UNIT 11 GREEN REVOLUTION

Structure

11.0 OBJECTIVES

After going through this unit, you will be able to:

- explain the concept of green revolution (GR);
- outline the historical context and main features of the first green revolution;
- describe the features of green revolution from both its positive and negative dimensions; and
- indicate the need for post-green revolution efforts that had to be initiated to achieve agricultural development of the regions to which the GR did not spread.

11.1 INTRODUCTION

Agricultural development and food security have been the major concerns of India since independence. The emphasis given has, however, varied with the result that the development of the agricultural sector has witnessed its peaks and troughs intermittently. The First Five Year Plan kept at its core the development of agriculture as its primary focus. Despite this, during the Second Plan, India faced severe food shortage. To deal with this problem, in 1958, India invited a team of experts (led by Dr. S.E. Johnson of US Department of Agriculture) to examine the causes of food grain shortages and suggest remedial measures. The team [in its report entitled "*India's Food Problem and Steps to Meet It*" (1959)] recommended that India should focus more on those areas where the potential of raising agricultural productivity was high. Consequent to this, some already developed regions were selected for intensive cultivation to grow more food grains. Later in 1960s, two major programmes viz. Intensive Agriculture Area Programme (IAAP, 1961) and Intensive Agriculture District Programme (IADP, 1964) were launched. These two programmes made large investments in irrigation, fertilizer, agricultural R&D, education, and extension services which together led to achieve a period of high growth in productivity and production in Indian agriculture, popularly referred to as the green revolution (GR). Although hailed for its success widely, the very fact that it was focused on some already agriculturally developed regions, and it was promoted by intensive investment in those regions, also instilled into its very approach factors favouring a focused regional development. In other words, in its approach and design it was not marked for achieving a balanced development of all regions centered around agricultural development in general. Thus, although the green revolution transformed the food-deficit economy into a food-sufficient one by substantially raising the overall agricultural production, productivity and income, it also generated several negative effects in the rural economy. In particular, its economic and ecological consequences in terms of: (i) depletion of groundwater table; (ii) deterioration in the quality of soil; (iii) increased input cost; (iv) increased credit requirement; etc. marked it for its grey side of the success story. Against this background, in the present unit we will study in detail the positive and negative impacts of the GR on the Indian economy. We will also study about the dimensions of a much needed second GR which in the current circumstances has become crucially needed owing to factors of international perspective and dimensions. But before this, we will begin by making a brief reference to the historical aspects of the first GR.

11.2 CONCEPT OF GREEN REVOLUTION

The term 'Green Revolution' refers to the new agricultural technology developed during the 1950s and 1960s by a team of agricultural experts at the International Centre for Maize and Wheat Improvement in Mexico and at the International Rice Research Institute (IRRI) in Philippines. The technology developed at these two centers was subsequently adopted by most of the developing countries in Asia and Latin America contributing to improving the agricultural productivity and attain self-sufficiency in food grains in these countries. The technology involved the use of high yielding variety (HYV) seeds and adoption of a package of modern agricultural inputs, tools and practices (like chemical fertilizers, pesticides, assured and controlled irrigation, tractors, threshers, electric and diesel pumps, etc.). Although initially the new agricultural strategy was limited mainly to wheat and rice crops, later it spread to other crops. These practices were instituted in place of

traditional farm practices which were mostly based on farmers' self-owned inputs and resources [like indigenous seeds, farm yard manure, manual irrigation, use of draught power (animal power), etc.]. The problem with the indigenous seeds was that they were unable to withstand high doses of chemical fertilizer applied to increase productivity whereas the HYV seeds, in conjunction with chemical fertilizers and irrigation, yielded the much needed higher productivity. The term 'green revolution', was coined by Dr. William Gaud (the then Administrator of USAID) who in 1968 used the term to describe the success achieved by the new agricultural technology in developing countries of Asia and Latin America.

11.2.1 The Historical Context

The process of green revolution began with the initiation of agricultural research programme in early 1950s in Mexico by the Rockefeller Foundation team of agricultural experts, including Dr. Norman Borlaug. Dr. Borlaug intensively researched on the Mexican wheat and became successful in inventing high yielding varieties of dwarf wheat in mid-1950s. With the application of HYV seeds for wheat, Mexico became self-sufficient in wheat production by the early 1960s and even began to export. Later on, in 1962, the International Rice Research Institute (IRRI) was set up in Philippines [again with the support of Rockefeller and Ford Foundation] to develop new HYV seeds of rice crop. The new varieties of rice crop developed by the IRRI increased the rice productivity in Philippines even better than in case of wheat in Mexico. Like the Mexican wheat, the rice seed varieties were also highly responsive to the use of chemical fertilizer and irrigation. These two efforts made significant contribution in achieving the green revolution in most of the developing countries, including India. Dr. Borlaug was given Nobel Peace Prize in 1970 for his contribution to agricultural development and solving the world's food problem at that time.

