
UNIT 21 ENVIRONMENTAL IMPACT OF AGRICULTURAL PROGRESS

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21.0 OBJECTIVES

After going through this unit, you will be in a position to:

- define the concepts relating to the environmental impact of agricultural progress;
- identify the factors contributing to adverse impact of agricultural progress on environment;
- describe the agricultural practices having an adverse impact on environment;
- explain the factors associated with the intensified use of inputs creating a negative impact on environment; and
- outline the policy issues related to disturbing/restoring sustainable agricultural progress.

21.1 INTRODUCTION

The issue of environmental impact of agricultural progress relates to the degradation and unsustainable depletion of natural resources used in its production viz. soil, land, water, air, other matters of ecological system, etc. The concern on this issue has of late become so prominent that you would have noticed that in many of the previous units also we have discussed this aspect within the limits of the focus in those units. For instance, unit 2 discussed about the factors influencing soil erosion. Unit 11 discussed both the positive and the negative impacts of agricultural progress in the context of our achievements by green revolution. Unit 14 discussed the ‘sustainability related practices’ and ‘conservation agricultural practices’ both as has been traditionally practiced and also recently adopted following the awareness on the importance of minimising environmental damage while focusing on achieving higher output. Given this background, the objective and scope of this unit is to consolidate (by recapitulation supplemented by an extended discussion) the various aspects discussed before and then look at its policy dimensions. In this, both the policy initiatives that have contributed to environmental degradation and those that have since been taken to reverse them would be discussed. As ever, we will begin by studying some concepts of relevance to the theme of this unit.

21.2 CONCEPTS

In the context of environmental impact of agricultural progress, it is necessary to know in the first place what constitutes environment? This requires us to know the meaning and scope of the broader term ‘bio-diversity’. Evidently, apart from basic natural resources like air, water, forests, etc. bio-diversity includes many other bodies and micro-organisms all of which play their role in keeping the environment balanced in a sustainable manner. How far the practices in the direction of achieving higher agricultural output is causing the larger ecological system to be affected? We shall familiarise ourselves with the definition of some of the terms related to this issue in this section.

21.2.1 Bio-diversity

The term bio-diversity, or biological diversity, refers to the variability in ecosystems. There are different ecosystems like seas and oceans, rivers and lakes, deserts and grasslands, forests and mountains, main land and hinterland, etc. These ecosystems provide habitat for a community of living organisms (i.e. humans, plants, animals and microbes) and non-living components of environment, important for sustaining life like air, water, soil, etc. Within each ecosystem there are various species of living organisms in which each individual is genetically different. This diversity within the ecosystem needs to be conserved for the reason that the entire life system on a planet (e.g. earth) is interconnected with direct or indirect dependence on each other referred to as the ‘web of life’. Due to this, if one species becomes extinct, it affects other species. This could eventually start a chain reaction leading to the death of several species thereby disturbing the ecosystem in a lasting manner. In the context of agriculture, harvesting the trees in the forest, to make way for more agricultural land, has the potential of reducing the forest cover on the one hand and disturbing the habitat of many wild animals on the other. Likewise, pollution of water bodies could make the fish population suffer. Soil also could lose out its fertility levels due to excessive use of chemical fertilisers and over drawing of water from deep underneath. The disturbance to the ecosystem in terms of the quality of land, water, soil and air constitutes an environmental damage which can be observed in a shorter time span. In contrast, the disturbance to the environment in terms of ecosystem changes happens over a comparatively longer time span. Biodiversity changes resulting in degradation of environment impacts human health both positively

and negatively. While pollution of water and soil leads to the contamination of agricultural produce thereby harming the health of its consumers, loss of biodiversity (e.g. by the usage of HYV seeds) have resulted in the displacement of many indigenous species and agricultural systems leading to the extinction of valuable gene pools (vide 11.3.2.2). While these are instances of negative environmental impacts of agricultural progress, achievement of food security and the potential for the discovery of many medicinal products (most of which are sourced to plants and animals growing/living in the natural wilderness) with its immense benefits to mankind are positive dimensions of conservation of biodiversity. A type of biodiversity specific to agriculture is 'agricultural biodiversity'. This connotes all forms of life directly relevant to agriculture such as rare seed varieties, other organisms like weeds, pests, etc. including all animal breeds.

