UNIT 15 IMPERATIVES

Structure

15.1 INTRODUCTION

So far in this course, you have been acquainted with the agriculture-environment relationship and the concept of sustainable agriculture. You have learnt about various resources such as soil, water, biodiversity, energy, fertilizers, etc. needed for agriculture and the issues and challenges involved in their environmentally sustainable management. In the previous block, we have discussed various strategies for eco-friendly agriculture viz. Integrated Resource Management, Integrated Farming Systems and eco-friendly strategies for plant protection. You have also studied about several socio-economic issues that influence the practice of agriculture in South Asian countries such as agriculture and trade policies, institutional capacity and people's participation.

In this unit, we take up some important issues that have implications for **the practice of sustainable agriculture in future**. The first and foremost among these is the challenge of ensuring food security for the poorest of the poor in a manner that the ecological security is not endangered. Since modern agriculture depends heavily on technology, the questions of technology transfer and appropriate technologies for resource poor farmers assume great significance if we wish to ensure food security and remain competitive in the world markets. We also discuss the issue of genetic conservation, which is equally important in a scenario where biotechnology in agriculture is enabling manipulation at the genetic level. You will learn more about the new technologies and the issues involved in their use in the next unit.

Objectives

After studying this unit, you should be able to:

- discuss various aspects of the issue of ensuring food security in the era of globalisation;
- explain the concept of ecological security and analyse the issues involved; and
- discuss the various dimensions of technology transfer and the appropriate technologies for resource poor farmers.

15.2 FOOD SECURITY

You have studied in Unit 14 that the well-being of the people of any country depends not only on adequate and sustained production of food but also its distribution. The problem of low agricultural productivity and lack of access to food continues to persist in South Asia. Nearly 37 percent of the world's malnourished and hungry people belong to this region. Emergencies, such as drought, floods, and war, are responsible for only 5-10% of the hunger in the world. For most hungry people, however, food shortages are simply a fact of everyday life.

Therefore, a major social objective of these countries is to ensure adequate food for all at reasonable prices at all times with special provision for the chronically undernourished, underprivileged and other vulnerable groups of the society. This is the crux of the issue of food security. Let us begin the discussion on the issue by understanding what it means in our context.

According to the FAO Committee on World Food Security, food security means that "all people at all times have physical and economic access to the basic foods they need." To elaborate further, sustainable food and nutritional security may be defined as a condition in which every individual at all times has physical, economic, social and environmental access to **safe**, **nutritionally adequate** and **personally acceptable foods in a manner that maintains human dignity**. This means that in order to enjoy food security, there must be on the one hand a provision of safe, nutritious, and quantitatively and qualitatively adequate food and, on the other, rich and poor, male and female, old and young, all must have access to it.

Food security requires that at all levels **- production, distribution, consumption and waste management** - measures need to be taken to guarantee a democratic and sustainable food system. A sustainable food system aims for the satisfaction of basic human needs without compromising the ability of future generations to meet their own needs. It involves maintaining ecological integrity, and incorporating conservation and development.

We now discuss various dimensions of the issue of food security.

Availability

Availability refers to the **assured and reliable supplies of sufficient quantities of food of appropriate quality, now and in the future** through increase in domestic agricultural production or imports.Sufficient supply of food for all people at all times is a precondition for food security and has historically been a major challenge.

In 1979 the World Food Programme Report conceptualized food security, equating it with an "assurance of supplies and a balanced supply-demand situation of stable foods in the international market." The report also emphasized that increasing food production in the developing countries would be the basis on which to build their food security. For a long time, there was a tendency on the part of planners, policy makers, economists and agricultural scientists to understand the issue of food security *only* from the point of view of increased supply through increase in production. It was thought that increased food production would automatically lead to assured food supply to all people. Thus, the monitoring of food insecurity in the early years focused only on the availability of food in the world marketplace and on the food production systems of developing countries.

The Green Revolution of the 1970s was seen as the answer to the problem of hunger. But such a largely technological approach has come under rigorous critical scrutiny both on the counts of environmental sustainability and social equity. In countries like ours, it has largely benefited rich farmers at the expense of poor farmers. We shall visit this aspect in detail shortly. Here we briefly talk about the limitation of the technology per se.

Most of the technologies used to bring about the Green Revolution have been focusing on the *quantity* of food (mostly wheat and rice) produced, and *economies of scale* without paying enough attention to the sustainability of the practices. Not much attention has been paid to the production of the nutritionally superior grains such as coarse cereals and pulses, which has been extremely uneven over the last several years. It has had an adverse implication for the country's nutritional security. One-third of the population living below the poverty line is afflicted with wide-spread protein deficiency and malnutrition. Coarse cereals and pulses are known as the

cheap sources of protein for the common man, but the per capita availability of both has declined consistently.

