt to external changes by either returning to its original state or by evolving into a state preferable to the initial one. A basic hypothesis, shared by ecologists and economists, is that biodiversity has a number of functions which contribute to the resilience of agro ecosystems. For instance, soil biodiversity (earthworms and termites, in particular) can enhance soil fertility which enables the rehabilitation of degraded soils. Another example is that crop and tree biodiversity in agroecosystems enhances the ability of farmers to remain economically viable by diversifying their revenues under uncertain market conditions with respect to volatile market price changes of inputs, crops or tree products.

4.6 IMPACTS OF ADOPTION OF GENETIC ENGINEERED (GE) CROPS

The majority of the world's plant genetic resources is located in tropical and subtropical regions. It is primarily small farmers who preserve and take care of these resources and the related agricultural diversity. As genetically modified crops have also been cultivated in these regions for some 12 years now. An estimated 40 percent of the global acreage of transgenic, i.e. genetically modified

(GM), crops is to be found in developing and emergent countries, and, in fact, almost exclusively in just six countries: Argentina, Brazil, China, India, Paraguay and South Africa. Four crops account for 95 percent of all transgenic varieties planted: soybean, maize, cotton and canola. Genetically engineered crops are grown for industrial purposes or as animal feed.

Genetic engineering has accelerated the industrialization of agriculture and thus amplified the negative impact of farming on biodiversity. In addition, it holds new, unknown risks. The introgression of genetically modified plants into non transgenic varieties and races poses a potential threat that is currently impossible to predict. Agricultural genetic engineering is usually justified with the argument that, it can achieve a quantum leap in intensification of agriculture and accelerate breeding of varieties. So far, no evidence of this has been seen. Most of the progress in plant breeding (yield potential, drought resistance and salt tolerance) has been achieved by conventional methods.

Biodiversity is a strategic resource for the future and therefore indispensable common property. Intensification of agricultural productivity must not proceed at the expense of biodiversity, but instead must harmonize with it. In both economic and ecological terms, agricultural genetic engineering does not stand better than other innovative technologies, that promote agricultural intensification. In fact, methods such as marker assisted selection (MAS), integrated pest management and organic agriculture are more in line with the aims of sustainable intensification of agriculture.

4.6.1 Technical Aspects of Adoption of GE Crops

Till date, only two genetically induced traits have gained commercial importance: herbicide tolerance (HT) in crops and pest resistance through insertion of a gene from the bacterium *Bacillus thuringiensis* (Bt). These traits have been introduced to maximize agricultural production by countering the effects of herbicides and pests. Effects of these traits on agrobiodiversity, however, have not always been favorable. There are studies which say that these traits have been neither ecologically viable nor economically profitable in long run.

Herbicide tolerance is seen to have an effect on biodiversity. Transgenic soybean varieties have been grown in Argentina since the mid 1990s. The introduction of these varieties has enormously accelerated a trend that already existed: the large-scale expansion of monoculture cultivation of soybeans. The plants are resistant to the herbicide glyphosate, allow fully-mechanized production and require less agricultural skill than conventional varieties. Within ten years (1994 - 2004) the acreage under soybean has increased from 6 to 14 million hectares, and the share of transgenic soybean in the fields from zero to 99 percent. The Argentine government aims to increase the acreage by another four million hectares by 2010.

Bt technology is used to produce transgenic plants, cotton, for example has the Bt-toxin in its DNA. Most insects that eat the Bt toxin die, making chemical pesticides unnecessary. Experience with Bt cotton in the early years was very promising. Many studies showed that pesticide use was substantially reduced, alleviating damage to insect fauna, decreasing costs of production, and improving net incomes.

Later studies have confirmed that only Bt technology is not confined to positive results. In a study in China, researchers found that the majority of farmers had to treat their cotton fields 15-20 times more often than in the early years of growing Bt-cotton to kill secondary pests, in particular mirids (Miridae). Farmers now spend the same amount on pesticides as neighbouring non Bt growers, in addition to having to pay about 2-3 times more for Bt seed. A similar finding is reported from the leading cotton growing area in South Africa. Furthermore, the effect of Bt toxins on beneficial insects and soil microorganisms is not yet clear. To sum up therefore: based on current knowledge, the impact of Bt technology on biodiversity is at best neutral.