21.2.2 Green House Gases

In recent times, there is a growing realisation that the growth process must take due note of the sustainability and inclusive concerns. While this calls for expansion of activities spanning all sectors of the economy, in agriculture its manifestation encompasses the dimensions of meeting: (i) the food security concerns on the one hand and (ii) the need for agricultural diversification with the supporting expansion of non-farm sector on the other. In this context, controlling the unsustainable practices contributing to environmental disturbance is a major policy challenge. To understand the linkage, it is necessary to bear in mind that a basic tenet of all living organisms, including modern machinery and equipments, is that they need energy to function. And a major off-shoot of the generation/consumption of energy is the releasing of harmful gases into the atmosphere. It is here that the environment plays a crucial role in maintaining the biodiversity balance. This mechanism works as follows.

In the natural process, the amount of radiation from the sun rays is filtered by the atmospheric gases making the earth optimally warm thereby enabling life to exist on earth. But the increased demand for power/energy needed to fuel the growth process releases huge amounts of pollutants into the atmosphere. In most cases, this is released in one or the other of its gaseous forms. These gases (which are broadly five viz. water vapour, carbon dioxide, methane, nitrous oxide, and ozone) are called green house gases (GHGs). When the production of these gases is in excess of the nature's capacity to assimilate or absorb, the unabsorbed part radiates backwards (called re-radiation) to the lower layers of earth's surface. This causes the average climate on the earth to increase with the phenomenon popularly referred to as *global warming*. The crucial role of the environment is in the absorption of green house gas emissions. The limits on its absorptive potential are, however, set by the extent of sustainable/unsustainable practices pursued by man owing to demands of all round technological development. In particular, this potential is decreased when the green cover is reduced and increased when the amount of GHG emissions are not high. In view of this, the importance of matching afforestation and nature conserving measures needs no emphasis.

World over, it is estimated that agriculture is responsible for about 20 percent of green house gas emissions. The policy challenge is, therefore, to make the growth efforts so balanced that the GHG emissions (with its consequent re-radiation effect) are not allowed to outpace the capacity of environment to absorb and nullify their negative effect on earth. We have already seen that the contribution of agriculture to this phenomena is abetted by the changing cropping practices and improved post-harvest agricultural facilities (like establishment of cold chains, transportation and processing facilities, etc.). To recapitulate and expand on some of the other factors: (i) deforestation leading to higher concentration of carbon dioxide in air; (ii) unscientific

livestock manure management practices and intensified rice production contributing to higher emission of methane; and (iii) excessive usage of chemical fertilizers contributing to higher nitrous oxide emissions. The measurement of greenhouse gases is made in terms of their potency to contribute to global warming. In other words, the potency of a greenhouse gas is referred to as its global warming potential. Taken in units of carbon dioxide equivalent, it is estimated that methane's potency is 23 times higher and nitrous oxide's potency is 310 times higher than carbon dioxide. From this, the extent of impact on environment by the two agricultural emissions can be clearly understood.

21.2.3 Agro Economic Systems

The technological changes which act as drivers for environmental impact are also influenced by the agro economic system (AES) specific to a region. In this sense, besides the major domain of environmental impact i.e. biodiversity (of which air, water, soil, etc. are parts), the AESs themselves become domains of impact. The AESs are classified by their geographical characteristics like: (i) arid or dry region; (ii) coastal region; (iii) hilly and mountainous region; (iv) rain-fed region; (v) irrigated region; etc. The environmental impact on the AESs are a result of either the establishment of agriculture promotive facilities due to technological developments or the adoption of an agricultural practice unsuited naturally to that region. Such instances include: (i) construction of dams to provide irrigation to overcome the arid character of a region (instead of promoting dry-land farming); (ii) excessive grazing and conversion of common land for cropping purposes making the land become dry and grass scarce for animals; (iii) growing a water intensive crop in a water scarce region rendering the water table levels to sink (a result of HYV seed development); etc. We may, however, note that redistribution of a scarce resource like water from a surplus region to a deficit region by channelizing its course so that water does not go waste, paying attention to the commercial viability of a crop to yield higher income to the farmers, etc. are issues of importance justified in their own right. However, to the extent that their adverse environmental impacts are the result of intensified agricultural practices with unsustainable resource use, there is an adverse impact on environment. This calls for the adoption of a balanced and scientifically determined course of action. A policy thrust of Indian agricultural development pursued [from the Eighth Plan period (1992-97) onwards] has been to divide the country into specific agro economic zones (AEZs) [under the agro-climatic regional planning approach] and pay attention to its specific features for development. Another major feature of policy dimension has been the adoption of watershed management practice which was introduced during the seventh plan period (1985-90).