You have studied in the previous blocks about how the wide use of chemical fertilizers and pesticides has thrown up serious ecological problems in many parts of the world. The intensive land use and widespread biomass shortage have led to the depletion of essential nutrients and organic matter in cultivated soils. Resources such as water, forests, fisheries, and livestock are also under tremendous strain. This has led to a rethinking about the Green Revolution and to a quest for more sustainable approaches to increase food production.

Experience has also shown clearly that global food availability does not ensure food security to any particular country because what is available in the world market (or the surplus in the developed countries) cannot be accessed by hunger/famine-affected people in developing countries; the economies of these countries, in general, cannot afford to purchase food from the world market.

Moreover, an increase in national food production does not by itself guarantee food security. Availability of food at the national level is but one factor for food security. The assumption underlying this perspective is that whatever food is produced in the country will be evenly distributed to each region and to each household. But the fact is different. **People will have access to the surplus in the country** (through the markets) **if, and only if, they have the required purchasing power**. In most poor countries, however, many people do not have such power. National governments, too, often lack the necessary financial resources to purchase the surplus and to distribute it to the have-nots, especially when millions become destitute. Therefore, food availability at the national level alone does not provide food entitlement to households and individuals.

As the world's population continues to swell toward 8.1 billion by 2030, even advocates of the Green Revolution agree that increasing food production alone will not ensure assured food supply for all. “Despite the successes of the Green Revolution, the battle to ensure food security for hundreds of millions of miserably poor people is far from won”, says Norman Borlaug, who received the 1970 Nobel Peace Prize for his work to increase food production around the world that sparked the Green Revolution. It is now a well accepted fact that technological innovation is no panacea to all problems of poverty and sustainable development - it is just one stone in a large and complex socio-economic mosaic.

Further, there is no relationship between the prevalence of hunger in a given country and its population. For every densely populated and hungry nation like Bangladesh, there is a sparsely populated and hungry nation like Brazil and Indonesia. The world today produces more food per inhabitant than ever before. Enough is available to provide about 2 kg of food for every person every day: more than 1 kg of grain, beans and nuts, about half a kg of meat, milk and eggs and another half a kg of fruits and vegetables. The real causes of hunger are **poverty**, **inequality** and **lack of access**. Too many people are too poor to buy the food that is available (but often poorly distributed) or lack the land and resources to grow it themselves. **Access to food** is now recognized as an important parameter of food security. But before we move on to it, you may like to consolidate these ideas.

SAQ 1

Explain why food availability is a necessary but not a sufficient condition for food security.

Accessibility

Distribution and **access** by households and individuals to appropriate foods for a nutritious diet are as important aspects of food security as food production. It is not enough to produce surplus food if it can't get to those who need it, if those who need it can't afford it, or if they don't know how to use it. Food security depends on household income, access, and knowledge. Thus, the issue of food security is intimately linked with the socio-economic conditions of a given society.

Unequal distribution of wealth, power and resources are seen today as major barriers to food security. Other constraints include commodification of food, environmental degradation, trade agreements that encourage cash cropping rather than food production, and agricultural research carried out without farmer participation. **Inequities**, within and between societies, have resulted in class, gender, ethnic, racial and age differentials in access to food and other resources. There are also national and regional gaps in development within and between the segments of the societies. In developing economies inequalities in access to food and the resulting food insecurity are most acute among the marginalized segments of the population. It is evident that if food grains cost, say, Rs. 10 per kg, a person earning Rs. 3000 per month will be in a better position to buy them than a person earning Rs. 1000 per month. Social and cultural disparities are also involved. We now take an in-depth look at the various aspects of access to food.

Let us first understand which sections of the population face food insecurity due to lack of access and why. These are

- Small and marginal farmers who also toil on other fields for their survival,
- Agricultural labourers,
- Wage labourers and unemployed poor in the cities most of whom may have migrated from villages due to lack of employment opportunities, and
- Women, girls and socially disadvantaged people.

You may like to know: Why do small farmers appear in this list? Why do they themselves not have access to food? Why do they not have the required purchasing power?

Let us understand this issue with the help of a concrete example from India. A cursory comparison of the free market price of food products and their minimum support price announced by the government reveals that the farmer gets only a fraction of the market price. The rest goes to the middleman – be it the government or the private trader. After deducting the input costs, farmers are left with a very small profit per unit. A study carried out in the Chattisgarh state reveals that of the Rs. 11per kg of rice paid by the consumer in the market, the middleman gets Rs. 6.50 and the farmer Rs. 4.50 as the official support price. An evaluation of input cost reveals that the farmer invests around Rs. 4.212 per kg. This leaves a profit margin of a meagre Rs. 0.28 per kg.

