UNIT 3 GREEN REVOLUTION

Structure

3.0 OBJECTIVES

We hope now you have a reasonably sound understanding of our Agrarian Movements and Land Reforms. After reading this unit, you should be able to:

- explain the peculiar compulsions faced by the Indian planners in the mid-sixties and the reasons why the strategy of the Green Revolution was adopted;
- describe the elements of this strategy and the nature of its spread across the country;
- analyse the impact of this strategy on agricultural growth and the different aspects of rural development;
- outline some problem areas which have come up as a consequence of the Green Revolution;
- identify challenges posed to agricultural development due to globalisation of the economy; and
- indicate the manner in which current challenges are being addressed.

3.1 INTRODUCTION

Indian agricultural development can be looked at from two different perspectives: institutional and technological. The *institutional approach*, mainly typified by land reforms and changing agrarian relations, was the strategy adopted way back in the mid-fifties. This strategy is outlined in unit 2 of this block, which we hope you have already worked through. Land reforms, as an engine of agricultural development, registered limited success. Moreover, it was realized that in the absence of further scope for increasing the area under cultivation, advances in productivity remained the only means of stepping up food-grain production in the country. As a result *technological approach* to agricultural development, popularly known as the "Green Revolution" was adopted in the mid-sixties, which made a decisive impact on agricultural production and productivity. This unit will discuss the background under which this approach was introduced, its spread, impact and some recent problems that have come up for redressal.

3.2 WHAT IS THE GREEN REVOLUTION?

The Green Revolution, which began in the mid 1960s is the name given to the first systematic attempt to increase agricultural production, particularly that of food-grains, in India and some other developing countries by applying new technologies of cultivation. It is based on "biochemical innovations" that include high yielding varieties, chemical fertilizers and pesticides. There are three main components of this approach:

a) An improved technology in the form of new high-yielding varieties (HYVs) of crops:

b) A package of practices which consists of appropriate application of chemical fertilizers, pesticides and irrigation facilities which are necessary for the technology to be effective, and

c) an overall strategy, which includes government policies for the provision and subsidy on inputs, remunerative prices for output and availability of credit.

This has been the broad strategy for agricultural growth followed by India since the mid 1960s.

3.3 NATURE OF THE GREEN REVOLUTION: BACKGROUND AND STRATEGIES

3.3.1 Indian Agriculture in the 1950s

In the 1950s, Indian agriculture was backward in the sense that output per worker and output per unit of land area were low. There were regional variations in agro-climatic conditions, spread of irrigation and varying extent of market penetration in different areas. Nonetheless, most parts of rural India had unequal land ownership patterns in which a major part of cultivated land was controlled by a few large landowners. About one fifth of the rural population had no right to land at all. In some parts of the country, notably the northwestern region, land was generally held by middle-sized peasant farmers who were engaged in direct cultivation involving family labour. Tenancy was widespread and crop-share rents were the major form of rent, especially in the East and the South of the country. Availability of institutional credit was insufficient in rural areas and most cultivators had no option but to go to the local money-lenders for credit. In many parts of rural India, particularly in northern India, inheritance pattern led to continuation of the subdivision of holdings (the average size of holding was well within 2 hectares). These conditions discouraged and prevented investment in agriculture by all classes. The

available varieties of crops were low yielding and cultivation practices primitive. This inhibited the growth of Indian agriculture during the said period.

3.3.2 Agricultural Strategies during the Pre-Green Revolution Period

During the period of the first three Five Year Plans (1951-66), considerable emphasis was given to institutional changes and the development of irrigation for raising agricultural output. It was thought that institutional changes, particularly land reforms, would lead to increasing private investment in cultivation and crop output. Therefore, the main thrust was on legislation regarding agricultural property and social relations in the countryside.

The other main policy thrust of the government with regard to agriculture was on increasing irrigation facilities. Many of the large river valley projects were undertaken during this period and considerable public expenditure was made on tubewells. Although the gross irrigated area went up from 23 million hectares in 1950 to 32 million hectares in 1965, at the end of this period, only 17 per cent of the total cultivated area was irrigated. Futhermore, most of the irrigation projects were concentrated in a few states namely Punjab, Haryana, Uttar Pradesh, Tamil Nadu and Andhra Pradesh. Other states had a much lower proportion of cultivated area under irrigation and most of the Indian agriculture remained heavily dependent on the behaviour of the weather and monsoon.

Apart from this rather slow and uneven growth of irrigation, there was no major technological advancement in the Indian agriculture during the period. The only notable change was a small increase in tractors and power driven pumps for wells, chiefly in the northwestern states. Implements of cultivation, by and large, were primitive (such as wooden rather than iron ploughs) and the use of fertilisers and other 'modern inputs' remained very limited.

Significantly, most of the increases in output were due to the expansion of the cultivated area, resulting partly from a move to cultivate poorer quality land and partly from an increase in multi-cropping made possible by irrigation, which led to an increase in *gross cropped area*. By the mid 1960s, limits of increasing arable land were reached and it was clear that future increases in output would have to result from greater yield of crops rather than the expansion of cultivated area. The thrust towards increasing yields was also necessitated by the fact that:

i) effective land reforms had not taken place and a minority continued to control the major share of cultivable land;

ii) the rent that landlords extracted from the vast mass of tenants and share-croppers was enough to ward off any incentive for using new technology in cultivation and take risks; and

iii) there were limits to the possibility of expanding cultivated area.