Genetically modified crops also leads to contamination of indigenous crops by cross-pollination. Transgenic plants, when released from the greenhouse, may cross-pollinate with other varieties and with wild relatives. This pollination is irreversible and difficult to limit regionally. Sometimes their pollen grains of such crops are found up to 21 kilometers away from where it had been cultivated. This makes the coexistence of transgenic crops with non-transgenic crops virtually impossible. The UN's Food and Agriculture Organisation (FAO) advised all international agricultural research centres to do everything possible to avoid unintentional transgenic introgression into their *ex situ* gene bank collections. However, there is evidently no consensus at present on how to deal with this challenge.

4.6.2 Monopolization and Monoculture

Within the past 25 years there has been unparalleled concentration in the seed sector that is responsible for commercial breeding and propagation. In 2006, over half of the global seed market was supplied by only ten seed corporations. As far as transgenic crops are concerned, the market is cornered by just one company (Monsanto), which provides seed directly or indirectly for approximately 90 percent of the total area under transgenic crops.

Biotechnology has not caused the monopolization of the seed sector, but it has accelerated and reinforced the process. One main reason for this is that the breeding costs for GE crops are extremely high and the necessary investment can only be borne by larger companies. Conversely, to cover these costs a standardized variety or a whole cropping technology has to be distributed as widely as possible. This development creates dependency among farmers and leads to genetic uniformity of cropping systems as reported from the United States, for instance, where farmers say that it has now become virtually impossible to find high quality, conventional varieties of corn, soy and cotton seed.

Another consequence is the increasing control of genetic resources by a few companies through patents, licenses and the like. In the past, genetic material for breeding purposes was in the public domain. Today, it has increasingly become private property, accessible only with the permission of patent holders. This gives them have a strong influence on breeding programmes and strategies and on maintenance of varieties. Today, the concentration in the seed sector is probably the greatest threat to the diversity of agricultural crops.

In terms of the national economy, this drastic change to land use and farming systems due to adoption of genetically modified crop may initially appear to be positive, but it has had a negative impact on food production and the diversity of cropping systems. For instance in Argentina, rice and potato cultivation have suffered a reduction of 40 percent and 38 percent respectively. Even higher losses have been observed with vegetables, and a similar trend has been observed with products such as milk, eggs and meat. The mixed farming systems practiced by smallholders are gradually disappearing and are being replaced by lar ge monocropped fields.

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) Why does agricultural intensification reduce biodiversity?

....

....

....

....

....

2) How does use of GE crops promote monopolization of seed supply?

....

....

....

....

....

4.7 TRADITIONAL KNOWLEDGE AND AGROBIODIVERSITY

The term traditional knowledge encompasses the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles that are of importance for the preservation and sustainable use of biological diversity. This knowledge has been developed over the centuries and hence it is a collective asset of the local communities. It is passed on from generation to generation in such forms as stories, songs, cultural values, traditional laws, local languages, rituals, medical lore and agricultural practices.

Indigenous people and traditional local communities often have a profound understanding of their environment and its ecology. They know numerous ways of using wild plants and animals, for example as food, medicine and dyes. Different cultivation techniques have been developed for a large number of useful plants. This knowledge is an important foundation for the conservation and sustainable use of global biodiversity. In fact there are close links between cultural and biological diversity. Locally adapted cultivars, grown traditionally by the farmers have significant role in providing food security as well as environmental quality. After occurrence of natural calamities like tsunami, cyclones, revival of crop production in the affected areas depends largely on availability of these locally adapted crop varieties. Crop plant adaptation thus offers the best way to meet likely adverse impact of possible climate change.

Unfortunately, indigenous peoples suffer from the destruction of the environments in which they live. Often they are being uprooted or displaced from their native place and losing their identity. As a result of this, there is a threat that this great wealth of traditional knowledge will be lost forever. There is pressing need to protect these societies and to document the precious ecological knowledge that they have inherited across the generations.

Box 1: Local, Traditional and Indigenous Knowledge

Local knowledge is a collection of facts and relates to the entire system of concepts, beliefs and perceptions that people hold about the world around them. This includes the way people observe and measure their surroundings, how they solve problems and validate new information. It includes the processes whereby knowledge is generated, stored, applied and transmitted to others.

The concept of **traditional knowledge** implies that people living in rural areas are isolated from the rest of the world and that their knowledge systems are static and do not interact with other knowledge systems.

