UNIT 12 NEW TECHNOLOGY AND DISTRIBUTION OF GAINS

Structure

12.0 OBJECTIVES

After reading this unit, you will be able to:

- explain why technological developments in agriculture is important;
- identify the pathways through which gains accrue through new agricultural technologies;
- outline how green revolution (GR) technologies have impacted social groups and regions;
- indicate the potential impacts of new technologies like genetically modified (GM) crops;
- distinguish between the GR and the GM technologies in terms of their major differences; and
- suggest a policy strategy for ensuring better distribution of gains through innovation in the agricultural sector.

12.1 INTRODUCTION

As in the case of production of other commodities, productivity improvements through application of technology are very important to the agricultural sector. Even though increasing yield/output is the objective of technological change, the impacts are not confined merely to output. They also manifest in terms of: (i) employment increase or decrease; (ii) differentiated impacts like when the new technology is capital intensive, it benefits producers with easier access to capital more than the others; (iii) if new technologies are confined to specific crops, producers of those crops tend to gain more leaving out the others from being the beneficiaries of gains; etc. Gains from technological change, therefore, need not be distributed evenly across regions and groups of economic actors. In other words, technological change may create gainers and losers particularly in the short run. In the long run, however, generally some kind of equilibrium is restored. But several barriers continue to prevail in the path of ensuring equitable distribution of gains. This is particularly true in low income countries like India where the institutional development required to ensure a more equitable distribution of gains would not have been established. In this context, the present unit deals with the important issue of how the diffusion of new technologies impact differently on the various social and economic sections of the society and in this light what measures are needed to be taken to ensure the concerns of equity.

12.2 CONCEPTUAL OVERVIEW

How does technological development benefit the society and why does it leave out some sections and benefit only a few in an inequitous manner? And what policy challenge needs to be faced in order that equity concerns are duly addressed? Conceptually, these are the two questions which we shall try to answer in this unit. Technological advancement, as we know well, is inevitable for productivity raise. Recall from your study of earlier units that the agricultural sector has deep linkages with the rest of the economy through its income, employment and consumption effects. Further, ensuring food security without creating food price inflation is always an important challenge for policy makers. In addition to meeting the food requirements of a growing population, the sector also has to ensure a steady supply of raw materials for an expanding industrial sector. As large number of poor households in low income countries rely on this sector for their livelihoods, improvements in output can play an important role in poverty reduction. As a consequence, investments in new technological development and its effective diffusion remains an important dimension of policy-making in both the industrialized and low income economies. Until the 1960s, production could not keep pace with the growing demand for food grains in several low income countries including India. As discussed in the previous unit, in response to combating this severe food shortage, under a broad programmatic intervention called the ‘green revolution’, governments in several of these countries adopted a new technology called ‘high yielding variety seeds’ with complementary inputs of chemical fertilizers and irrigation. Even as such technological advancements led to improvements in yields, its welfare effects remained debatable. There is a wide contention that the poor were unable to participate successfully in the adoption of new technology (during the green revolution in Asia in general) mainly due to their inability to access complementary inputs. While the higher outputs yielded high profits for rich farmers as their marketable surplus was huge (their actual consumption needs being less), for small and marginal farmers who shifted to cash crops it was different. They not only lost their access to subsistence food but also lost out heavily when the prices for their output fell as their ability to withstand such losses was minimal. There are, however, others who argue that over time the gains brought about by introduction of GR technology did benefit even the poor as the productivity of crops improved in general. Facilitating the poor to access the new technologies through credit and markets, which was the key to improving the welfare of the poorer segments of the population, did not take place in the manner and to the extent that was required. In still later years, in case of genetically modified (GM) technologies which promised to provide the next breakthrough in agricultural production, similar concerns of equity and sustainability hampered its application. In such contesting situation, therefore, the policy challenge essentially centre around addressing the distribution of gains. In other words, conceptually, we can broadly identify the following ways through which gains from technological advance in agriculture can accrue to different sections of population:

a) consumers through lower prices;

b) agricultural labour by way of getting more employment opportunities both on-farm and off-farm;

c) subsistence farmers through improved consumption and production albeit of much lower degree than the rich farmers; and

d) agri-business entrepreneurs by way of opportunities for business with lower nominal wages and hence higher surplus for investment enabling cumulative benefits of repeated profit/investment till the stage when the level of wages match improvements in productivity.