The problems of agriculture were highlighted by two consecutive bad monsoons in 1965-66 and 1966-67. There was a dramatic fall in output and several areas (such as Bihar) experienced near famine conditions. By 1960-61, imports accounted for a significant part of domestic food-grain consumption. Cosequent upon the two bad harvests, imports accounted for nearly one-sixth of domestic production of food-grains. By 1966, India was heavily dependent on food aid from USA, and this forced India to accept harsh terms for aid from USA and international multilateral agencies such as the World Bank. Many domestic economic policies were adjusted under this external pressure, including substantial devaluation of rupee in June 1966. The poor agricultural performance had also a negative impact on industry and the overall growth of the economy was affected adversely. This highlighted the urgency of an agricultural strategy, which could release a steady and growing market surplus of food-grains to meet the consumption demand and the demands of industry. The strategy that emerged as a response to this crisis was called the ***Green Revolution***.

3.3.3 The Basic Strategy of the Green Revolution

The new policy towards agriculture, which began in the mid 1960s, was a departure from the earlier approach in a number of ways. The main features are summarised below:

a) The government policy was now oriented towards ***changing the technical conditions of production*** in agriculture rather than introducing land reforms and other changes in the property relations in the countryside. In so far as institutional changes were part of the policy, they were chiefly in the form of spread of state agricultural extension services in order to spread information and provide access to the new technology, establishment of ***Agricultural Price Commission (now known as Commission on Agricultural Costs and Prices, CACP) in 1965***, establishment of Food Corporation of India (FCI) in the same year and efforts towards ensuring the availability of credit from institutional sources.

b) The new ***technology consisted essentially of a package of inputs*** and practices including seeds of high yielding varieties, which responded very favourably to fertilisers, irrigation and pesticides.

c) The emphasis was ***primarily on increasing the output of food-grains*** (especially wheat and rice). Other crops such as sugarcane, oilseeds, pulses, coarse cereals, jute and cotton were not a part of this policy.

d) Given the requirement of assured water supply, the new technology was introduced and employed successfully in areas ***having irrigation facilities***. The strategy was, therefore, selective in approach. The focus was on selecting new areas with assured irrigation water or rainfall for the effective application of this package. This combined with the higher yield of new wheat seeds in India, led to a regional concentration of the new HYV technology in the irrigated wheat-growing region of northwest India. This region, comprising the states of Punjab, Haryana and West Uttar Pradesh, became major success stories of the Green Revolution by early 1970s.

e) The new strategy also focussed on increasing ***marketed surplus of food-grains through price support and procurement operations***. It meant a focus on those groups of farmers who could produce surplus for sale, over and above their own consumption. Essentially, these were the larger and richer farmers, who had both resources and access to market, which encouraged them to adopt the HYV package. Although the package itself was scale neutral (that is, yields did not vary with the size of the holding), there were two major forms of bias in favour of larger farmers: the need for irrigation and access to institutional credit which were more easily obtained by larger farmers. This bias was also to some extent a conscious policy choice by the government—a policy to favour faster growth in output with a view to attaining self-sufficiency in food-grain production. The government hoped that the effects of this growth would "trickle down" to the rest of the rural population, as against a policy in favour of greater equality within a slower growing agriculture. In other words, gains in productivity rather than better distribution of rural incomes was emphasised.

Check Your Progress I

Note: a) Use the space provided for your answers.

b) Check your answers with the possible answers provided at the end of this unit.

Put a tick (√) against the correct answer for each question.

1) During the 1950s, most of the Indian agriculture used techniques that were

a) the same as used in cultivation in the advanced industrial countries.

b) traditional, with very little use of fertilisers or new machinery.

c) recently adopted from countries like Japan.

2) Before the Green Revolution, increase in output was mainly due to:

a) high yield.

b) expansion in cultivated area.

c) expansion of irrigated area.

d) land reforms.

3) Why was the government forced to adopt a new agricultural strategy around the mid 1960s?

(Hint: The preceding section will give you some idea about the kind of problems that Indian policy makers faced during this period.)

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3.3.4 The HYV Package

The crucial element in the HYV package was the seed, which was typically a hybrid designed to give much higher yields in response to the use of fertilisers. Some of the other characteristics of these new varieties were: shorter maturing period which enabled double cropping, shorter (dwarf) stems which could withstand damage caused by winds, positive response to fertilisers and larger leaf surfaces to help the process of photosynthesis.

The basic method of creating these seeds is called ***"hybridisation***". This is a process of crossing two strains of the same crop in order to combine desirable characteristics of both the strains. Thus a crop plant with *good fertiliser response* can be combined with one with *strong and short stalk*. Hybridisation can create varieties of seeds with much higher yields than those of their parent varieties.

The new wheat seeds introduced in India were developed from two Mexican varieties namely *Sonora 64* and *Lerma rojo*. Indian agricultural scientists evolved four new varieties, which were more suited to local conditions: Kalyan Sona, Sonalika, Safed Lerma and Chhoti Lerma. Kalyan Sona became the leading wheat variety, with the highest observed yields (more than 30 quintals per hectare) although it later became prone to diseases.