Indigenous knowledge systems are often associated with indigenous people. This concept is rather limiting for policies, projects and programmes seeking to work with rural farmers in general. Furthermore, in some countries, the term indigenous has a negative connotation, as it is associated with backwardness or has an ethnic and political connotation.

At the UN Conference for Environment and Development in Rio de Janeiro in 1992, there was for the first time broad recognition of traditional knowledge. Under the Convention on Biological Diversity (CBD) contracting parties have pledged to recognise and promote traditional knowledge and to make it available for general use. Access to traditional knowledge must be based on the consent of the knowledge holders and their equitable participation in the benefits arising from the use of such knowledge.

Traditional knowledge is often not confined within ethnic or geographical boundaries. In addition, biological resources and traditional knowledge are defined in the CBD as a collective asset. This contrasts with WTO usage, since the TRIPS Agreement (Trade Related Aspects of Intellectual Property Rights) defines private and individual rights to intellectual property. The contradiction between the CBD and TRIPS is as yet unresolved.

4.8 GENDER AND AGROBIODIVERSITY

In most traditional and modern farming systems there is a fixed division of labour. Men and women may be responsible for different crops or for different tasks related to a crop. Men tend to focus on market-oriented cash crop production, while women are often responsible for the family's subsistence needs. In Mali, rice was traditionally a "women's plant". Women possessed a vast store of knowledge about the native varieties they cultivated and could distinguish between

30 varieties. The men had more knowledge about cultivation of three improved varieties of rice that had been introduced into the village. In fact, how roles are assigned and who takes decisions relevant to agrobiodiversity will depend on the specific situations and culture. Depending on gender roles, the man or the woman may be the agrobiodiversity conserver.

Nutrition and health needs are most often considered the responsibility of women. It is therefore usually women who hold the knowledge of the plants and animals that serve these needs, whether with regard to their culinary, nutritional and curative properties or in connection with their agronomic and environmentally related characteristics. The variety of plants and animals contributing to subsistence is generally far larger than the range of products sold in the markets. When addressing agrobiodiversity conservation issues, therefore, it is primarily women who must be reached. There are many ways in which women in agriculture and men too can be supported in their role as conservers of agrobiodiversity. Participatory breeding, seed banks and livestock markets, tourism, home gardens, cooking, medical and religious traditions, to name but a few, are all areas with potential for successful development cooperation.

In poor families with two adults, more than half the available income comes from the labour of women and children. Furthermore, women spend most of their earnings on meeting the basic needs of their families. Women produce 80 percent of the food in Africa, 60 percent in Asia and 40 percent in Latin America. Women are the sole breadwinners in one-third of all households in the world. Male migration from rural areas to cities in search of paid employment has led to a predominantly female rural population in many areas. As men's participation in agriculture declines, the role of women in agricultural production becomes ever more dominant. Women are responsible for looking after the offspring of large livestock as well as smaller animals such as small ruminants and chicken.

Individual countries must in future formulate their agricultural policies in a way that does not exclude women. This is essential if states are to produce sufficient food for their growing populations. The fact that gender aspects have so far been neglected has had serious consequences not only for biodiversity but also for gender equality. The gender aware design of biodiversity conservation measures involves more than just taking account of traditional seed, old native varieties and traditional knowledge. If the roles of men and women are properly considered, many negative impacts on women can be avoided. Family nutrition and health are improved if a range of nutritious plants is cultivated. Improvements in production systems can increase the income of women farmers. If more attention is paid to the knowledge and skills of women, their position in society is strengthened.

Through their daily activities, experience and knowledge local farmers, and especially women, have a major stake in protecting agricultural biodiversity. However, they are still hampered by a lack of rights relating to access to and control of the resources that they rely on to meet their needs. National policies fail to take due account of the increasing responsibility of farmers for food production and the management of natural resources. Improvement of women farmers' access to land and water resources, to education, advice, training, credit and appropriate technology is essential if agrobiodiversity conservation is to be improved. Sound and equitable agricultural policies to provide incentives for the sustainable use of genetic resources are also needed.

A range of international agreements regulates the conservation and sustainable use of agrobiodiversity. Most of these agreements, however, take little account of gender issues. The United Nations Convention on Biological Diversity, however, in its preamble acknowledges the key role played by women, especially in the developing world, in the management and use of biological resources. The FAO Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture make detailed reference to the differing roles of women and men in the conservation of agrobiodiversity.