As stated before, India faced severe food shortages during 1950s and 1960s and had to import food grains. India was desperate to overcome shortages of food grains as early as possible. As a result, on the recommendations of Ford Foundation team of agricultural experts, India adopted the new agricultural strategy to grow more food grains, especially wheat and rice, in selected agriculturally developed regions. In the 1960s, the Ford Foundation with the approval of the Indian government initiated the Intensive Agricultural Area Program (IAAP) with better technological inputs to raise agricultural productivity. The emphasis was on concentrating more on those areas where the potential of agricultural development was high in order that rapid increase in food grains production could be achieved. Essential inputs and services were provided to the farmers in these selected districts. The programme proved quite effective in raising the food grains production in the selected regions. In the light of the encouraging results of the IAAP and the growing need for more food grains, the government (during 1964-65) initiated the Intensive Agriculture District Programme (IADP) in 114 selected districts where the potential of agricultural development was high. Both the IAAP and the IADP were based on the 'big push' theory of economic development. The two programmes became the most important steps towards achieving green revolution in India. Dr. Norman Borlaug and Dr. M. S. Swaminathan (agricultural scientists) and Shri. C. Subramanian, the then Minister of Agriculture had been the key persons in bringing the new agricultural technology to India. The main objective of the new strategy was to achieve self-sufficiency in food grains by providing access to farmers the necessary inputs and services. This was done by establishing significant agricultural research, extension and marketing infrastructure under massive

public investment in areas of: (i) surface and groundwater irrigation, (ii) manufacturing agricultural equipment and fertilizers, (iii) establishment of Agricultural Price Commission, (iv) nationalization of private banks and (v) setting up of cooperative credit institutions to provide credit facilities to the farmers. In addition, advent of tube-well technology during this period also became instrumental in contributing to the raising of agricultural productivity and changing the cropping pattern especially in Punjab, Haryana and Western Uttar Pradesh. Within a short span of time, the wheat revolution spread over the entire North India and tremendously increased the production and productivity of wheat crop. Later on, a similar revolution occurred in rice crop. The green revolution technology, in spite of its severe criticism on the issues related to equity, ecology and environment, thus made remarkable contribution in transforming the Indian economy from its notorious ship-to-mouth food-deficit status to that of not only a food-self-sufficient country but even a food-surplus country.

11.2.2 Main Features of Green Revolution

Unlike the traditional farm practices which mostly relied on indigenous seeds and internal inputs (non-purchased inputs), the new agricultural technology was mainly based on external inputs (purchased inputs) which required substantial financial resources for its adoption. The GR technology came in a package of HYV seeds – irrigation– fertilizers. All these are needed together in correct proportions as both inadequacy and excessive use of water were harmful to these seeds. Availability of assured and controlled irrigation and use of chemical fertilizers thus became the two critical factors in raising the productivity of HYV seeds. Therefore, GR technology was more suited to the areas that had adequate irrigation facilities as well as proper water irrigation/drainage system. While on the one hand the HYV seeds required high doses of chemical fertilizers for their growth, the use of fertilizers in turn generated weeds, requiring the application of weedicides.

One of the key features of HYV seeds is that they had shorter period of maturity which gave opportunity to farmers to grow more number of crops in a year. Thus, the GR technology helped increase cropping intensity. Higher level of productivity and cropping intensity under the GR technology made it a land-saving technology. However, in order to release the land for next crop, farmers needed to do various farm operations, including crop harvesting and land preparation for the next crop, in time. For this, use of modern farm machines such as tractors, threshers, irrigation pumps, etc were required. Thus, the GR technology helped in attracting more investment in manufacturing of farm machines, irrigation pumps, etc. and also to set up banking and marketing infrastructure facilities in small towns and rural areas. Thus, since the GR technology involved heavy infrastructural investment, the technology was more suited to the big farmers who could afford to purchase the farm machines and equipments optimizing their use because of their large farm sizes. Though investment on heavy machinery was necessary for adoption of HYV crops, more investment on hiring and purchase of other inputs were essential even on small farms. Small and marginal farmers had no capacity to invest since access to credit was limited. Thus, although the HYV-fertilizer-irrigation technology was considered scale-neutral and increased the land productivity irrespective of the size of operational holdings, in practice it was certainly not resource-neutral. It was therefore, necessary to make cost-effective usage of new technology on small and marginal size holdings through some institution building measures like the formation of group-farming.

In brief, therefore, the HYV seeds, use of chemical fertilizers and pesticides, application of modern farm machines, extensive irrigation facilities, multiple cropping, improved credit facilities, support price policy and improved R&D and extension infrastructure came to signify the main features of the green revolution movement in India.