The HYV seeds for rice were ***based on seeds*** of Taiwanese origin. The main varieties were IR 8 and Jaya, which were released in 1968 with active support from the International Rice Research Institute, the Philippines. But the considerable agro-climatic differences across various rice growing regions made it difficult to adopt uniform varieties across the country. The HYV rice seeds were erratic in their performance in different areas and more vulnerable to pests and diseases when compared to wheat HYV seeds. New hybrid seeds of jowar, bajra and maize were also developed but these were not as effective as HYV wheat seeds.

The HYV seeds were designed to be very responsive to fertiliser intake, and so higher applications of fertiliser were crucial for the success of this technology. This implies that it became necessary to apply greater quantities of chemical fertilisers (nitrate, phosphate and potassium compounds) at the cost of organic matter applications to soil. This has led to inefficiency in the use of fertilisers and at times it becomes uneconomical to apply high doses of fertilisers. Nitrate pollution is already a documented phenomenon as a consequence of the application of high levels of nitrogenous fertilizers.

A similar tendency persists in the ***use of pesticides***. One of the major problems of hybrid varieties of seeds is their greater vulnerability to pests and diseases. There are some traditional means of checking pest incidence through cultural practices (e.g. changing the sowing date, crop rotations, intercropping, etc.). But these are less applicable with HYV seeds than traditional varieties. Though the average use of these pesticides is far below the required levels, lack of judicious use has become a major issue to be reckoned with.

The other crucial element of the HYV ***package is water***. A secure irrigation system is, therefore, an important condition for the success of the strategy. Ever since the Green Revolution started, there has been greater emphasis on groundwater irrigation, through tube-wells in particular. This can be undertaken by farmers privately (unlike canal irrigation which depends upon government policy and investment), and gives farmers greater flexibility and control over the use of water. Typically, such investment in tube-wells is made by large farmers not only because they have the resources for such investment but also because using tube-wells for a minimum spread of about 10-15 acres gives the best results.

With these four major elements, the HYV package has one very important feature: each of the elements must be applied in correct quantity and at the appropriate time to give the best results. Thus using HYV seeds independent of (or with inadequate amounts of) fertilizers, pesticides or irrigation water will not lead to complete realisation of the yield potential of such varieties. Further, any deviation from the recommended time schedule for sowing and the application of other inputs leads to less than the optimum yield.

One of the effects of Green Revolution was a hike in the cost of cultivation. The adoption of HYV seeds meant using higher levels of inputs, thereby increasing the cost of cultivation per hectare. This was, however, more than offset by a significant increase in the yield of crops, as it has been reported that there has been a decline in the real cost of production (Rs/tonne) in the case of rice and wheat over the last two and half decades.

3.3.5 The Spread of the Green Revolution

The green revolution by its very nature was a region and crop focused strategy. It was primarily directed towards regions with favourable ***"initial conditions"*** (such as irrigation facilities). Northwestern parts of the country became the cradle of this Revolution. Wheat emerged as the leading crop in the growth of food production.

Box 1

The Geen Revolution: The People Who Shaped it

India was in the grip of a food crisis in the early 1960s. It was a situation of ship-to-mouth food economy. The country heavily depended on wheat imported from the USA under the Public Law 480. The things looked so bleak that the Paddock brothers, William and Paul, declared India as an incurable case of a nation heading towards severe famine by 1975. It was then that India discovered Norman E. Borlaug and the dwarf varieties of wheat. Borlaug sent in 100 kg of seed of four high yielding varieties (HYVs) of wheat for trials and visited India in March 1963. *Lerma rojo* and *Sonora 64* performed the best. But these were just experiments and there were still several ifs and buts with adopting a policy.

In May 1964, Lal Bahadur Shashtri became the Prime Minister of the country. C. Subramaniam, the Minister for Steel, Mines and Heavy Engineering in Nehru's cabinet was now given agriculture, a sector which was weak and under severe pressure due to food shortages and exploding population. Subramaniam was a devoted Gandhian, a freedom fighter, a member of the constituent assembly and a great visionary. Above all, he was a man of action. He initiated the process of providing institutional support to agriculture. Agricultural Price Commission (APC) and Food Corporation of India FCI) were set up in 1965, which still play a major role in the management of food economy of the country.

Ralph Cummings, an officer from Rockerfellor Foundation met Subramaniam and told him about dwarf HYVs of wheat, but also conveyed that Indian scientists and bureaucracy were going very slow on these. The minister decided to reorganise the Indian Council of Agricultural Research (ICAR) and appointed Dr. B. P. Pal a renowned scientist as its Director-general. Scientists went in for targeted and time-bound research. M.S. Swaminathan led a team of scientists to the job of indigenising the Mexican varieties, especially their colour and baking quality.