4.9 PARTICIPATORY PLANT BREEDING

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. An example is the participatory barley breeding programme in Syria. Breeders and farmers make crosses and selections over several generations, according to the evolutionary breeding method. The populations thus obtained are then tested over a period of three years in field experiments. Once this stage has been completed, either the material is released as a variety or the whole process is repeated.

Participatory approach to plant breeding has many benefits. The effectiveness of breeding can be improved as the farmers' experiences, as well as their agricultural knowledge and skills, are fed into the entire breeding process. Varieties bred by this method have high acceptance and accelerated adoption rates because the farmers, as users of the new seed, are able to input their own needs and preferences. The breeding time can be reduced by several years because, in contrast to classical breeding methods, a lower DUS (distinctiveness, uniformity and stability) level is sought and variety screening trials can also be omitted. This saving of time is an important aspect during our period of rapid climate change, with the resultant need for fast adaptation of agriculture.

In socioeconomic terms, this method empowers farmers to regain control of their seed systems, and to safeguard their interests after decades of marginalization due to global trade liberalisation. From an ecological standpoint, it will become easier to exploit unfavourable sites and to tap the potential benefits of plants that have been little used in the past. The new method thus contributes substantially to improving global food production. Furthermore, it will enable us to sustain the diversity of agrogenetic resources and to develop it further for a more rapid adaptation to environmental change.

Participatory evolutionary plant breeding has emerged over the past 10 years. It is mainly supported and promoted by international agricultural research centres (e.g. ICARDA and ICRISAT) and by a number of NGOs (e.g. Misereor and Oxfam). The process is now being practised in many countries with outstanding results. Using this method to breed varieties with higher drought tolerance and better adaptation to low rainfall environments has been particularly successful. Outstanding successes include barley in the Middle East, rice in South Asia and sorghum in West Africa. The ongoing paradigm change in agriculture towards sustainable intensification must embrace the role of agrobiodiversity in general, and the need for innovation in plant breeding in particular. Evolutionary, participatory plant breeding could make a significant contribution to agriculture in the future.

4.10 INTELLECTUAL PROPERTY RIGHTS AND PLANT VARIETY PROTECTION: GLOBAL FRAMEWORK

Serious attempts for protecting intellectual property in plant varieties and seeds started in the early periods of the twentieth century. It was the legislation in U.S.A., Germany, Hungry, Italy, Netherlands, Austria, etc. in the 1930s, which really led to private monopolization of plants and business. That time private firms raised the question of plant breeder's rights in the international forum. It was followed by a counter concern for farmer's right, in particular by the developing world, under the support of the Food & Agriculture Organization of the United Nations (FAO).

In the meantime, there has been significant advancement in new technologies, particularly the biotechnology. The costs of research and investments in production have thus increased several folds. In order to safeguard the interests of investors, the Intellectual Property Rights (IPR) has emerged. Protection of IPR was necessitated either by patents or other forms of protection including the Plant Variety Protection (PVP). Whereas, the IPR protection can be granted only by the governments within their national jurisdiction, there are several international treaties, which facilitate collective action for governance of these issues.

There are a number of international level agreements related to IPR, protection of plant varieties and international trade on agrobiodiversity. Major agreements include the General Agreement on Tariff and Trade (GATT), the International Undertaking on Plant Genetic Resources (IUPGR), the Global Plan of Action (GPA), the Convention on Biological Diversity (CBD), etc. However, some international conventions were not held on the common intergovernmental platform. The Convention of the Union for Protection of New Varieties of Plants (UPOV) may be listed as such Convention, which was held by the countries of the Europe.

The UPOV aimed to ensure protection of Plant Breeder's Right (PBR) by the grant of an exclusive right on the protected new plant variety on the basis of a set of uniform and clearly defined principles: distinctness, uniformity, stability and novelty, also known as DUS criteria. At present, membership of UPOV has exceeds 50 and several other countries are either its observers or these are in the process of becoming its members. Notwithstanding the fact that the UPOV system is the first system of plant variety protection, many developing countries, such as, Belarus, Croatia, Morocco, Uzbekistan, Venzuela, Zimbabwe, Philippines, India, etc. have evolved or evolving their own sui generis legislation which provide a more comprehensive framework for the plant variety protection containing several deviations from UPOV model.