21.2.4 Watershed Management

Watershed management is defined as an integration of technologies within the natural boundaries of a drainage area for optimum development of land, water and plant resources in a sustainable manner. Their importance over the last nearly three decades on the policy front indicates a shift to micro level conservation practice. Watershed management aims at improving the productivity of soil by minimising its erosion due to continuous flow of water in a region most of it not only going waste but also creating human distress due to flooding. In agriculture, the approach is aimed at ameliorating the problems of low yield in areas dependent on rains by developing appropriate technology suitable to the natural framework of a region. In particular, the technique aims at achieving rainwater efficiency to improve productivity of crops in arid regions. Watershed studies record the benefits of this approach to: (i) increase the cropping area and cropping intensity; (ii) minimise or eliminate the problem of soil erosion; (iii) promote high value crop like groundnuts (in place of traditional low yield low value cereals like finger millet); (iv)

increase the number of working days per year in comparison with non-watershed areas; (v) increase yields ranging from 10 to 100 percent; and (vi) result in qualitative improvement like increase in water table levels. The environmental significance of watershed management's principle are thus clear from this illustrative list of benefits.

Check Your Progress 1 [answer in about 50 words using the space given]

- 1) What does the term bio-diversity imply? Mention its various components.

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- 2) Why is it important to conserve bio-diversity? Give examples to indicate its importance to agriculture.

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- 3) The impact of bio-diversity changes on environment are both positive as well as negative. Give illustrations in support of this statement.

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- 4) What are the five main greenhouse gases (GHGs)? In what way environment plays a natural role in containing their adverse effect on earth?

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- 5) Mention the three specific ways in which agriculture contributes to disturbing the bio-diversity balance. What specific measures would you suggest to restore the balance in this regard?

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- 6) In quantitative terms, how much is the estimated global contribution by agriculture to the GHG emissions? In what unit-equivalent are they measured? Which two GHG emissions, and by what measure, agricultural development potentially contributes to the environmental damage in this regard?

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- 7) Geographically, which are the five different agro-economic systems (AESs) that are also the domains of environmental impact on bio-diversity?

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- 8) Mention any three examples to indicate the manner in which the technological developments for agricultural growth contribute to disturbing the AES of a country.

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- 9) Mention the two policy responses that have been adopted in India to counter the adverse impact on environment by agricultural growth.

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- 10) Mention the various economic and environmentally beneficial advantages that have accrued by the adoption of watershed management practices in Indian agriculture.

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21.3 FACTORS CONTRIBUTING TO ADVERSE IMPACT ON ENVIRONMENT

We can classify the various agricultural factors/practices that contribute to adverse impact on environment under four heads: (i) intensive agricultural practices in general;

(ii) inputs associated with intensification; (iii) intensive rice production in particular; and (iv) industrial crop processing. Under each, among other things, we shall discuss how they contribute to disturbance of bio-diversity in general and/or the type of GHG emission that they release in the process in particular.

21.3.1 Intensive Agricultural Practices

Under this, we discuss five types of agricultural practices viz. monoculture, continuous cropping, tillage, intensive cultivation in hillside areas and intensive livestock systems.

21.3.1.1 Monoculture

Monoculture refers to the cultivation of a single crop species in a field. Unlike poly-culture, which mixes or intersperses crops with other activities like rearing domesticated animals or planting trees, monoculture is adopted for achieving higher yields through economies of scale. However, this practice impacts negatively on biodiversity as it provides for a narrower range of habitat to crops than in poly-culture fields. The practice also tends to need more chemical pesticides as crops are found to be more susceptible to insect infestation and other plant viruses. There are the consequent negative impacts on water quality, wildlife population and human health.