You must also understand that small and marginal farmers cannot afford to stock their produce to sell it when higher market rates prevail as they have to repay their earlier loans and prepare for the next crop. It turns out that for their own food needs, they have to depend on the market. Thus, the economic compulsions force farmers to sell their own produce at cheaper prices but buy them later at higher (unaffordable) prices. This gives rise to the anomalous situation that the farmers who fill the granaries, lack food security themselves.

Moreover, in a highly resource intensive agriculture dependent on expensive inputs, the share of human labour and wages for labour are progressively declining. In the above-mentioned study, within the input costs, agricultural wages accounted for barely Rs. 0.72 per kg. The wages of the labour put in by the agricultural labourer or

the farmer and his family members on their own fields are pegged at much lower rates compared to a daily wage earner, resulting in their impoverishment.

It can be surmised from this analysis that the process of deciding the minimum support price does not rationally account for the input costs, in general, and the cost of manual labour in agriculture in particular. It favours rich farmers who have large land holdings, can use resource intensive technologies along with mechanized agriculture to attain economies of scale and can afford to sell their produce at favourable market rates. A large section of the population comprising small farmers and agricultural labourers is left with limited purchasing power that impacts their food security. The lack of employment opportunities in rural areas forces large scale migration to cities. However, the industrialisation and employment opportunities in the urban areas have not kept up pace with the demand. The result is huge unemployment, devaluation of labour costs and resulting poverty, which affects the food security of the rural migrants.

Another factor that affects food security is the **distribution** mechanism. If the pricing of food commodities is left to market forces, it is the middleman or the rich peasantry that benefits. But the bulk of food is still produced by small and marginal farmers, and so they lose in the bargain. The answer to this lies in a strong public distribution system, a facility that India can boast of. However, the recent process of liberalization and globalization has witnessed a rapid erosion in the public distribution system, which itself is not beyond the purview of a critical evaluation.

We need to evaluate the current public distribution system (PDS) in India around the following issues:

- Who decides what to distribute and at what prices?
- Location of food godowns.
- Who distributes it?

Firstly, the PDS in India distributes mainly rice and wheat. The coarse grains consumed by the majority of the poor people are outside its purview in spite of their better nutritive value. For example, bajra and jowar have 11.6% and 10.4% protein which is comparable to wheat (11.8%) and much more than rice (6.8%). Ragi, bajra and jowar are also rich in iron and other minerals in comparison to rice.
The location of go downs in urban areas and the consequent high transport costs to rural households serves as a disincentive for public distribution in poor economies with the result that the PDS has seen steady erosion. Corruption is also rampant in PDS with most of the food to be distributed finding its way into the market instead of reaching the poor people for whom it is intended.

Moreover, the problem of access does not automatically get resolved by government intervention to provide aid or by taking special distribution measures for poor people. For example, in many parts of rural India, the poorest of the poor are found to sell their special ration cards for immediate relief from hunger as they do not have even that miniscule purchasing power. There are other socio-economic and cultural inequities that impact food security. For example, the caste system is entrenched deeply in many parts of India. The caste one is born into determines what education and occupation one can have, which determines one’s income, one’s purchasing power and hence one’s food security.

It is also not correct to assume that access to adequate food by households over time will imply that each member of the household is secure. The assumption here is that food is **shared equally** by each member of the household. However, there are intra-household factors that may affect equitable and adequate access to food by all members. For example, the head of the household may have more power in determining the use of food resources and may misappropriate it. Moreover, household members' nutritional requirements may vary, for example, if some exert more energy in work than others.

Cultural factors can also deprive members of the household (i.e., women and girls) from getting an equitable share. For example, in spite of the plethora of policies and programmes about gender sensitivity and equality, the bitter truth is that tens of thousands of women and girls in India lack access to adequate food, opportunities of education and health care within their own families. Thus we find that individual household members may suffer from inequitable distribution because of cultural and intra-family obstacles.

As parasitic and other diseases substantially hamper the metabolism and assimilation of food, individual state of health and knowledge about health and nutrition also figure significantly in the food security equation. Optimal uptake of nourishment through a sustaining diet, clean water and adequate sanitation, together with health care are essential components of food security.

SAQ 2

Describe the factors that influence access of the poor people to food.

Acceptability

Food security requires **culturally acceptable** food and distribution systems which are respectful of human dignity and **social** and **cultural norms**. As an essential ingredient of human health and well-being, the kind of food consumed and the ways of consuming it reflect the social and cultural diversity of humanity.