In 1965, 250 tonnes of *Sonora* 64 and *Lerma rojo* were imported for seed multiplication, which yielded about 5000 tonnes of seed. Subramaniam was now convinced of the technology and ready to play his final stroke. He wanted to import a very large quantity of these seeds from Mexico to give the effort a single massive boost. His idea was opposed in the parliament as well as at public for a, but he steered through all the criticisms, political hurdles, bureaucratic wrangles and public debates, first with the support of Prime Minister Shastri and later with that of Indira Gandhi. Finally 18,000 tonnes of HYV wheat seeds were imported in 1966 and about a thousand national demonstrations were held all over India over that year and the next. The results were miraculous. The new varieties had more than doubled the existing yields. India harvested 17 million tonnes of wheat in 1967-68, five million tonnes more than the previous best of 12 million tonnes. There was no place to store this sudden burst of grain. Schools in rural Punjab were closed down to store the new harvest in classrooms. A revolution was ushered in.

In 1968, U.S. Agency for International Development (USAID) Administrator William S. Gaud coined the term "Green Revolution" to describe the phenomenal growth in agriculture in Asia and Latin America. But the real unsung heroes of the Green Revolution in India, as Subramaniam himself puts it, were Punjabi farmers. He said "they were the pioneers in this technology and but for them I am convinced we would not have made a success of it. When this new technology was offered to them they took it like fish to water. Everybody vied with one another to demonstrate that he was best able to utilise the new technology." These were the real people behind the Green Revolution.

Source: "The Green revolution: Grain of Truth" by Ashok Gulati, published in India Today, Millenium Series, 2000

Table 3.1 shows the level of adoption of HYVs of different crops over the period. It can be seen during TE 1974-75 when most of the other crops had a very small area under HYV cultivation, more than 50 per cent of HYV adoption had already taken place for wheat. In the begening years, HYVs of rice spread in some areas of Andhra Pradesh and Tamil Nadu. The states such as Assam, Bihar, Madhya Pradesh, West Bengal, etc. which were predominantly rainfed areas picked up with quantum jump in rice yields only in the 1980s. Interestingly, the traditional wheat growing areas of Northwestern region have also become major rice growers in the post-Green Revolution period.

Table 3.1: Area cultivated with High Yielding Varieties for Different Crops

HYV area as per cent of area under respective crops

TE	Paddy	Wheat	Maize	Jowar	Bajra	Total
1968-69	4.93	18.90	5.39	2.69	3.30	5.91
1971-72	15.34	35.65	7.77	3.88	13.40	14.80
1974-75	26.01	57.80	14.51	6.89	21.70	25.79
1977-78	35.43	69.68	19.35	15.83	23.32	33.77
1980-81	42.57	70.10	24.59	19.78	28.37	38.91
1983-84	50.13	76.69	29.89	27.40	42.56	46.87
1986-87	56.92	82.30	34.31	34.72	47.43	53.19
1989-90	60.16	85.12	40.00	41.91	48.66	57.44
1992-93	65.17	87.77	44.95	52.20	53.89	64.33
1995-96	70.92	90.16	55.14	60.53	54.83	70.06
1998-99*	74.82	88.22	57.94	82.84	70.43	75.79

Source: Fertiliser Statistics 2002-2003, Fertiliser Association of India, New Delhi.

TE - Triennium ending, * Provisional

Check Your Progress II

Note: a) Use the space provided for your answers.

b) Check your answers with the possible answers provided at the end of this unit.

Put a tick (√) against the correct answer for each question.

1) The crucial element of the HYV package is:

   a) The seed that responds favourably to other inputs like water and fertilizers.

   b) Machines that can till the soil more deeply.

   c) The spread of canal irrigation which always raises yields of all seeds.

2) The HYV package resulted in:

   a) an increase in the cost of cultivation per hectare.

   b) a decrease in the cost of cultivation per hectare.

   c) no change in the cost of cultivation per hectare.

3) The major achievement of the HYV cultivation has been increase in the production of

   a) non-food-grains. b) pulses and oilseeds.

   b) maize and jowar. d) wheat and rice.

4) Because of the HYV package, farmers have become

   a) more dependent on market for buying inputs.

   b) more dependent on market for selling outputs.

   c) more dependent on market for buying inputs and selling outputs.

5) The Green Revolution

   a) has spread uniformly throughout India.

   b) remained confined to the north-western part of India.

   c) has spread only in the irrigated areas of India.

6) What are the different elements of the strategy of the Green revolution? Write your answer in the space provided below.

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3.4 IMPACT OF THE GREEN REVOLUTION: YIELD, INCOME AND EMPLOYMENT

3.4.1 Patterns of Output, Growth and Instability

The Green Revolution was intended to provide a breakthrough in the yield of crops and food-grain production. A perusal of Table 3.2 reveals that the strategy was successful in achieving this objective. With the introduction of the ***Kalyan Sona*** variety of wheat and ***IR 8 and Jaya varieties*** of rice, technological change in agriculture was established providing a quantum jump in the production of cereals. The growth in food-grain production ranged between 2 to 3 per cent per annum over both the pre-Green Revolution and the post-Green Revolution phases. It may be noted that the growth rates in the Pre-Green Revolution phase were based on a low base level of production, whereas those in the Green Revolution phase were based on a higher base level of production, which was achieved through the technological change. If we divide the Green Revolution (GR) period into two phases, some interesting pictures emerge. It may be seen that in the later phase of the Green Revolution, the growth rate of the production of all the food-grains has decreased. How do we explain this fall in the growth? It may be seen from Table 3.3 that growth in the yield of all the crops has been lower in the later phase of the Green revolution as compared with the earlier phase. With the net decline in cultivated area, any declining trend in yield levels affects growth in production adversely. This is an issue of concern. Concerted efforts on the part of crop breeding programmes and resource management aspects should be made to break the yield barriers. Another important feature has been a very low rate of growth in the yield of pulses and coarse cereals. It may have adverse nutritional implications.