21.3.1.2 Continuous Cropping

The historical practice of leaving fallow periods has of late been given up in preference to continuous cropping systems. This is due to the rising demand for food and the changing demand for food preferences associated with the rising incomes of people resulting from economic growth. However, this has led to detrimental impact on soil conditions as consecutive crop cycles reduce the nutrient supply to the soil. In regions with good rainfall or irrigation facilities, this problem can be overcome with use of fertilizers. However, even in such areas, over time, soil tends to develop micro nutrient deficiencies. The long term effect of continuous cropping could lead to negative impacts on biodiversity as changes caused by the disruption of farmer's ability to take advantage of natural pest balances. In light of these facts, there has recently been an emphasis for allowing a period of fallow with leguminous crop rotation to restore the levels of soil fertility.

21.3.1.3 Tillage

Tillage reduces soil's organic matter content. This makes soil lose its ability to absorb and retain water rendering themselves prone to erosion and run-off. An important indicator of overall soil quality is its organic matter content derived from the falls of animals and plants. Abbreviated as soil organic matter or SOM, it provides many benefits to soils and crops such as: (i) protection against erosion by binding and stabilizing the soil particles, (ii) providing energy for soil micro-organisms, (iii) enhancing storage and transmission of water and nutrients, etc. Intensive tillage tends to reduce SOM levels, negatively affecting the air and water quality. Tillage also increases carbon dioxide emission. In light of this, there is a trend towards adopting 'zero tillage' practices on which you have studied in section 14.5 of unit 14.

21.3.1.4 Intensive Cultivation in Hillside Areas

Cultivation in steep slopes of hilly areas causes environmental impact of a different type than in the plains. Due to scarcity of land by large population depending on agriculture, there is a tendency to increasingly adopt intensive cultivation methods without proper soil conservation techniques. This degrades soil quality. Such soil when hit by the rainfall shifts the sediments and nutrients to lower regions rendering the upward sloping soils

less fertile. Further, the run-off of fertilizers and chemical particles makes the water quality for downstream human population contaminated. Over time, intensive cultivation practices have, therefore, the potential to adversely impact the eco-system of the hill region.

21.3.1.5 Intensive Livestock Systems

Livestock like cattle, sheep, goats, etc. play an important role by: (i) providing organic manure for fertilizers; (ii) supplying draft power for field operations; (iii) serving as a diversified source of food and income; etc. However, due to excessive grazing necessitated by intensified livestock population, they could: (i) convert grasslands into desert lands, (ii) place greater demand on water resource, (iii) result in soil compaction and erosion, (iv) destabilize stream banks and release large amounts of sediment into fragile aquatic ecosystems, (v) necessitate reseeding of natural meadows displacing native grassland plants, (vi) degrade water quality by excess application of inorganic fertilisers (which the reseeding usually requires) and unscientific livestock waste disposal practices, etc. Degraded water quality may also pose health risks to humans who rely on open water resources for their drinking purposes. In short, the impact on bio-diversity and water quantity/quality by intensive livestock rearing pose an environmental threat alongside its certain benefits to the farming families.

21.3.2 Inputs Associated with Intensification

The environmental impact on account of inputs associated with intensification could be discussed under four heads viz. (i) inorganic fertilizers, (ii) pesticides, (iii) irrigation systems and (iv) new seed varieties.

21.3.2.1 Inorganic Fertilisers

Usage of synthetic supplements have yielded increases in per year yields significantly. However, their inefficient application and crop uptake have impacted soil fertility, water and air quality and released lot of GHG emissions. For instance, impact on soil happens due to a process of chemical seepage into soils called acidification and nitrate leaching. Likewise, accumulation of unabsorbed nitrogen and other nutrients leaks into aquatic ecosystems leading to a state of overabundant nutrient concentration. This results in oxygen depletion reducing fish population and species diversity. Impact on air quality manifests in terms of nitric acid gas emissions contributing to smog and acid rain. Unabsorbed nitrogen is emitted as nitrous oxide, a GHG, which is estimated to have contributed to 38 percent of total global agricultural GHG emissions. Additionally, use of natural gas to manufacture inorganic fertilizer contributes to significant levels of carbon dioxide gas emissions.