Food is an integral part of one's culture. Hence, people should have the option of producing what they desire to and the policies and technologies should be supportive of that. Consumers should also have the freedom to choose the food they prefer to buy from the public distribution system just as they have in the free market, so that they can access the food that is culturally acceptable to them. For example, a significant percentage (65%) of the poor people in India consumes coarse grains but the PDS distributes wheat and rice. For a moment, think of the reverse situation: Suppose special measures are taken to increase the productivity of coarse cereals (jowar, bajra, ragi etc.) in the wheat-rice zones, will the people of these regions like to switch over to eating coarse cereals? Then wherein lies the appropriateness of forcing a wheat-rice regimen on coarse grain eating people? Is it because these people have never been asked whether they would like to eat wheat or rice that they do not have any say in deciding what is to be produced and then distributed through the PDS? Thus, the question of cultural acceptability of food assumes significance in any discussion on food security.

Agency

Agency refers to the policies and processes that enable (or disable) the achievement of food security. It reflects our focus on governance and systems for poverty alleviation and enabling citizen participation.

Food insecurity is one of the most terrible manifestations of human deprivation and is inextricably linked to every other facet of the development predicament. Poverty is one of the major causes of food insecurity and sustainable progress in poverty alleviation is critical to improved access to food. Poverty is linked not only to poor national economic performance but also to a political structure that renders the poor people powerless.

So policy matters of a general nature, and in particular good governance are of overriding importance for food security. For example, it requires that poor rural communities be given access to and control over land for food production through agrarian land reform and assistance from capacity-building organizations such as seed banks. Agricultural trade policies under GATT must be changed to prevent

cheap imported foods from destroying markets for local production, and intellectual property rights systems must be reformed to take into account farmers' rights. The central role of women to long-term food self-sufficiency must also be recognized, and women's access to land, extension services and technological expertise must be ensured.

The main precondition for food security is a constructive political leadership that is responsive and responsible to the people. Secondly, progress for food security requires a proper macro-economic framework. The elements which have been most important for successes on the food security front are known today. **If and when poor small farmers have access to land, to agricultural extension services**, **to marketing opportunities, to working equipment, agricultural inputs, to fair terms of credit and to environmentally sound technologies**, they can contribute substantially towards food production. Rural employment can be generated and there can be an increase in their incomes. All these measures can be used to bring about noteworthy advantages and more food to the mass of small farmers.

If more can be grown on the available land, if less water and less fertilizer is needed for higher yields, if there is tolerance against major pests, and adverse cropping conditions and if the nutritional quality of food can be increased through appropriate measures, small and large farmers alike will benefit. If there is more pre- and post-harvest work to be done, further stimuli for rural employment and rural development will be the consequence.

Let us end this discussion by asking: Is there an alternative to the present methods of enhancing food production, the skewed public distribution system and providing access to quality food? We give here the example of the Deccan Development Society working for the last 20 years in District Medak of Andhra Pradesh. It has come up with the idea of SDK (Samudayik Dhanya Kothi translated as Community Grain Store) as an alternative production and public distribution system.

The SDK movement has been successful in cultivating wastelands through sustainable agricultural technologies, collecting the local produce and distributing it locally in the region where it is produced. Its control and management is in the hands of the poor women in the area. This is an example of people-oriented growth and decentralised public distribution system which can ensure food security without being subsidised year after year. In fact, this project was started with financial help from the Government of India in 30 villages. Around 80 to 100 farmers in each village were identified and each one of them was given 1.5 acres of waste land. They were trained in appropriate technologies to cultivate the wasteland and they grew coarse cereals that were culturally acceptable to them. They were given wages on the basis of food for work. The results were gratifying.

At an average of 100 beneficiaries per village, each village now stores 150 quintals of food grains, in the Community Grain Store for distribution. This suffices for six months at the rate of 25 kg grains per month to each family. The entire range of activities (from cultivation and collection of food grains to biodiversity management and identification of beneficiaries) is carried out by local women, a majority of whom belong to the Dalit families. Families are no longer dependent on traders to buy grains or on government officials to issue their ration cards and distribute grains. They now decide on what to grow, how to collect it and how to distribute it to the community on a priority cum need basis.

This alternative public distribution system has allowed 1000 hectares of barren land to be regenerated and produce 8000 quintal surplus grains in the very first year. This implied 3 million meals equivalent of excess grain production in 30 villages. Thus each family in these villages could access 1000 extra meals with acceptable food grains as well as fodder for 6000 animals.

The community distribution system has not only given positive results at the quantitative level but also at the qualitative level. It has shown the way to the success of sustainable organic agriculture and provided a road map for people-oriented food

security as against special schemes-oriented food security. It shows us that the access to nutritious food is best assured when it is locally produced, processed, stored and distributed.