Check Your Progress 1 [answer in about 50 words within the space provided]

1) Would you say that the concept of Green Revolution was unique only to India? Who were the key scientists who played a major role in this respect in India?

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2) What key inputs were fundamentally needed for the success of the Green Revolution Technology?

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3) What are the two projects under which the GR strategy spread in India? What distinguished the two projects in their basic approach?

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4) Which are the key institutions that have contributed to the spread of GR culture in India?

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5) Do you think that the GR technology can also benefit the small and marginal farmers segment? How?

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11.3 IMPACT OF GREEN REVOLUTION

GR technology in India has made phenomenal impact on agriculture in particular and entire economy in general. It has, however, made both positive as well as negative impacts.

11.3.1 Positive Impacts

On the positive impact front, the GR technology helped to raise the production and productivity of crops, especially wheat and rice, increase cropping intensity,

change the cropping pattern from coarse cereals to super cereals and later on to cash crops, including sugarcane and horticultural crops; and solve the problem of food security.

11.3.1.1 Increase in Production and Productivity of Food Grains

One of the most important impacts of green revolution (GR) was on raising the production and productivity of cereal crops, especially wheat and rice. The cereal production was increased due to three factors: (i) increase in net area under cultivation; (ii) growing two or more crops in a year on the same piece of land; and (iii) use of HYV seeds. The GR resulted in a significant increase in the production of food grains from 72.4 million tons in 1965-66 to 131.9 million tons in 1978-79 establishing India as one of the world's biggest agricultural producers. Per hectare yield of food grains increased from 6.3 quintal per hectare (Q/ha) in 1965-66 to 10.2 Q/ha in 1978-79. Percentage of total food grains area under irrigation also increased from 20.9 in 1965-66 to 28.8 in 1978-79. These productivity increases also enabled India to become an exporter of food grains around that time.

Figure 11.1 shows the trends in area, production and yield of wheat crop in India since 1950-51 to 2009-10. It is evident from the graph that the production of wheat has significantly increased during and after the green revolution period. The production went up from 10.4 million tons (MT) in 1965-66 to 35.5 MT in 1978-79 and further to 80.7 MT in 2009-10. The spectacular increase in production of wheat was mainly due to massive rise in its per hectare yield which went up from 8.3 Q/ha in 1965-66 to 15.7 Q/ha in 1978-79 and further to 28.3 Q/ha in 2009-10. Area under wheat also grew notably during the green and post-green revolution periods as can be seen from the Figure 11.1. However, in the recent years, per hectare yield of wheat grew faster than its area, implying that productivity growth in wheat has contributed more to the wheat production than the increase in area under it. Although production of wheat shows significant rise over the period, it also indicates fluctuations across years.