Another area of concern for agriculture has been the biological diversity and genetic resources. In this context, the Convention of Biological Diversity (CBD) further recognised agricultural biological diversity as a sub set that needs specific attention for conservation, access, sustainable use including use of biotechnology, and equitable sharing of commercial benefit. The CBD considered the raw genetic resources as a management concern. The developed varieties, including those developed by the conventional approaches were, however, treated as being the finished products that required protection of intellectual property involved in their development. Also, the traditional knowledge of farmers in relation to the crop varieties or their use got specific attention under the area of protecting intellectual property rights.

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) constitutes one of the important agreements of the World Trade Organisation (WTO). The TRIPs Agreement sets out clear cut options for Member countries on protection of plant varieties. This may be achieved by any one of the following, (a) patent for plant varieties, (b) an effective sui generis system of protection for plant varieties, and (c) a combination of patent and effective sui generis system for protecting plant varieties. By exercising such choice countries might allow only one or both forms of protection for varieties of all plant species or, alternately, there may be one form of protection for varieties of certain group of species and a different form of protection for other group of species.

4.11 PLANT VARIETY PROTECTION IN INDIA AND PPVFR ACT, 2001

India has ratified or agreed to various inter-governmental arrangements in larger national interest as well as in the interest of the humanity at large. India has been participating in the major United Nations led inter-governmental collaborations concerning agriculture, biodiversity and trade right from their beginning. For example, the country has been the founder member of GATT, IUPGR, GPA, CBD etc. India is its founder member and also that of its predecessor, the General Agreement on Tariff and Trade (GATT). India has observed the developments in UPOV right from the beginning although the country is not its member as yet.

Indian legislations on plant variety protection (PVP) are primarily required to be established in compliance with the international agreement, like TRIPs, which required its Members to have a sui generis legislation for IPR protection regime. Sui generis literally means ‘self-generating’ and sui generis system in the present context refers to a ‘novel system’, ‘of its own kind’. Apart from meeting these requirements, such legislations have to address balance for many other national requirements and policy objectives such as those related to food security, livelihood of farming community, material exchange, trade, environment, private investment, technology transfer, etc.

In this context, the Protection of Plant Varieties and Farmer’s Rights Act, 2001 of India is relevant and first of its own kind in the world. It attempts to optimise and balance claims for protection by both plant breeders and the farmers. Indian PPVFR Act, 2001, has many unique aspects. It recognizes farmer as breeder, conserver and preserver of traditional varieties of crops and wild species in addition to cultivator, either directly or indirectly. Protection is provided not only to new varieties but also to the existing varieties. Protection of varieties other than extant and farmers’ varieties is limited to those genera or species notified by the Government of India in Official Gazette from time to time. A plant variety having genetic use restriction technology (GURT), like 'terminator gene', is disqualified from protection. A different and possibly less rigorous procedure is adopted for the protection of farmers' varieties. There is provision for creation of a National Gene Fund (NGF) wherein the benefit shared under the Act, shall be credited for supporting conservation at local community level including *in situ* and *ex situ* conservation of agrobiodiversity. There is provision for compulsory license for a period determined by the competent authority when a breeder or institution or their licensee fails to produce and supply enough planting material of the variety to farmers and causes its non-supply or short supply or charges prohibitively high prices for such planting material. There is also provision of Establishing Plant Variety Tribunal for speedy disposal of legal disputes related to this Act.

Indian PPVFR Act, 2001, contains an extensive list of farmers' rights including the aspects like right to register farmer's varieties; entitlement for benefit sharing for the use of biodiversity conserved by the farming community; right to save, use, sow, re-sow, exchange, share or sell farm produce including seed of registered variety but not the branded seed; right to claim compensation for under performance of a right protected variety from its promised level under defined production conditions; mandatory need to secure consent of farmer(s) when a farmer variety is used to develop an essentially derived variety (EDV); protection from legal proceedings related to alleged infringement; exclusion from paying fee in any legal proceedings in the Tribunal and Higher Courts.

There is a need to be more practical and cohesive in our approach to implement various provisions already made in the Act. This is the time to concentrate on developing a road map and establishing the institutional mechanism, including awareness generation and increasing IPR literacy and information services. The most important challenges in the pre-implementation stage of theAct are, bridging the information gaps, simplifying the interpretation of the law , and institutionalized law enforcement for the administration of justice. The need to elaborate and strengthen the area of jurisprudence related to protection of plant varieties in conformity with the TRIPs Agreement should also be realized on priority.