21.3.2.2 Pesticides

Increased use of chemical pesticides, since mid-1900s, to limit crop losses from pests and plant diseases has affected biodiversity by harming animal and human health. Estimated efficiency rates of pesticide application are far lower than fertilizers with some estimates indicating that less than 0.1 percent of pesticides applied to crops actually reach the intended pests. A large remainder, therefore, accumulates in soil which filters down into ground water sources proving toxic to micro-organisms, aquatic animals and humans. Domesticated livestock also get affected by exposure to pesticides. Increased pesticide use spurs weeds and pests develop pesticide-resistance resulting in a constant need to develop new varieties of pesticides. This creates a chain reaction of negative biodiversity impacts.

21.3.2.3 Irrigation Systems

Over-irrigation and poor drainage causes water logging and soil salinization which decreases soil productivity. This prevents plant roots from getting adequate oxygen. One of the most common negative environmental impact of excess irrigation is that it makes water tables to rise artificially. As water tables reach the soil surface, water evaporation leaves behind salts which increases the salinity levels. This causes lowered soil productivity. The problem of salinization particularly affects semi-arid and arid regions more on account of lower amounts of rainfall which could otherwise help clear away the accumulated salts. However, such run-offs damage downstream natural ecosystems. Irrigation discharge also contains numerous suspended particles. This becomes another factor for degrading the ground and surface water qualities.

21.3.2.4 New Seed Varieties

Technological advances have greatly increased the ability to manipulate plants' genes. This has led to developments in gene revolution which relates to development of hybrid seeds to provide both high yields and better resistance to pests. In developing countries as a whole, modern semi-dwarf wheat varieties make up for about 80 percent of wheat cultivation. Environmental concerns around such seeds centre around their high input requirements and effect on biodiversity. This is because to realise the high potential of such hybrid seeds, increased quantities of fertilizer, nutrient supplements and water are needed. We have already studied the negative impacts of such excess inputs on soil and aquatic life. Such seeds are also feared to affect the genetic diversity considered vital for future development of new seeds. For instance, conventional breeding and biotechnology draw on the stocks of genetic diversity contained in seeds responsive to environmental conditions. With higher usage of hybrid or genetically manipulated seeds, the traditional genetic diversity would be lost. In order to protect against such losses, countries have established centres to store gene banks. However, such ex-situ collections separate the natural seed qualities available in the natural ecosystems. Scientists are also concerned about the consequences of genetic exchange between transgenic crops and wild plant population. You have already studied about these concerns in section 11.5 of unit 11.

21.3.3 Intensive Rice Production

Intensive rice production through HYV seed technology requires all of the above discussed methods viz. monoculture, continuous cropping, irrigation, fertilizer & pesticide use, etc. The environmental impact of this production are, therefore, on soil, water quantity & quality, human and animal health through contaminated water flows and declining water levels, nutrient deficiencies, etc. In areas lacking water supply, this has the potential of depleting the water supplies for other regions. This has happened in Tamil Nadu where 80 percent of paddy fields are irrigated and in one decade water table has fallen by as much as 25 to 30 meters. Usage of urea, which provides 80 percent of nitrogen demand to rice, makes nitrogen dissolve in irrigated water. Such water, when flows to other regions, causes water pollution proving lethal to fish in downstream ecosystems. The low oxygen conditions of flooded rice paddies makes the waterlogged soils ideal habitat for methane producing microbes. This is the reason why intensive rice production also emits significant levels of methane gas into the atmosphere. Globally, rice systems account for 11 percent of agricultural GHG emissions. In South and East Asia they are accountable for 82 percent of total methane emission. The environmental impact of intensive rice cultivation must, therefore, be quite clear by this.

21.3.4 Industrial Crop Processing

With agricultural exports becoming an important item of international trade, and cash crops among the items occupying a significant overall share of such exports, the post-harvest processing has assumed industrial dimensions. Such crops include: coffee, cotton, cocoa, etc. all of which impacts on water quantity and quality, air quality and climate change. Moreover, processing requires substantial amounts of water whose use varies by the method adopted for processing. For instance, the 'wet method' processing of coffee seeds used for separating quality coffee seeds from defective ones transports the berry husks from coffee grains threatening the supply of water for other human use. Water used for processing becomes polluted with chemicals and other heavy metals from all stages of the production cycle. Such untreated water effluents are discharged into river or other water bodies due to laxity in laws or their strict implementation. There would thus be negative impact of such effluents on fish population due to depleted oxygen. Besides these factors, the energy-intensive processing machinery are a source of carbon dioxide emissions. Emissions from processing plants also degrade air quality by contributing to acid rain and ozone depletion.