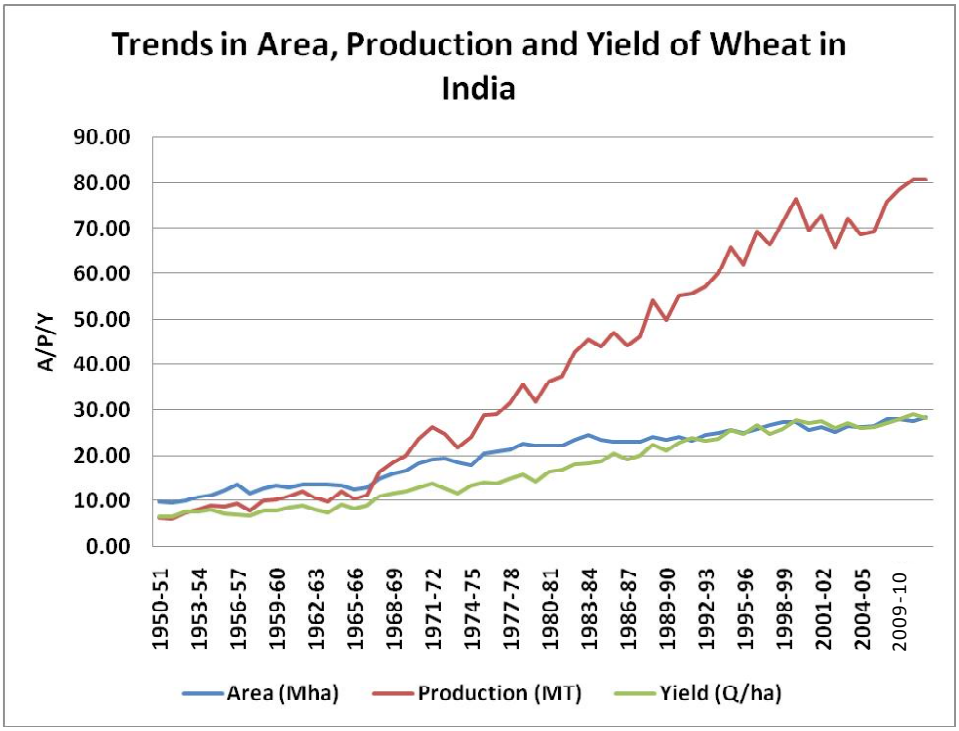

Fig. 11.1: Area, Production and Yield of Wheat in India – 1951-2010

Area, production and yield of rice (paddy) also increased significantly during the green and post-green revolution periods. The production went up from 30.6 MT in 1965-66 to 53.8 MT in 1978-79 and further to 89.1 MT in 2009-10. The per hectare yield of rice increased from 8.6 Q/ha in 1965-66 to 10.7 Q/ha in 1978-79 and further to 21.3 Q/ha in 2009-10. The per hectare yield of rice grew at a rate much slower than that of wheat. This implies that the GR technology had penetrated more in wheat crop than in the rice crop. Further, the area under rice achieved a relatively slow growth when compared to the area under wheat. However, it is important to know that the data on area, production and yield of wheat and rice crops presented in the graphs are all-India aggregates which comprise both the irrigated and the un-irrigated regions.

Estimates of growth rate in area, production and yield of two principal cereal crops (wheat and rice) during four periods viz. pre-green revolution period (1950-51 to 1964-65), green revolution period (1967-68 to 1978-79), post-green revolution period (1979-80 to 1990-91) and post-economic reform period (1991-92 to 2009-10) is presented in Table 11.1. In case of wheat, area recorded the highest growth during the green revolution period (3.3 percent), followed by the pre-green revolution period (2.7 percent); the lowest being in the post-green revolution period and post-reform periods (0.6 to 0.7 percent).

Table 11.1: Compound Annual Growth Rates in Area, Production and Yield of Wheat and Rice during Different Time periods (percent)

Time Periods	Wheat			Rice		
	Area	Production	Yield	Area	Production	Yield
1950-51 to 1964-65 (Pre-GR)	2.7*	4.3*	1.5*	1.5*	4.4*	2.9*
1967-68 to 1978-79 (GR)	3.3*	5.9*	2.5*	0.8*	2.6*	1.7*
1979-80 to 1990-91 (Post-GR)	0.6**	4.2*	3.6*	0.6**	4.3*	3.7*
1991-92 to 2009-10 (Post- reform)	0.7*	1.7*	0.9*	0.1	1.2*	1.1*

Note: * and ** stand for significance at 1% and 5% level respectively.

Similarly, production of wheat recorded the highest growth in the green revolution period (5.9 percent) followed by the pre-green revolution period (4.3 percent). The growth in wheat production in the post-GR period (4.2 percent) of 1980-91 was also not too low but in the post-economic reform period it was the lowest at 1.7 percent. In terms of per hectare yield of wheat, however, the post-green revolution years had the highest yield (3.6 percent). Once again, the per-hectare yield was the lowest (0.9 percent) in the post-reform years of 1992-2010. A similar trend is noticed in the per-hectare yield of rice in which the post-GR years of 1980-91 had witnessed the highest growth (3.7 percent). Like in the case of wheat, for rice too there was a steep decline in the per-hectare yield in the post-reform years of 1992-2010 (1.1 percent).

11.3.1.2 Employment Generation

The impact of GR technology on employment generation in agriculture has been

contentious. Critiques of Green Revolution argue that increased mechanization of farm practices in the green revolution regions reduced the employment absorption in agriculture. C. H. Hanumantha Rao, for instance, observed that GR technology in terms of 'seeds-fertilizer-irrigation' package had substantial positive impact on employment generation in agriculture but increased use of farm machines such as tractors contributed to a reduction in the employment generated. However, the use of tractor and other modern machines increased the aggregate level of employment by raising cropping intensity, farm productivity and changing cropping pattern. Moreover, farm machines and equipment also helped generate additional employment in the non-farm activities by way of forward and backward linkages. In other words, the use of technology and better inputs have created significant employment opportunities in the non-agricultural sectors of manufacturing as well as service sectors. Further, expansion of irrigation (which was considered a pre-condition for the adoption of GR techniques) has generated more employment as irrigated crops have more agricultural operations as compared to the un-irrigated ones. In fact, the green revolution regions such as Punjab, Haryana and Western Uttar Pradesh experienced one of the major problems of shortage of agricultural labour resulting in the migration of workers from backward and poor agricultural regions to the GR regions for agricultural employment. Thus, the GR technology has created indirect employment opportunities to the agricultural workers of other regions.