To sum up, food security deals with food production in relation to food availability; it addresses distribution in that the produce should be accessed by all; it covers consumption in the sense that individual food needs are met in accordance with the individual's cultural preference and ensures that the individual is active and healthy. The only pathway to eventual food security is sustainable human development. This means breaking the vicious circle of continuing poverty, environmental deterioration, and acute institutional deficiencies. Because deficits in food security stem from the combined effects of factors such as poverty, low levels of food production, and diminishing environmental quality, the best way to deal with the challenge lies in strategies that tackle all problems comprehensively, i.e. transforming local agriculture into a sector that generates employment and income for the rural people, stimulates the non-farm sector and the overall economy, and increases food supply.

The principal operational implications of the food security may be summarized as follows:

- Physically, assured food security requires a transition from chemical and machinery-intensive to knowledge and labour-intensive farming technologies. It requires better seeds, soil management and other sustainable agricultural practices. It also requires agricultural systems that maintain farm worker health, biological diversity, farmers' access to genetic resources, soil fertility and watershed protection.

- Economically, food and nutritional security requires the promotion of multiple income-earning opportunities, and provide sustainable livelihoods through appropriate policies, e.g., just distribution of land and production assets, proper support prices that take into account the component of labour wages, value addition to the produce and lowering of input costs.

- Environmentally, food and nutritional security involve attention to sustainable agricultural practices viz. soil and water management, conservation of biodiversity as well as adequate food safety standards and enforcement.

- Socially, food and nutrition security requires addressing social discrimination based on gender, class, and ethnic differences in society, incorporation of women into decision-making processes, and the right of communities to make informed choices regarding healthful eating patterns.

At this point, you may like to take a break and revise these ideas.

SAQ 3

What lessons can be learnt from the example of Community Grain Stores to ensure food security for the poor? Consider all aspects of the issue in your answer.

15.3 ECOLOGICAL SECURITY

The term 'security' reflects a deep seated human longing to be safe. But when we refer to ecological security, you would like to know: Safe in what sense? Safe from what? You would perhaps agree that the end of the cold war was marked by a transition in perceptions of threats to human security. The traditional kinds of insecurities vis-à-vis major nuclear/conventional wars are now being replaced by non-military threats. In the wake of the escalation in public concern over environmental degradation in the previous decade - intensified by nuclear fallout from Chernobyl, burning oil wells in the Gulf War, depletion of the ozone layer and predictions of global warming - it is not surprising to find that the environment has

also found its way onto this expanded security agenda. Environmental problems such as global warming, deforestation, species extinction, and pollution are now being added to the range of "threats" to the interests of humanity as a whole.

What constitutes ecological security? **Clean air, safe and reliable water supplies, nutritious and safe food, healthy housing and workplaces, civic services and protection against disease and disasters for all people form the corner stones of ecological security**. Its ambit may be expanded to include ecological sanitation, i.e., efficient, cost-effective eco-engineering for treating and recycling human excreta, waste water, and other wastes.

Let us first examine the general threats to ecological security, and then particularly in the context of agriculture.

We now live in an increasingly crowded, environmentally stressed and resource degraded planet. Clean air, water and land are not available to large sections of people across the world. These include the economically and socially disadvantaged people, small farmers, factory workers, street vendors, women, children and slum dwellers, who are pushed back into the most undesirable areas, forced to live in hunger, and quite often persecuted and jailed. Urban pollution is concentrated in areas where the most impoverished live, where there are effluents in the drinking water and where people fight with birds of prey for the scraps in rubbish bins.

The development paradigm itself creates the conditions for ecological insecurity: Waterways are polluted and fertile soils degraded or flooded to make way for mega projects, chasing weak people away, extinguishing life, exterminating fish and filling dams in order to generate energy that may even be squandered afterwards. Forests are destroyed to create paper and precious resources squandered in creating and running a consumerist society unmindful of the consequences of its actions. The commercialization of water and energy production and distribution has left thousands of people without access to these services.

Instead of invading armies we must now contemplate the likes of 'invading' deserts, water shortages, air, water and soil pollution, rising sea levels, increased ultra violet radiation and an increased threat of diseases that may be the off-shoots of tinkering at the genetic level. These constitute *direct threats to environmental health and safety*. One of their consequences is mass migration of *ecological refugees*, fleeing from wars as well as ecological threats to health and livelihood. For example, on the margins of the Sahara and the Horn of Africa, refugee populations of several millions have crossed borders to escape starvation caused by overgrazing and drought. Sea level rises may trigger even more massive migrations than desertification.

The ecologically destructive power of the military is itself increasingly seen as one of the biggest threats to ecological security. Military training, production, storage and disposal of weapons and, above all, armed conflict (especially nuclear, chemical and biological warfare) are themselves major causes of environmental degradation. The use by the US military of Agent Orange to destroy forest cover and food crops during the Vietnam War or the burning of oil wells in the Gulf War are examples of the wilful destruction of ecological assets and natural resources by nations/states.