Check Your Progress 2 [answer in about 50 words using the space given]

- 1) State the four broad areas into which the agricultural practices contributing to adverse environmental impact can be classified? State also the four heads under which the intensified use of agricultural inputs can be grouped?

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- 2) In what way does 'monoculture' negatively impacts the biodiversity of a region?

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- 3) State the distinguishing feature between the traditional cropping system and the modern continuous cropping system? In what way does the latter affect soil quality? What is the long term impact on biodiversity in the continuous system of cropping?

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- 4) How does 'tillage' affect soil quality? Which particular GHG emission does it emit?

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- 5) How does intensive cultivation in hills adversely affect the eco-system of the region?
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- 6) State the various ways in which excessive grazing in intensive livestock systems pose an environmental threat in a region?
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- 7) Which two GHG emissions are released by the use of inorganic fertilizers in agriculture? How does it affect the aquatic life of a region?
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- 8) In what way does the irrigation facility contribute to damaging the natural ecosystem of a region?
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- 9) How does the 'new seed varieties' pose an environmental concern? What measure is taken to protect the genetic diversity posed by this? Despite this step, what major concerns are being faced by mankind?
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- 10) State the different adverse environmental impacts posed by 'intensive rice production'. Which GHG emission is released by this production system?
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- 11) How does 'industrial crop processing' contribute to adverse environmental impact? What particular negative impact does this pose for the aquatic life and air quality of a region?

21.4 POLICY ISSUES

Alongside the various developments marking for negative environmental impact, there have been various conservation measures initiated for negating the negative environmental impacts of agricultural progress. We have already studied some of them in Unit 14. To recall and add on to some of these positive impacts of agricultural progress on environment are: (i) mechanical and agronomic soil and water conservation (SWC) measures (e.g. contour cultivation, contour strip-cropping, mixed cropping, tillage and surface mulching, zero tillage, etc.); (ii) change in land use (e.g. livestock farming in arid AES regions, agro-forestry in hilly areas, integrated farming system in coastal regions, etc.); (iii) water harvesting through tanks; (iv) watershed based management system; (v) resource conserving technologies (RCTs) (e.g. rice-wheat consortium or crop establishment options for wheat/rice, site-specific nutrient management, etc.); (vi) integrated pest and nutritional management; etc. Thus, both the positive and negative impact on environment are a result partly of government policy introduced for agricultural progress and partly due to lack of awareness on proper utilisation of modern practices. In this section, we shall briefly classify and discuss some of these policy initiatives that have contributed to these impacts on environment.

Output Price Policies: As noted before in units 19 and 20, the policy of minimum support price in favour of rice and wheat crops became more pronounced after 1980. This led to the accumulation of huge grain stocks. Further, crop specific policies heavily protected oilseeds in the years following 1980s. These policies greatly influenced the choice of crops grown by farmers in total disregard to available natural resource endowments.

Input Subsidy Policies: The higher output support price policies were also accompanied by input subsidies on water, fertilizers and power. Subsidies on these three factor inputs have formed the bulk of total subsidy for the farm sector. Over the period 1980 to 1990s, as a percentage of GDP the subsidy on these items increased from 3.4 percent during 1980-81 to 9.8 percent during 1995-96. Due to increased use of fertilizers, the production of fertilizers during 1999-2000 fell short of consumption by as much as 27 percent. The policy of government to accelerate food production introduced bias in favour of states with more/better irrigation facilities. This encouraged the production of irrigation intensive crops like wheat and rice in these states. To rectify this bias, many researchers suggested that there was a need to reorient policies to promote agriculture in states like North East, M. P., Rajasthan and H. P. where agriculture was prone to

high risks and relatively less developed. While this was done in the subsequent years, the result of which are now becoming evident with some of these states having become the leading agricultural producers, there was policy emphasis for promoting balanced and integrated use of fertilizers. For instance, a national project on the development and use of organic/bio-fertilizers was launched in a big way during the Tenth Plan period. Policy initiatives to reduce the use of chemical pesticides, under integrated pest management (IPM) policies had also been launched since 1985. It is thus clear that efforts to promote agricultural growth which contributed to environmental degradation have simultaneously been pursued with nature conservation measures right from the 1980s.