11.3.1.3 Flow of Public/Private Investment in Agriculture

The most important factor behind the success of green revolution in India is availability of assured irrigation. The advent of tube-well technology, especially in the Indo-Gangetic basin, made significant contribution to enhance the per hectare crop yields. The new agricultural strategy required public investment in agricultural infrastructure, including investment in agricultural research, extension, power, roads, irrigation, etc. Government of India made huge public investment in agriculture in the regions where the new strategy was adopted. This investment made favourable impact on accelerating the pace of private investment too in agriculture. Farmers invested in tube-well, tractor & its accessories, electric and diesel pump sets, land levelling & development, etc. The share of mechanical and electrical power in India increased substantially from 39.4 percent in 1971-72 to 86.6 percent in 2005-06. The ratio of human labour in the total power consumption in agriculture declined from 15.1 percent in 1971-72 to 8.6 percent in 1991-92 and further to 5.8 percent in 2005-06. Similarly, the share of draught animal power declined sharply from 45.3 percent in 1971-72 to 15.6 percent in 1991-92 and further to 8 percent in 2005-06. These trends imply that private investment in agriculture after the green revolution significantly increased following the stimulus provided by increased public investment.

11.3.1.4 Land Saving

Land is a limited resource with competing claims for alternative uses. Due to fast growth of population, urbanization and industrialization, demand for land for non-agricultural purposes has been continuously increasing. Release of land for non-agricultural purposes would be a less contentious issue if requirement of land for agricultural purposes is met through raising the productivity of land and other resources. In this context, GR technology is considered land-saving as it significantly increased the per hectare yield of various agricultural crops. Productivity growth in agriculture has also indirectly saved the forest land as in the absence of increased

agricultural output due to GR, more forestland would have been converted into agriculture to meet out the requirement. From this point of view, it is also sometimes argued that the green revolution, instead of having negative impact on environment, has had positive impact on it by way of saving the forestland.

11.3.1.5 Impact on Rural Non-farm Economy

The green revolution has made significant positive impact on boosting the rural non-farm economy. It has led to sizeable increases in returns to land thereby raising farmers' incomes. Since farmers and agricultural labour comprise a sizeable proportion of rural population, rise in their income due to agricultural development enhances the demand for locally produced goods and services thereby augmenting the employment and income in the non-farm sectors. Moreover, expansion of demand for farm inputs, repairs & maintenance of farm tools and machines, transportation and marketing services, agro-processing, etc. generates additional income and employment to the rural households engaged in non-agricultural activities.

11.3.2 Negative Impacts

Green revolution in India has also made a number of negative impacts. Since GR technology is based on the strategy of "betting on the strong" with its inbuilt feature of unequal access and 'unbalanced development of regions', it has created disparities in agricultural development across regions and categories of farms. There was also a tendency of growing intensively two or even three of the same wheat or rice crops without any rotation and with heavy doses of water, fertilizers and pesticides. In the process, it has left adverse effects on soil fertility and quantity/quality of water. We can elaborate more on these negative aspects of GR as follows.

11.3.2.1 Decline in Soil Fertility

GR technology has caused deterioration in soil fertility. As per the Working Group Report on 'Natural Resource Management' (Government of India, 2007), the estimated loss to the economy on account of soil degradation during 1980s and 1990s ranged from 11 to 26 percent of GDP. Absence of reliable advice and soil-testing facilities contributes to the indiscriminate and harmful use of chemicals. Use of Farm Yard Manure and Green Manure has declined due to various reasons like decline in draught animals, change in the cropping pattern from legume crops to rice, wheat, sugarcane and other commercial crops, etc. It is also argued that green revolution technology could not promote crop-diversification but rather encouraged the crop-concentration. A recent Greenpeace India Report on '*Soils, Subsidies and Survival*,' (2011) observes that *"indiscriminate use of chemical fertilizers is murdering our soil and threatening our food security. It is time to move away from them and nurture our soil the ecological way".*

11.3.2.2 Loss of Biodiversity

Biodiversity is necessary for sustaining the rural livelihoods and achieving the food security. But the use of HYV seeds displaced indigenous species and agricultural system that had been built up over generations. This has led to loss of biodiversity and agricultural genetic resources aggravating the genetic vulnerability of many valuable gene pools.

11.3.2.3 Depletion of Groundwater Resources

Development of tube-well technology in 1960s is one of the vital factors in bringing

the green revolution in the Indo-Gangetic regions. However, the exponential growth of tube-wells in these regions has also been the main reason in the rapid decline of groundwater resources. While groundwater irrigation is preferred on the equity, efficiency, and private investment grounds, many government policies [e.g. agricultural subsidy on critical inputs, lack of effective regulation on sustainable groundwater usage, etc.] have contributed to rapid depletion of ground water resources.

11.3.2.4 Impact on Small and Marginal Farmers

It is argued that shifting from traditional farming to monoculture had negative effects on small farmers. Small and marginal farmers had to purchase costly HYV seeds, fertilizers, and pesticides for which they took loans at relatively higher interest rates and consequently came under 'debt trap'. Also, over-exploitation of groundwater by rich farmers rendered the accessibility of water to the small and marginal farmers difficult.