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) Why do rural women bear special significance for agrobiodiversity?

....

....

....

....

....

....

....

2) How does participatory plant breeding helps in agrobiodiversity conservation?

....

....

....

....

....

4.12 LET US SUM UP

- The growing pressure on agricultural landscapes is leading to agricultural intensification which results into loss of agrobiodiversity and its services.
- Modernization of agriculture is due to many factors including rapid population growth, breakdown of traditional institutions, and stronger market forces, exacerbated by the role of agribusiness and international trade pressures.
- Genetic engineering has accelerated the industrialization of agriculture and thus amplified the negative impact of farming on biodiversity.
- Methods such as marker assisted selection (MAS), integrated pest management and organic agriculture are more in line with the aims of sustainable intensification of agriculture as compared to genetically engineered crops.
- Traditional knowledge is an important foundation for the conservation and sustainable use of global biodiversity. In most traditional and modern farming systems there is a fixed division of labour between the two genders.
- Participatory plant breeding is one good approach to promote agrobiodiversity in which farmers are involved throughout the breeding process and most of the breeding takes place in their fields.
- With the advancement in technologies, particularly the biotechnology, the costs of research and investments in production have increased several folds. In order to safeguard the interests of investors, the Intellectual Property Rights (IPR) have emerged at national and international levels.
- The Protection of Plant Varieties and Farmer's Rights Act, 2001 of India is relevant and first of its own kind in the world. It attempts to optimize and balance claims for protection by both plant breeders and the farmers.

4.13 KEY WORDS

Genetically Engineered (GE) Crop : Crop produced by alteration of genetic material through introduction of genes of other organism by use of biotechnology.

Intensive agriculture : Agriculture which is based on the principle of high input and high output. Fertilizers, irrigation and pesticides are some of the inputs.

Marker Assisted Selection (MAS) : It is a method in which gene-markers are used to identify desired traits more easily and can be used as early as the seedling stage of a plant and it also allows wild relatives to be included more easily.

Integrated Pest Management : Control of pests by use of physical, chemical and biological means

Organic agriculture : Agriculture based on use of biological resources as inputs like farm yard manure, green manure etc.

Intellectual Property Rights: Legal framework to compensate or protect the interest of person or community who innovated a particular product or idea, often with some commercial prospects.

4.14 REFERENCES AND SUGGESTED FURTHER READINGS

- FAO. 2004. What is Agrobiodiversity? In: Building on Gender , Agrobiodiversity and Local Knowledge.
- FAO. 2005. The state of food insecurity in the world. FAO, Rome, Italy.
- Jackson, L., Bawa, K., Pascual, U., and Perrings, C. 2005. agro biodiversity: A new science agenda for biodiversity in support of sustainable agroecosystems. Diversitas Report N°4. 40 pp.
- Kontoleon, Andreas, Pascual, Unai, and Smale, Melinda (Editors) 2009. Agrobiodiversity conservation and economic development. Routledge, London and New York.
- Lossau, Annette von, and Qingsong, Li (Eds.), 2011: Sourcebook on Sustainable Agrobioidiversity Management, Social Sciences Academic Press (P.R. China).
- Millennium Ecosystem Assessment 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington DC.
- Pandey. B.N. Intellectual property in agriculture, protection of plant varieties and related issues. In: Communication Support for Sustainable Development. Eds. Dipak De and Basavaprabhu Jirli, GangaKaveri Publishing House, Jangamawadi Math, Varanasi

Relevent Websites:

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

4.15 KEY TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Your answer must include the following points:
   - Use of lesser number of crop species
   - Species loss due to clearing of forests for agriculture
2) Your answer must include the following points:
   - Process of making GE crops is very expensive and only big firms can afford it
   - Processes like patenting and licensing also restrict their production

Check Your Progress 2

1) Your answer must include the following points:
   - They have good knowledge about traditional crops and their conservation
   - They particularly know about the several crops important for subsistence
2) Your answer must include the following points:
   - It involves farmers in breeding and hence their traditional knowledge is incorporated which is good for agrobiodiversity conservation
   - Crop breeding is done in the farmers field and hence the resultant crop seeds have better adaptability to the local environmental conditions