Irrigation: The creation of irrigation potential was matched with policies for promotion of their optimum utilization. This was done by way of fixation of water usage charges for agriculture at low rates. It has been criticised that these rates did not cover even the working expenses of providing the service let alone the capital costs of its supply. Low charges on irrigation prevented the farmers from adopting efficient water usage practices which could in turn have reduced methane emission levels. There were also wide variations in the water charges between crops and among states. This encouraged farmers to opt for water intensive crops in preference to crops which were environmentally sustainable.

Electricity: In addition to low water charges, heavy subsidy on electricity greatly contributed to increased irrigation levels and over extraction of ground water. The policy of subsidy was biased to irrigated farming which led to changes in cropping pattern in favour of water intensive crops like rice. This has since been identified as a major factor of environmental externalities. The increasing cost of extracting water due to falling water table levels was not getting reflected in the private costs of farmers as they were paying electricity charges to operate tube wells at flat rates. In other words, the marginal cost of extracting ground water was zero. Thus, the policy of subsidies led to: (i) distortions in the cropping pattern in favour of water intensive crops; (ii) adverse environmental effects like water logging and salinity; (iii) depletion of ground water levels; and (iv) serious long term implications for inter-regional disparities in agricultural development due to bulk of benefits having gone to irrigated areas.

Credit, Investment and Trade Policies: The credit flows to agriculture and rural sector have concentrated in a few regions and on well-to-do farmers. As noted before in Unit 18, the eastern and central states were particularly affected due to their low credit share. Although the major share of land holding are from the small and medium farmers segment, the credit system has not been favourable to meet their credit needs. This has prevented this large farming community from adopting practices needed from the point of view of environmental and natural resource concerns. Capital investment policies have also largely favoured major irrigation works to the neglect/exclusion of investment in other categories. This has led to large areas becoming waterlogged and saline. In the matter of trade liberalisation, which is more encouraging for horticulture, floriculture, fisheries, etc., the strategies needed are different for eastern/dry land/wasteland regions in view of their comparative advantage in horticulture and livestock products. For harnessing the export potential of such diversified products in these regions, it is necessary to reorient trade/investment policies towards these regions. This would minimise degradation of the natural resource base in these regions by discouraging the growing of water intensive crop like rice which is being practiced in these regions.

Institutional Issues and Peoples Participation: From the conservation and sustainability perspective, tenancy reforms are argued to be less likely to receive soil conservation investments. However, legislative measures like the 73rd and the 74th

constitutional amendments have accorded a definitive role for local bodies in the management of natural resources like land, water and forests. Thus, to off-set the inabilities of small farmers in adopting conservation measures, collective structures like cooperatives are suggested as best institutions for sustainable development. This is required to be pursued actively in the coming years.

Check Your Progress 3 [answer in about 50 words using the space given]

- 1) State some of the major policy measures which have contributed to a positive impact on environment due to agricultural progress.

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- 2) Do you agree that the output price policies have contributed to negative environment externalities? How?

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- 3) Which are the three agricultural inputs that have received the bulk subsidy support? In what way has this contributed to becoming an environmental concern?

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- 4) Mention some of the major policy measures initiated during the earlier plan periods for the promotion of balanced and integrated use of natural resources.

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- 5) How has subsidised water charges contributed to environmental degradation?

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- 6) In what specific respects the policy of subsidised electricity supply to agriculture has contributed to adversely affecting the environment?

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- 7) How have the credit and investment policies contributed to degradation of environmental and natural resources?

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- 8) Do you think there is a need for reorientation of strategies to promote commercial agricultural practices? In what way it would help in minimising natural resource degradation?

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- 9) How would you say that the promotion of tenancy reforms has contributed to natural resource degradation? What strategy would you suggest to rectify this situation?