Technological innovations in transport have increased the speed with which ever-larger number of people and accompanying microbes move and the territory over which they range. The large-scale and rapid movement of people and products internationally has given birth to a host of global hitchhikers – viruses, bacteria and pests – that move fast into new environments where they flourish. Larger migrant organisms have also been transforming the environment and adding to ecological insecurity. Dozens of migrant organisms ranging from mussels to killer bees and weeds to super bugs have flourished when they have been transported into unexploited environments. They cause huge damage to native ecosystems.

In the context of agriculture, ecological security encompasses

- Management of agriculture to minimize environmental damage and degradation; regulatory mechanisms in agriculture for organic production; and scientific advances to improve agriculture and environmental security.

- Evaluation of medical and biological toxicity of agricultural chemicals and environmental pollutants accumulated in agricultural production; new techniques of detecting these substances, their toxicity mechanisms, and methods of removal or minimization.

- Promoting use of ecologically- safe technologies in agriculture – in crop production, in livestock, in processing and storage and new techniques that decrease toxic environmental inputs without lowering productivity.

New methods of producing and distributing food products can also adversely impact security from disease. The centralized production and large-scale distribution of food raises the spectre of potentially more severe outbreaks of disease rapidly spreading through human populations. For example, there have been several recent large-scale outbreaks of disease in many countries. "Mad Cow" disease has devastated herds in England leading to possible illness in human beings, sharply reduced consumption of beef, and a halt in beef exports. In Japan an outbreak of E-Coli bacteria felled thousands of school children. The recent bird flu in China posed a grave threat to human lives.

The agricultural genetic engineering biotechnology has not been critically reviewed from the stand point of ecological security. The potential risks of eating genetically engineered foods and their effect on human health are yet to be studied. Since genetically engineered (GE) food remains unlabelled, consumers cannot discriminate between GE and non-GE food, and should serious health problems arise, it will be extremely difficult to trace them to their source. The global fight for market share is leading multinational companies to massively deploy transgenic crops around the world (more than 30 million hectares in l998) without proper advance testing of short- or long-term impacts on human health and ecosystems.

There is a potential risk of generating new virulent strains of viruses, especially in transgenic plants engineered for viral resistance with viral genes. Many results emerging from the environmental performance of released transgenic crops suggest that in the development of 'resistant crops', there is a need to test not only direct effects on the target insect or weed, but also the indirect effects on the plant (i.e. growth, nutrient content, metabolic changes), soil, and non-target organisms. History has shown that a huge area planted to a single crop variety is very vulnerable to new matching strains of pathogens or insect pests.

Furthermore, the widespread use of homogeneous transgenic varieties will unavoidably lead to 'genetic erosion', as the local varieties used by thousands of farmers in the developing world are replaced by the new seeds. Genetic pollution, unlike oil spills, cannot be controlled easily, and thus its effects are non-retrievable and may be permanent.

Unquestioned expansion of this technology into developing countries may not be wise or desirable. There is strength in the agricultural diversity of many of these countries, and it should not be inhibited or reduced by extensive monoculture, especially when consequences of doing so may result in serious problems of environmental security. In fact, preservation of bio diversity and genetic conservation is one of the imperatives of sustainable agriculture.

Genetic conservation involves all activities aimed at ensuring the continued existence, evolution and availability of genetic resources, in situ and ex situ, e.g.

- **The collection, maintenance, storage and sustainable management of genetic resources aimed at ensuring their continued existence, evolution and availability for current and future generations;**
- **The management of human use of genetic resources so that they may yield the greatest sustainable benefit to present generations while maintaining their potential to meet the needs and aspirations of future generations;**
- **Protection of plant and animal habitats;**
- **The management or control of human use of resources (biotic and abiotic) and activities on the planet, in an attempt to restore, enhance, protect, and sustain the quality and quantity of a desired mix of species and ecosystem conditions and processes for present and future generations.**

Fig.15.1: We must ensure ecological security along with food security

Ultimately, the sustainability of a given ecosystem depends upon the maintenance of diverse and healthy gene pools of the organisms that constitute it. The need to preserve wild-type gene pools for domestication in plantations is vital; having a diverse gene pool from which to select, will help in the search for varieties that are resistant to pathogens, pests and environmental pollutants and have high growth rates and good qualities.

Lessons can be learnt from the agricultural experience so far: the genetic identities of almost all modern domesticated crop species are now quite different from those of their wild progenitors. Indeed, in many cases, those ancestral species no longer exist, severely limiting the improvements that can be made. The importance of maintaining a broad and viable genetic base, therefore, is an accepted principle among agricultural scientists.

Thus genetic conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment and is an essential ingredient of ecological security.