11.3.2.5 Over-capitalization in Agriculture

The traditional farming system was mostly based on the locally available farm inputs and implements such as farm grown seeds, wooden and iron ploughs, animal power, farm yard manure, bullock-cart, and other farm tools made by local carpenters and blacksmiths etc. Procurement of these inputs and implements required less or no money as most of them were self-owned or provided by carpenters/ blacksmiths in lieu of food grains provided by the farmers under "Jazmani" system. While the traditional system is on the decline, the emerging practices in agriculture appear to be tending towards more capitalisation in many regions. The new agricultural technology required huge investment in modern farm machines, tractors, pump sets, etc. which in most of the cases remained underutilized due to division of operational holdings. For instance, division of operational holdings encourages the farmers to purchase more tractors and accessories and irrigation pumps which lead to over-capitalization in agriculture. In agriculturally developed regions, such as Punjab and western Uttar Pradesh, there is over-capitalization in agriculture. Chand and Kumar (2004) find an increase in the number of operational holdings as one of the important determinants of private capital formation in agriculture. Division of holdings increases the number that, in turn, raises the demand for investment in farm assets and machinery. It may be relevant to know that the number of operational holdings in India has increased from 97.16 million in 1985-86 to 115.58 million in 1995-96 and further to 120.28 million in 2000-01. The availability of institutional credit and subsidy to the farm sector motivates these divided holdings to increase investment in farm machinery. This type of private investment in agriculture is not desirable, as it increases the unit cost of cultivation, reduces competitiveness of small farmers, and enhances indebtedness among them.

11.3.2.6 Widening Disparities

The GR technology has created disparities across regions, and categories of farms. Since it was based on the "betting on the strong" approach, the disparity was inherent in it. The benefits of the new technology was mainly limited to the few crops, such as wheat, rice, sugarcane and few agriculturally developed regions, having adequate irrigation facilities. Most of the crops and rain-fed agricultural regions did not get sufficient benefits from GR. It is observed that in most of the countries, where the new technology was adopted, its benefits accrued to the farmers of already developed regions, and not to the farmers of the poorest and least developed regions. There is conflicting evidence as to whether it has had

"spread effect" or, has intensified income differences across regions. Initially, the green revolution was largely confined to wheat crop in northern India, resulting in a limited contribution to overall economic development of the country. Since the seed-fertilizer technology was not suited to agriculture of the un-irrigated and rain-fed regions, to a greater extent it contributed to inter-regional income disparities. The spread of GR to dry regions proved inappropriate and often caused serious distress to farmers who adopted GR in dry regions based on groundwater resources. GR technology worked effectively on those farms which possessed controlled production environment, such as good quality soils, better irrigation facilities and markets. Since this environment is not sufficiently available in the agriculturally backward regions, farmers of these regions could not get much benefit from the new technology; rather, they lost competitiveness and they remained relatively in the disadvantaged position vis-à-vis their counterparts in the developed regions. C.H. Hanumantha Rao concluded that the technological changes in the Indian agriculture had widened economic disparities between different regions, between big and small farmers and between landholders and land-less workers. However, he observed that in absolute terms in the sense of rise in productivity, production and access to foodgrains, the gains of GR technology reached all sections of the society in general.

11.3.2.7 Impact on Ecology and Environment

As stated before, one of the most adverse consequences of the GR technology is in terms of its ecological and environmental impact. While the increased use of chemical fertilizer and pesticides in agriculture has been the main source of decreased land fertility, it has also polluted the river water resources affecting aquatic life in general and fish production in particular. The productivity stagnation during the recent decades is also generally attributed to the degradation of soil and water resources induced by the agricultural practices particularly in the rice–wheat and wheat-sugarcane production systems of the north Indian states. Thus, the intensive use of fertilizers, pesticides, and weedicides have not only caused degradation of natural resources but also resulted in stagnant productivity.

11.3.2.8 Energy Problems

Another issue related to green revolution technology was its high dependence on fossil fuel energy sources. It is argued that increase in the cost of energy-based agricultural inputs has resulted in an increase in the prices of agricultural products making the GR system economically and ecologically questionable. As observed before, the share of mechanical and electrical power consumption in agriculture has significantly increased over the period. High demand for diesel import has also put more pressure on India's foreign currency reserves.

Check Your Progress 2 [answer questions 2-5 in about 50 words in the space provided]

1) Fill in the blanks

   a) Production of wheat went up from ……. Q/ha in 1965-66 to …… Q/ha in 1978-79 to …… Q/ha in 2009-10.

   b) The relative impact of GR technology on the per-hectare yield of rice was much ……. than that in wheat.

   c) In terms of the three main factors viz. area, production and yield, for

both the wheat and rice in the post-reform years of 1992-2010 in terms of average annual percentage growth it has been the …… as compared to the other three periods of ……., …….. and …….