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21.5 LET US SUM UP

The progress of agriculture in India during the last few decades have had both positive and negative impacts on the natural eco-system of the country. Many of these are a direct result of policies adopted to promote agricultural growth. While many specific policy initiatives to minimise the environmental damage from agricultural practices have also been implemented, environmental distortions in terms of GHG emissions and imbalanced regional development are marked in the agricultural progress in India. The trend in the former (i.e. GHG emissions) is, however, not unique to Indian agriculture alone. It is a global phenomenon in which the contribution of modern agricultural practices to adverse climatic change has become a matter of international concern. Among the factors which have contributed to this adverse impact on environment, intensive agricultural practices like monoculture, continuous cropping, tillage, etc. on the one hand and intensified use of inputs in terms of inorganic fertilisers, pesticides, new seed varieties,

etc. on the other, could be enumerated. In respect of agrarian economies like India in particular, there is a need to reorient strategies in order to institute collective participation aimed at adoption of sustainable agricultural practices.

21.6 KEY WORDS

- Global Warming** : Normally, when the sunlight and its radiation (i.e. heat or energy) reaches the earth's atmosphere, part of it is absorbed by the atmospheric gases and the rest by the earth. This process maintains the potential of the environment to keep the earth's climate at an optimum level. However, in the presence of unsustainable emission of GHGs, this optimum potential of the environment is disturbed. As a result, while a part of the GHG emissions are absorbed, the unabsorbed part radiates back to the earth. This makes the earth warmer causing the earth's average temperatures to rise. This is called as the global warming effect.
- Watershed Management** : Watershed is a hydrological unit of an area having only one outlet for drainage of runoff/surface flow of water. Watershed management refers to the 'in situ' (i.e. with in a localised area or place) control of rainfall for its optimal use within the boundary of an area.
- Water Logging and Water Runoff** : Water logging refers to water stagnation due to excess irrigation and poor drainage facility. It causes increased salinization and decreased soil fertility. Water runoff, on the other hand, is a problem of water flow from uphill areas to downhill areas in hilly regions. It causes transportation of contaminants like chemicals making the downstream water sources polluted and harmful for human and animal consumption. Both are factors for loss of potential water resources.

21.7 SUGGESTED BOOKS/REFERENCES FOR FURTHER READING

Jenifer Wightman, Production and Mitigation of Greenhouse Gases in Agriculture, <http://www.climateandfarming.org/pdfs/FactSheets/IV.1GHGs.pdf>

Katherine Killebrew and Hendrik Wolff, Environmental Impacts of Agricultural Technologies, EPAR Brief No. 65, University of Washington, March, 2010. [<http://faculty.washington.edu/hgwolff/cv.pdf>]

Sudhakar Yedla and Sowjanya Peddi, India Environment National Assessment, October, 2003. [ftp://ftp.fao.org/es/esa/roa/pdf/2_Environment/Environment_IndiaNA.pdf]

V. P. Sharma & Hrima Thaker, Fertiliser Subsidy in India: Who are the Beneficiaries?, Special Article, EPW, Vol. XLV, No. 12, March, 2010.

21.8 ANSWERS/HINTS FOR CYP EXERCISES

Check Your Progress 1

- 1) See section 21.2.1 and answer.
- 2) See section 21.2.1 and answer.
- 3) See section 21.2.1 and answer.
- 4) See section 21.2.2 and answer.
- 5) See section 21.2.2 and answer.
- 6) See section 21.2.2 and answer.
- 7) See section 21.2.3 and answer.
- 8) See section 21.2.3 and answer.
- 9) See section 21.2.3 and answer.
- 10) See section 21.2.4 and answer.

Check Your Progress 2

- 1) See sections 21.3.1 & 21.3.2 and answer.
- 2) See section 21.3.1.1 and answer.
- 3) See section 21.3.1.2 and answer.
- 4) See section 21.3.1.3 and answer.
- 5) See section 21.3.1.4 and answer.
- 6) See section 21.3.1.5 and answer.
- 7) See section 21.3.2.1 and answer.
- 8) See section 21.3.2.3 and answer.
- 9) See section 21.3.2.4 and answer.
- 10) See section 21.3.3 and answer.
- 11) See section 21.3.4 and answer.

Check Your Progress 3

- 1) See section 21.4 and answer.
- 2) See section 21.4 and answer.
- 3) See section 21.4 and answer.
- 4) See section 21.4 and answer.
- 5) See section 21.4 and answer.
- 6) See section 21.4 and answer.
- 7) See section 21.4 and answer.
- 8) See section 21.4 and answer.
- 9) See section 21.4 and answer.