The need of the hour is more enlightened global ecological governance, genetic conservation, the 'conversion' of military budgets towards peace and sustainable development, and the redirection of military activities towards research in environment friendly technologies data collection, monitoring, technological innovation and transfer, and restoration. There is also an urgent need to challenge the patent system and intellectual property rights intrinsic to the World Trade Organisation (WTO), which provide multinational corporations with the right to seize and patent genetic resources.

Financial support for ecologically-based agricultural research should be expanded as the dramatic effects of rotations and intercropping organic production systems and general agro ecological techniques on crop health and productivity, as well as of the use of biological control agents on pest regulation, have been confirmed repeatedly by scientific research.

Yield increases are being achieved by using technological approaches, based on agro-ecological principles that emphasise genetic conservation, diversity, synergy, recycling and integration; and social processes that emphasise community participation and empowerment. When such features are optimised, yield enhancement and stability of production are achieved, as well as a series of ecological services such as conservation of biodiversity, soil and water restoration and conservation, improved natural pest regulation mechanisms, etc. leading to increased ecological security, are promoted.

The issues of technology transfer and appropriate technologies for the resource poor are critical in our quest for food security. We take them up in the next section. But before that you may like to attempt an SAQ.

SAQ 4

What do you understand by ecological security? Outline the factors that threaten ecological security.

15.4 TECHNOLOGY TRANSFER AND TECHNOLOGIES FOR RESOURCE POOR FARMERS

You have learnt that the sustainable development of rural economy and advances in agriculture are intertwined with the goals of poverty eradication and reduction of social and economic inequalities in the developing countries. While the world has witnessed tremendous advancement in the fields of science and technology, the results unfortunately have benefited a small portion of the rural population in the developing nations. The major hurdles for the large proportion of poor have been the lack of access to latest technologies and a lack of awareness regarding resource management techniques. The main factors responsible for such a state of affairs may be attributed to the lack of technology transfer and the communication divide between the farmer, the scientists and other sectors involved in agriculture. The technology options appropriate to farmers include, for example:

- improved soil usage through drainage, terracing and intercropping of food crops so as not to exhaust the soil;
- conservation, management and development of 'agricultural biodiversity', to make use of the vast range of plant genetic resources which farmers themselves have developed over centuries, such as thousands of indigenous varieties of staple food crops that are adapted to particular local conditions;
- sustainable use of wild foods and medicinal plants; and
- irrigation, water harvesting and other appropriate technologies.

The most appropriate technology will be one that builds on the use of local resources and is also sustainable. In terms of sustainability, the key issues are that the technology should be affordable, culturally acceptable, and the soil should not suffer from nutrient depletion, erosion or degradation.

Fig.15.2: Farmers need appropriate modern technology to improve productivity

Use of various technologies is involved in different aspects of farming, viz. seed preservation, planting, sowing, applying fertilizer, crop protection, harvesting, animal husbandry, livestock production, processing, transporting, storing, and marketing of food as well as use of tools and implements suitable for on-farm and off-farm activities. Appropriate technologies also include products to aid in fuel and water collection, food harvesting and crop processing, such as pumps, crop storage systems, efficient or smokeless stoves, water hauling devices, food driers, grinding mills, dehuskers, butter churners, beehives and honey extractors, transport vehicles such as trailers and carts, wheelbarrows, animal harnesses, hand-operated oil presses, biogas digesters, etc.

Access to and training in the use of appropriate small-scale technology has the potential to greatly enhance the quality of life and work of especially the poor farmers. However, information on the types of technologies developed for poor farmers is sorely lacking, as is the evidence of their appropriateness or success. Even in countries like India that have a comparatively stronger R & D base in rural technologies, the dissemination of these technologies to the poor farmers has a tremendous scope.

Thus, while the development of appropriate technologies per se may not be an insurmountable problem, but their transfer from the lab to the land is not that easy. Many of the technologies promoted to the farmers have been rejected, or partially and half-heartedly adopted with the result that the poor farmers have failed to benefit from them. Let us try to examine the reasons for this state of affairs.

Traditionally, appropriate technologies for the farmers are developed at special research centres. Here, researchers try out different species, cultivation practices, cropping patterns, and develop various techniques, tools and machines. Based on these studies, an appropriate technology is identified which is then extended to farmers. Even though in many cases the technologies developed are truly appropriate, as proven by their widespread adoption by farmers, in many more cases the technologies have failed miserably. Many reasons can be identified.