Table 3.2: Pre- and Post-Green Revolution Period Growth Rates of Crop Production in India

(per cent/annum)

Crops	Pre-GR Phase 1949-50 to 1964-65	GR - Phase I 1967-68 to 1984-85	GR - Phase II 1985-86 to 1999-2000
Rice	3.50	2.69	2.54
Wheat	3.98	4.92	3.51
Coarse cereals	2.25	0.94	0.53
Total cereals	3.21	2.85	2.50
Pulses	1.41	0.94	0.40
Total Food-grains	2.82	2.74	2.36
Oilseeds	3.20	2.58	5.24

Source: Agricultural Statistics at a Glance (various issues), Directorate of Economics and Statistics, Ministry of Agriculture, GOI.

Table 3.3: Growth in Yield of Crops in Post-Green Revolution Period

(per cent per annum)

Crops	1967-68 to 1980-81	1980-81 to 1989-90	1990-91 to 1999-2000
Rice	1.46	3.19	1.27
Wheat	2.61	3.10	2.11
Coarse cereals	1.57	1.62	-0.08
Total cereals	1.78	2.90	1.58
Pulses	-0.66	1.61	0.96
Total Foodgrains	1.54	2.74	1.52
Oilseeds	0.77	2.43	1.25
All principal crops	1.43	2.56	1.31

Source: Agricultural Statistics at a Glance (various issues), Directorate of Economics and Statistics, Ministry of Agriculture, GOI.

A major issue, which came up with the advent of the Green Revolution strategy, was the instability in production. It may be seen from Figure 1 that yield instabilities in the case of rice and wheat, which are the major constituents of food-grain production, decreased immediately after the Green Revolution, but later they started increasing. This has been due to higher vulnerability of new varieties to pests and diseases. The initial focus of the crop-breeding programme was on developing high yielding varieties. It was only after the mid 1970s that proneness of new varieties to pests and diseases was realised and thereafter efforts have been made for developing varieties with resistance to insects, pests and diseases. Use of fertilisers also picked up during the later phase of the Green Revolution. These developments have led to relative stabilisation of yields in recent years. Yield instability is still very high in the case of coarse cereals, primarily because they are grown in marginal environments and rainfed conditions.

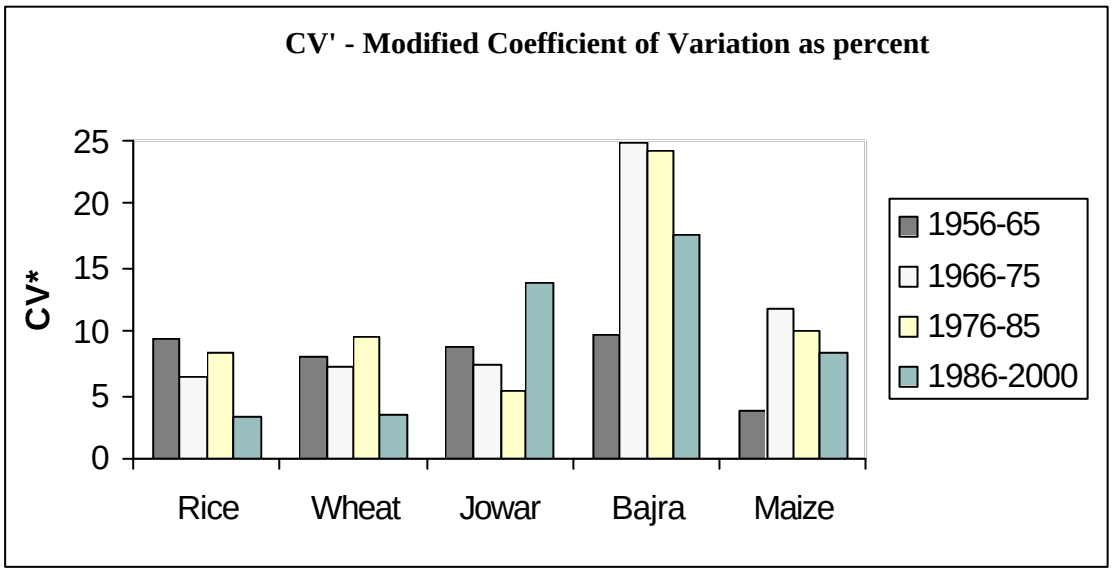

Figure 3.1: Instability in the Yield of Major Cereals

3.4.2 Output Prices, Marketed Surplus and Food-grain Consumption

An important aspect of the *green revolution* was the output pricing policy and announcement of the ***Minimum Support Price (MSP)*** by the government for selected crops with the twin objectives of ensuring remunerative prices to farmers so that production gets encouraged and food becomes available at affordable prices to non-farm population. At the same time, a number of inputs required for HYVs such as fertilisers, electricity and diesel were subsidised so that farmers could be encouraged to

use these inputs. The supply of subsidised industrial inputs to agriculture meant that the relative prices of agricultural produce became costlier when compared to inputs of industry used by the agriculture sector. This approach operated to shift the inter-sectoral terms of trade in favour of agriculture in the period between 1964-65 and 1974-75. During the eighties the *terms of trade* were largely unfavourable for agriculture, but in the 1990s, once again, they became favourable to this sector.