2) On what basis can you say that the increased agricultural production due to GR technology can be considered environment-friendly?

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3) What evidence has become available in the recent years to make a case favouring the adoption of earlier methods of agricultural practices followed in the pre-GR years?

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4) State any two pro-agricultural developmental policies which have also contributed to unsustainable use of ground water resources.

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5) For what reason is it claimed that the GR benefits has resulted in the widening of economic disparities while accruing overall gain to the economy in general?

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11.4 POST-GREEN REVOLUTION EFFORTS

As noted before, the benefits of the first green revolution period (1968-79) were largely confined to a few crops and big farmers of agriculturally developed regions. A large part of India, especially rain-fed regions of eastern states such as Assam, Bihar and Orissa remained largely untouched by the green revolution technology. In view of this, the Government of India initiated specific efforts in the agricultural development of those regions and crops which could not get the benefits of the first green revolution. These efforts centred around: (i) policy thrust on agricultural development of eastern states; (ii) development of rain-fed and un-irrigated agricultural regions to improve people's livelihood and achieve food security; and (iii) greater involvement of agri-business companies in R&D, storage, marketing and processing of agricultural products with a focus on high value horticulture, floriculture and livestock products through contract farming and other innovative efforts.

The main reason why GR technology benefits could not spread to eastern region was that the installation of private tube-wells did not progress well due to the small

size of holdings and lack of financial resources to install tube-wells and buy pump-sets. Delay in electrification of villages was also one of the factors in the slow growth of private tube-wells. In view of these reasons the groundwater development in the eastern region was lowest among all the regions. However, owing to the later efforts made by focused policy support to the farmers of the eastern states to improve their productivity and diversification of various crops, agricultural growth significantly increased in Bihar, Orissa and Assam. Further, focus on rain-fed and dry land agricultural regions [which comprise about 60 percent of total NSA (net sown area) accounting for nearly 40 percent of total agricultural output] through government interventions in terms of investment in soil and water conservation and water harvesting related activities contributed to increasing the productivity in these regions. The policy focus in achieving the agricultural development in these regions was one of a holistic approach for conservation, rejuvenation and management of natural resources for sustaining the livelihoods of people by raising agricultural productivity and income. Likewise, initiatives to attract the corporate investment in agricultural sector was made by many mission mode efforts like National Horticulture Mission, National Oilseed Mission, National Food Security Mission, National Bamboo Mission, National Pulses Mission, etc. Other efforts made, besides promotion of contract farming, centred around: (i) institutional credit to small and marginal farmers for purchasing land to enlarge their size of operational holdings, (ii) liberalization of land lease market, (iii) direct marketing of agricultural products reducing the role of intermediaries by amending the APMC Act, etc.

The above outline of efforts made in the post-GR period suggests that while the agricultural growth during the green revolution period was largely driven by the supply side factors, during the post-green revolution period it was driven to a greater extent by the demand side factors. As a result, during the post-green revolution period, agricultural development was more in the direction of diversification towards high value horticulture crops like fruits, vegetables, flowers, etc. besides the development of allied activities like dairy, poultry, and fishery. However, while it is true that huge investment in agricultural R&D, extension, irrigation, power, processing, marketing and supply chain are required to revitalize the farm sector for raising the agricultural income and employment for which a corporate approach is desired, it is also feared that involvement of the agri-business companies, particularly the MNCs in reaping the benefits of genetically modified (GM) seed technology, may create oligopolistic power among these companies which could exploit the farmers in the long run once the intermediaries are eliminated and role of public investment/institutions are reduced. Due to this reason, there is a growing debate on the need for maintaining a balance between the corporate approach and the public investment centred policies.

11.5 FROM GREEN REVOLUTION TO GENE REVOLUTION

As noted earlier (from the estimated growth rates in the productivity of wheat and rice), increase in productivity associated with the GR technology began to taper off during the 1990s. In this context, bio-technology is envisaged to provide the required potential for raising the agricultural productivity and solving the problem of food security. The biotech revolution gained momentum in the early 1980s when large corporations began investing huge amounts in R&D for developing transgenic crops. The use of genetically modified (GM) seeds was recognised to hold the promise of making spectacular increase in the productivity of land and