The primary reasons for low usage of appropriate technologies include **limited distribution systems, insufficient awareness among farmers of the technologies, high cost, and lack of coordination, training and attention to the specific needs of farmers.** Quite often farmers fail to understand the technology developed by the scientists. But more often, it is because the researchers fail to understand the background of the farmers for whom the technology is supposedly intended. In some cases, the problem may not be correctly identified, since only the technological aspects may be taken into consideration and the farmers' perspective ignored. In other cases, the technology recommended may be inappropriate: too costly, conflicting with social and cultural norms, ignoring farmers' preferences, not adapted to the local agro ecosystem, etc. In some other cases, technologies may be rejected, not because of the technology itself, but because those promoting it may be perceived as outsiders with no credibility as farmers.

The majority of farmers who are supposed to use these technologies are most of the time poor and illiterate. More often than not, technology development is not driven primarily by their knowledge or their perceived needs, but rather by imported prototypes and the views of technology developers and promoters are more theory based. Technology development is also biased in terms of socioeconomic class, with more attention given to those who can afford the technologies.

For example, improved water lifting technologies are currently limited to motorized pumps. While these pumps may be appropriate for larger-scale farmers, they are unaffordable and uneconomical for the majority of poor farmers who irrigate relatively small plots of land.

How can this situation be remedied? Firstly, farmers must participate in all stages of the technology development cycle: from the very first step of problem identification and planning to the implementation, monitoring and evaluation of the technology that may be termed as Farmer participatory approach. Farmers' input into the technology development is essential. It is necessary to create an honest, open, and equal two-way communication with farmers through appropriate programme approaches and extension methods.

Communication here does not only mean researchers and extension workers *telling* the farmers what they should and could do, but also the other way around; researchers and extension workers *being told* what to do by the farmers. What is needed is

communication in the truest sense of the word; a mutual exchange and sharing of opinions between equal partners.

Farmer acceptance and his assessment of the value of technology may not need controlled experimentation many a times. The farmer draws on his own experience to make decisions about application. Acceptance of a previously unused technology by a lead farmer usually means that many farmers "looking over the fence" will pick up the technology. However, following farmer acceptance, controlled farmers' field experimentation may be needed to fine tune the technology and overcome major local and unpredicted constraints.

Innovations carried out by the farmers themselves with proven results need to be given due recognition and disseminated amongst other farmers. For example, in India, the National Innovation Foundation supported by the Government of India maintains a database on the technologies innovated at the grassroots level by farmers across the country. It was set up with the main goal of providing institutional support in scouting, spawning, sustaining and scaling up grassroots green innovations and helping their transition to self supporting activities. It also helps in faster dissemination of information.

To sum up, there is a clear-cut need to forge strong linkages between research scientists, technology transfer agencies and farmers. Farmers' involvement at present is limited to on-farm trials but it is absolutely essential that the farmer must be the focus in all technological interventions. It is vital that the farmers are able to articulate their needs and views in all aspects of technology generation and application, including patent rights and access to genetic resources that has significant consequences for them in the short and long term. Moreover, their own innovations in technology need to be recognized and combined with the frontier technology, if needed, and disseminated. Farmers' participation at all levels is one of the key elements of technology development, transfer and the effective use of appropriate technologies to ensure food and ecological security of the current and future generations.

With this we end the discussion on the imperatives for a greener future. We now summarize the contents of this unit.

15.5 SUMMARY

- **Sustainable food and nutritional security** may be defined as a condition in which every individual at all times, has physical, economic, social and environmental access to **safe**, **nutritionally adequate** and **personally acceptable foods in a manner that maintains human dignity**. Along with availability, access to food, cultural acceptability and appropriate policies and processes are needed to achieve food security.

- Clean air, safe and reliable water supplies, nutritious and safe food, healthy housing and workplaces, civic services and protection against disease and disasters for all people form the cornerstones of **ecological security**. Its ambit may be expanded to include ecological sanitation, i.e., efficient, cost-effective eco-engineering for treating and recycling human excreta, waste water, and other wastes.

- **Genetic conservation** involves all activities aimed at ensuring the continued existence, evolution and availability of genetic resources, in situ and ex situ.

- While the world has witnessed tremendous advancement in the fields of science and technology, the results unfortunately have benefited a small portion of the rural population in the developing nations. This brings forth the importance of the issues of **technology development, transfer** and **appropriate technologies for the poor farmers**. There is a clear-cut need to forge strong linkages between

research scientists, technology transfer agencies and farmers. Farmers' participation at all levels is one of the key elements to ensure food and ecological security of the current and future generations.

15.6 TERMINAL QUESTIONS

1. Discuss the social, economic, cultural and environmental aspects of the issue of food security.
2. What do you understand by genetic conservation? Explain in what ways it influences food and ecological security.
3. Analyse the factors that inhibit the transfer of technology from the lab to farmers. List the technologies needed by the resource poor farmers to improve productivity. Suggest measures that can be taken to enable farmers to benefit from new technologies.