The increased output of larger farmers, especially in the wheat growing regions of the northwest, combined with favourable price policies made the marketed surplus of food-grains grow rapidly. Assured income due to minimum support prices encouraged farmers to go for the rice-wheat system. At present the country is maintaining around 50 million tonnes of food-grains as a buffer stock mainly through procurement primarily in Punjab, Haryana and Western Uttar Pradesh. Studies have shown that the bulk of the marketed surplus comes from the larger and richer farmers, and to some extent from the middle level peasants. Small and marginal farmers are often net buyers of food-grains.

Despite the increase in output and marketed surplus, per capita food-grain availability remains at much the same level (i.e. hovering around 450 gms/day per capita) as it was 35 years ago. Though there has been a rise in the consumption of food-grains, it has been accompanied by a dramatic fall in the availability of pulses, which are the chief sources of protein for a large part of the population. The per cpita availability of pulses was 56.1 gms/day in 1968, which declined to 31.8 gms/day by 2000.

Check Your Progress III

Note: a) Use the space provided for your answers.

b) Check your answers with the possible answers provided at the end of this unit.

1) In the later phase of the Green Revolution the growth in the yield of all major crops shows

   a) an increasing trend. b) a constant trend.

   c) a decreasing trend.

2) As a result of the Green Revolution in the past thirty-five years:

   a) per capita food-grain availability in India has increased.

   b) per capita food-grain availability in India has remained about the same.

   c) per capita food-grain availability in India has increased.

3) In the post–Green Revolution phase per capita availability of pulses has

   a) declined. b) increased. c) not changed.

4) Instability in yields of major crops in the later phase of the Green Revolution has

   a) increased. b) decreased. c) not changed.

5) The Green Revolution has resulted in

   a) an increase in regional inequalities in food-grain production.

   b) a decrease in such regional inequalities.

   c) no change in such regional inequalities.

6) After the Green Revolution, the rate of growth of marketed surplus of food-grains has

   a) increased. b) decreased. c) remained the same.

3.4.3 Income Distribution, Mechanisation and Employment

The Green Revolution stimulated a large body of empirical literature on how agro-technological change affects the poor farmers. Critics of the Green Revolution argued that owners of large farms were main adopters of the new technologies because of their better access to inputs. Small farmers were either unaffected or harmed, because the Green Revolution resulted in higher input prices, lower product prices and efforts by landlords to increase rents and force tenants off the land. Critics also argue that Green Revolution encouraged unnecessary mechanisation, thereby pushing down rural wages and employment. Although a number of village and household studies conducted soon after the release of the Green Revolution technologies lent some support to early critics, more recent evidence shows mixed outcomes. Small farmers did lag behind large farmers in adopting the HYV package, but most of them eventually did so. Many of these small farm *late* adopters benefited from increased production, greater employment opportunities due to intensive cropping and higher wages in the agricultural and non-farm sectors. Moreover, most land-owners were able to keep their land and experienced significant increases in total production. Mechanisation did substitute some labour in the wheat growing areas but with total overall increase in labour requirement for the rice-wheat system and HYV package resulted in considerable increase in wage employment. However, with no increase in the net cultivated area and massive increase in population, Indian agriculture has been harbouring disguised unemployment. Rural non-farm sector such as rural services and agro-processing industries could play a major role in creating further employment opportunities.

3.5 IMPLICATIONS OF GREEN REVOLUTION: SOME PROBLEM AREAS

A revolution of this magnitude was bound to create some problems of its own. Critics charged that the effects of the Green Revolution show an uneven spread leading to increased income inequality and environmental degradation. Some of these criticisms are valid and have been or still need to be addressed. Some of the important problems are discussed in the following sub-sections.

3.5.1 Uneven Spread

A large body of empirical literature suggests that the green revolution increased regional inequalities and adversely affected the poor farmers. It was found that better endowed areas and owners of large farms were the main adopters of the new technology because of their better access to irrigation water, seeds, fertilisers and credit. The Revolution was also criticized for being crop-specific. On the one hand the rice-wheat system of cultivation made a spectacular growth, on the other pulses, oilseeds and coarse cereals suffered from low productivity and poor production. With greater area coming under rice and wheat, these crops were pushed to marginal lands. The situation is reflected in the fact that the per capita availability of pulses has declined and a large quantity of edible oil is still imported.