other resources helping the farmer to increase their income from agriculture on the one hand and benefit the consumers by way of providing cheaper and quality food on the other. Use of bio-technology centric methods was also considered scale-neutral as it focused on seeds and not on chemical fertilizers and costly farm machines. The GM seeds are considered to be more productive, more pest-resistant and more suitable to all categories of farms and all the agricultural regions. However, adoption of gene technology in Indian agriculture is subject to debate and discussions, as its positive and negative effects on plants, animals and human lives have not yet been fully examined. While on the one hand environmental, ecological and health related consequences of GM seed technology are weighed more than its economic benefits, on the other hand there are many issues which have attracted the attention of researchers and other activists. Prominent among them are the ethical, safety and proprietary issues. One of the biggest fears of its adoption is the monopoly control of a few multinational bio-seed breeding companies over a basic human need that is food. Thus, although the GM seed technology has immense potential to revolutionize the Indian agriculture, in view of the GM seed technology being costly and proprietary in its character, the technology is feared to be more suited to the resource-rich farmers leaving behind the large marginal and small farmers segments especially in the backward agricultural regions from getting its benefits. However, we must recall that even the GR based technology also favoured only the rich farmers as compared to the small and marginal farmers segment. Thus, the fundamental difference between green revolution and gene revolution may be pointed out as one in which while the former was mostly in the public domain, the latter is feared to keep it largely confined to the private domain. Against this background, the present debate is on ushering in a 'second green revolution' the broad features of which are spelt out in the National Agricultural Policy Vision Document on which you will study more in unit 22.

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

1) What are the three directions in which the policy initiatives of the post-GR efforts were centred?

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2) Mention the two reasons which are identified for the lack of spread of GR benefits to many regions?

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3) In what way the use of bio-technology (BT) methods considered more beneficial as compared to the GR technology based methods? In spite of this, why is it that its adoption has still not taken off in India?

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4) What is the fundamental difference between the GR and the GM approaches?

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11.6 LET US SUM UP

The GR technology and the benefits that accrued out of it helped transform the Indian economy from a state of food deficient country to a food surplus one. However, the benefits of the GR technology did not reach many regions of the country notably the eastern Indian states because of the fragmented holdings held by large number of small and marginal farmers whose capacity to invest capital, much needed for applying the GR technology, was limited. Efforts made by the government to offer foucused policy support, in the post-GR years, improved the situation in this respect. The GR-technology was not environmental friendly as it depended heavily on chemical fertilizers and weedicides which rendered the soil and water resources polluted/contaminated. An alternative to GR technology namely the GM technology became popular for its non-polluting effects around the 1980s. However, the large scale implementation of this technology has not taken its roots yet in view of the many non-economic dimensions of this technology which basically centeres around its proprietary character (i.e. the possibility of rich MNCs/corporate houses making a monopoly of its reach/benefits). Both the GR and GM technologies, from this point of view of wider inclusivity, are unsuited to small and marginal farmers who cannot muster the wherewithal required for benefiting from these technologies i.e. fair amount of capital requirement which is common to both the GR and GM technologies. Of late, therefore, there is a talk on the need for instituting a 'second green revolution' suitable for addressing the issue of food security/insecurity from a more inclusive nature i.e. raising agricultural productivity with an emphasis on including small-marginal farmers, and rain-fed and dry regions as the main components of the process.

11.7 KEY WORDS

Green Revolution (GR) : Refers to a new agricultural technology developed in Mexico and Philippines in the late 1950s and early 1960s for wheat and rice crops respectively which transformed many food deficient countries of Asia and Latin America to food surplus economies. The technology, however, required large capital for purchase of fertilizers and machineries and its applicability was suitable only for regions which were already rich in terms of irrigation and agricultural productivity respects. This feature

of the GR technology contributed to many small and marginal farmers and poor states/ regions from being unable to be a part of its process. As a result, many parts of the country could not get its benefits.

High Yielding Variety (HYV) Seeds : These were special seeds which were to be used in the GR technology application areas. Unlike indigenously grown seeds, they could withstand high amount of fertilizers. But for this very reason they were also less environmental friendly as they reduced the fertility of soils. However, their quick yields enabled multiple cropping on the same field during a years thereby raising the productivity of agricultural produce and income/profits of farmers.

Genetically Modified (GM) Seeds : This was an alternative which was developed in 1980s. Unlike the HYV seeds, the GM seeds were not heavily dependent on chemical fertilizers. The technology, however, had a proprietary character associated in view of its limited reach due to the involvement of some MNCs/corporate business houses.

11.8 SELECTED REFERENCES FOR FURTHER READING

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11.9 ANSWERS/HINTS TO CYP EXERCISES

Check Your Progress 1

1) See section 11.2.1 and answer.

2) See section 11.2.1 and answer.

3) See section 11.2.1 and answer.

4) See section 11.2.2 and answer.

5) See section 11.2.2 and answer.

Check Your Progress 2

1) a), b) , c) & d); see section 11.3.1.1 and answer.

2) See section 11.3.1.4 and answer.

3) See section 11.3.2.1 and answer.

4) See section 11.3.2.3 and answer.

5) See section 11.3.2.6 and answer.

Check Your Progress 3

1) See section 11.4 and answer.

2) See section 11.4 and answer.

3) See section 11.5 and answer.

4) See section 11.5 and answer.