3.5.2 Soil Nutrient Depletion and Imbalances

Diagnostic surveys conducted by regional agricultural universities and international agencies have shown that in recent years higher amounts of fertilizer need to be applied for getting the same level of yield as that achieved in the 1970s and early 1980s. Crops remove substantial quantity of major nutrients from soil, particularly, in high input intensive rice-wheat systems. It has been observed that with time agricultural practices in north-western India have been removing more nutrients than the amount added externally through fertilizers. It is, therefore, not surprising that farmers would eventually need to apply higher amounts of nutrients per unit of yield. Further, it has been shown in long-

term experiments as well as at farmers' fields that soils are becoming deficient in potassium. A declining trend in available zinc content of soils has also been reported. This imbalance in soil nutrients has been attributed to be a major cause for the stagnation in the yield of rice and wheat. Awareness about balanced fertilization and efficient nutrient management would help ameliorate the situation.

3.5.3 Declining Total Factor Productivity

It was realised during the late 1980s that the rapid growth attained during the early years of the Green Revolution might not be sustainable in the long run. Total Factor Productivity (TFP), sometimes referred as *multifactor productivity*, is one of the widely used methods to quantify the sustainability of any system. It also measures economic efficiency. *TFP can be defined as the rate of growth in quality adjusted output less the rate of growth of quality-adjusted inputs.* It provides a measure of increase in output that is not accounted for by increase in the quantity of inputs. As an example, suppose we note that over a year the agricultural output (e.g. rice-wheat cropping system) has grown by 4% while the inputs used in production (e.g. land, labour, seeds, fertilizers, etc.) have increased by 3.2%. The difference between the two (i.e. 0.8%) is labeled the Total Factor Productivity Growth. A declining trend in TFP growth is a sign of declining sustainability of system. A recent study reports that during 1980s, 63 per cent of gross cropped area of the Indo-Gangetic plains showed moderate to high growth in TFP, which declined to 31% during the 1990s. On the other hand, 33 per cent of gross cropped area of the region showed either stagnant or negative growth in TFP during 1980s, which increased to 62 % during the1990s. This requires corrective steps in the form of agricultural research, infrastructure development and policy interventions failing which there can be serious implication for the food security of the country.

3.5.4 Water Management Concerns

There are two sources of irrigation water in Green Revolution areas – canal water and groundwater. Excessive use of water in these areas is causing a gradual decline in the water table and also in the quality of water in many regions. Pumping water from deeper layers increases the total operational cost and thus decreases the profitability of growing rice and wheat. Another problem for water management, particularly in the trans-gangetic plains, is that of waterlogging. Due to excessive use of irrigation water and percolation from canals, distributaries and water-courses, water table has risen in some areas of Punjab, Haryana and Uttar Pradesh. This has led to soil salinity in these areas.

3.5.5 Pest Problems

A change in the spectrum of pests is possible with a change in agro-ecosystems such as that brought about by the intensification of the rice-wheat area of northwestern India. Green Revolution led to the cultivation of uniform artificially produced seed types replacing the enormously large range of local seed types, which were grown and flourished through centuries of evolution. The susceptibility of new varieties to insect-pests has become evident from a considerable rise in their attacks since 1980s. Among weeds, *phalaris minor* has spread considerably over time. There is growing recognition now that resistance to herbicides has appeared in large areas under the rice-wheat sequence and that is a real threat to wheat production

3.6 GREEN REVOLUTION: AN ASSESSMENT

Overall, the Green Revolution is a major achievement for India, as it has provided an unprecedented level of food security. It represents the successful adaptation and transfer of the same scientific revolution in agriculture that the industrial countries had already

appropriated for themselves. It has lifted a large number of poor people out of poverty and helped many non-poor people avoid the poverty and hunger they would have experienced had it not taken place. The largest benefits to the poor are mostly indirect, in the form of lower food prices, increased migration opportunities and greater employment in the rural non-farm economy. The direct benefits to the poor through their own on-farm adoption, greater agricultural employment and empowerment have been more mixed and depend heavily on local socio-economic conditions. In many cases inequalities between regions and classes that adopted Green Revolution technologies worsened, but in a number of other cases they did not. Also, it has given rise to many negative environmental issues that have yet to be addressed adequately.

Indian agriculture is facing new challenges. The potential of the Green Revolution varieties appears to have exhausted. The yield barriers have to be broken through research and development. A tempting option is developing and growing genetically modified (GM) crops or transgenics. They are said to give higher yields, be nutrient enriched and display greater immunity to pests. However, an objective scientific assessment of the claims made for GM crops is not yet complete. Once such claims, which are mainly made by multinational companies are vetted, large-scale cultivation of such varieties may provide another opportunity. On the other hand, a large number of farmers have yet to adopt the existing yield increasing technologies. Extension access to such farmers should be ensured for wider acceptance of the existing technologies.

The indirect benefits to the poor due to another technological breakthrough in agriculture are likely to be weaker in the future as globalisation and trade in agricultural commodities makes food prices less responsive to local production. Diversification in crop production, value-addition and agribusiness development in the rural sector hold the key to livelihood security in rural areas. By building on the strengths of Green Revolution, while seeking to avoid its weaknesses, scientists and policy makers can take significant steps toward achieving sustainable food security in the country.

3.7 NEW CHALLENGES BEFORE THE INDIAN AGRICULTURE — WTO, IPR, ETC.

After having achieved the goal of food self-sufficiency during the Green Revolution period, nutritional and income security have emerged as the most important issues related to agriculture. There is a need to make cultivation of pulses and oilseeds more profitable than rice and wheat for increasing per capita availability of pulses and reducing the import of edible oils. Keeping in tune with the diversification in the consumption pattern of people, fruits and vegetables, milk, fish and meat production should be given emphasis. Post-harvest losses continue to be enormous in the country. There is a need to improve the shelf-life of perishable agricultural commodities through genetic enhancement and the creation of infrastructural facilities in rural areas. Such facilities will encourage development of agro-processing and value-addition to the farm produce, save farmers from price risks and provide income security. There is also a need to make research and development efforts to increase productivity in the areas that depend on rain.

Agriculture has become an important agenda of trade negotiations in the World Trade Organisation (WTO) regime of international trade. Three major aspects of WTO agreement concern Indian Agriculture – (a) ***Agreement on Agriculture (AoA***); (b) ***The agreement on Sanitary and Phyto-Sanitary (SPS) measures***; and (c) ***Trade Related aspects of Intellectual Property Rights (TRIPS).***

Agreement on agriculture covers three broad areas:

a) Domestic support or reduction of domestic subsidies,

b) Market access or import liberalisation, and

c) Export competition or export liberalisation.

In view of the above agreements, steps have been taken to make Indian agriculture more competitive to take on challenges posed by liberalisation and globalisation. The quantitative restrictions on import of agricultural commodities were removed with effect from April 1, 2000. The Plant Varieties and Farmers Rights Act was enacted in October, 2001. It safeguards the interests of breeders and farmers. In order to conform to SPS measures, however, the quality of agricultural produce needs to be upgraded and monitored. The support measures given to the agriculture of developed nations is a major force to be reckoned with both at the production level as well as at the level of trade negotiations.

3.8 LET US SUM UP

In this unit you have learned about the background, nature and the impact of the Green Revolution on rural India. The basic strategy which was adopted in the mid 1960s consisted of the application of an input package of new HYV seeds, fertilisers and pesticides combined with an assured irrigation facility. To encourage the adoption of this technology, the government also formulated policies regarding the pricing of output, subsidies on inputs and increased availability of credit for such investment.

The early success was in the wheat growing northwestern region. Some pockets of HYV rice cultivation have also emerged in south India. The other parts of the country, particularly rainfed areas of the country have been slow in adopting the new technology. The strategy has prevented the rate of growth of food-grain output from falling, but it has not been able to push up the productivity of other crops particularly oilseeds and pulses.

The limited spread of the Green Revolution has become a cause for concern, as it has remained largely crop- and area-specific. In recent years there has also been some environmental problems associated with this strategy.

On balance, the Green Revolution has been an important contributor to the growth of food-grain output in the last thirty-five years. Current strategies of agricultural development must take into account the need for sustainability enhancing technologies and the changes in international trade scenario. Issues such as suitable technology for rainfed areas, resource management, better livelihood strategies and trade should be incorporated in the policy and its implementation assured at all costs.

3.9 KEY WORDS

CACP : Commission for Agricultural Costs and Prices, which announces Minimum Support Prices (MSP) prior to the sowing season.

GMO : A genetically engineered organisam which carries specific traits such as resistance against herbicides.

HYV Package : The combination of high yielding varieties of seeds, with regular irrigation, fertilisers and pesticides designed to give higher yields.

Institutional Credit : Credit available from commercial banks and primary agricultural cooperatives and other organised institutions rather than from private sources such as money-lenders.

Marketed Surplus : The part of production, which is sold in the market.

Minimum Support Prices: Prices announced and offered by the government prior to the sowing of seeds to make the crop attractive for farmers and to avoide the risk of fall in prices.

Photosynthesis : The process by which plants convert carbondioxide and sunlight to produce their food.

Scale Biases : Sometimes a technology or the outcome of research *favours* only the *large* producers of a commodity. Such research/technology is said to suffer from scale-bias.

SPS : Sanitary and Phyto-Sanitary standards of WTO, which prescribes the minimum safety standards for export of agricultural produce.

Transgenic : GMO plants are also called transgenics.

3.10 REFERENCES AND SUGGESTED READINGS

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3.11 CHECK YOUR PROGRESS – POSSIBLE ANSWERS

Check Your Progress I

1) (b) 2) (b)

3) For purposes of increasing agricultural production, expansin of the area under cultivation reached its limits in the early sixties. The land reform measures and irrigation development programmes undertaken earlier did not result in adequate growth in production of food-grains. The food security of a fast increasing population was much dependent on imports, particularly from the USA. The overall economy was being adversely affected because of the lack of self-sufficiency in food-grains. Under such compulsions, the Government was forced to adopt a new agricultural strategy around the mid 1960s.

Check Your Progress II

1) (a) 2) (a) 3) (d) 4) (c) 5) (c)

6) The basic elements of the strategy adopted for the Green Revolution are the following:

   a) A package of inputs comprising HYV seeds, fertilisers, irrigation, and pesticides. All these were to be applied in accordance with a recommended package of practices, i.e. appropriate proportion of fertilizers and water at the right time etc.

   b) Institutional support in the form of minimum support prices, procurement operations and credit facilities, and

   c) A geographical focus on the areas having prerequisites for applying the package of practices.

Check Your Progress III

1) (c) 2) (b) 3) (a) 4) (b) 5) (a) 6) (a)