12.3 PATHWAYS OF TECHNOLOGICAL IMPACTS

In a more general sense, the pathways of technological impacts can be outlined as follows. In the realm of agriculture, technology can be distinguished for their:

a) embodied technological characteristics: This includes seed/plant varieties embodying genetic technology in the form of disease and weather resistant breeds that are more responsive to chemical fertilizers which can be produced on a large scale (as compared to organic/natural manures which has a natural limit to its production potential). This also includes mechanical and electrical implements embodying engineering technology.

b) dis-embodied technological characteristics: These are forms of knowledge that can be codified into rules and procedures which are essential for effective production and use of new technologies. Farmers trying to use embodied technologies would need to acquire information on how best to use them in the fields. However, even disembodied rules and procedures require farmers to understand and deploy them properly for which 'extension services' in the form of education and training are critical components of technology diffusion. Further, more importantly, even when information access/flow is duly streamlined by appropriate measures, production capabilities would still remain variant among participants depending on the inherent differences in persons/regions to benefit from new technology. The institutional capabilities to aid their better absorption which, inter-alia, depends on aspects of governance in establishing conditions favourable to technology absorption thus remains the key to successful realisation of optimum benefits from technological development.

These differences in the various dimensions of technology requires observable outcomes to assess the impact of technology. These may be called as *pathways* through which the diffusion effects can be quantified and thereby measured. These can be stated as:

a) through increased output (i.e. output augmenting);

b) through improved quality of products produced (i.e. quality improving);

c) through reduction in the crop cycle time and therefore by opening the possibility of increasing cropping intensity (i.e. time reducing); and/or

d) through reduction in the cost of cultivation (by reduced quantity of inputs required or by lowering the price of inputs or by introducing a set of new but cheaper inputs) [i.e. cost/input reducing].

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

1) Mention any three ways in which the impact of technological development in agriculture can create both losers and gainers in the short run.

....

....

....

....

2) Which two factors are pointed out as mainly responsible for the GR or HYV technology to have left out the 'small and marginal farmers' out of its ambit of positive influence?

....

....

....

....

3) Conceptually, how would you identify the beneficial influence of technological development in agriculture to the different sections of population?

....

....

....

....

4) State the components which enhance the agricultural output by virtue of its 'embodied technological characteristics'.

....

....

....

....

5) What would you identify as the 'key' to the successful realisation of optimum benefits from technological development?

....

....

....

....

6) What are the four major pathways in terms of which the diffusion effects of technological development in agriculture can be quantified/measured?

....

....

....

....

12.4 PROFILES OF DISTRIBUTION OF GAINS

In an ideal situation where factors for inducing equal distribution of gains are controlled, which would require establishment of well functioning institutions that are developed gradually with the extent of economic development attained by a country, there would be balanced regional development. However, as already noted, in the short term there would inevitably be gainers and losers. If so, what are the dimensions of variation in the distribution of gains owing to technological development? We can identify five main dimensions as follows.

12.4.1 Regional Variation

Disparities across regions arise from: (a) the nature of technological change; (b) differences in factor endowments (like soil conditions and amount of natural rain fall); and (c) institutional differences.

a) Nature of Technological Change: The nature of technological development in the developing world tends to be capital intensive as they largely flow from the advanced capitalist countries. As a result, they tend to favour the more prosperous regions that can better access capital intensive inputs. If capital access is critical to output, then the disparities in the flow of credit too will aggravate such regional differences.

   Many new technologies are also water-intensive requiring access to assured irrigation. In light of this, regions with better irrigation resources tend to benefit more than regions that are more dependent on rainfall for agricultural production. Due to this factor also, in the case of Indian agriculture it is argued that the Green Revolution aggravated the existing regional inequalities since it did not benefit rain fed and resource poor regions.

b) Differences in Factor Endowments: Crop specific technologies like HYV seeds tend to benefit only those who are producing those crops. Regions that are endowed with conditions more suitable for the production of these crops will therefore gain leaving out other regions from being a part of the technological change. In India, the Green Revolution in the initial phases favoured wheat producing regions as the HYVs were introduced primarily in wheat. In the subsequent phases, with the introduction of HYV seeds in rice, rice production regions also benefitted. The Green Revolution, thus, created considerable bias against dry regions which depended on growing so-called coarse grains and millets like *ragi and jowar*. Besides, there has been no improvement in plant varieties in oilseeds or pulses which are the main stay of dry regions. Technological breakthrough by way of evolving high yielding varieties in the type of crops grown in dry land regions is still an unfulfilled task. But, in the short run, several institutional constraints which are an outcome of specific historical factors of socio-economic development pose considerable barriers to the process of such equitable growth.

c) Institutional Differences: Institutional differences refer to variations in landownership patterns, labour and tenancy relations including the nature of other institutions like financial, education, health, etc. Land tenure systems and nature of ownership therefore play an important part in shaping the regional distribution of gains. It has been argued that one reason for the rapid diffusion of gains from HYV rice in Taiwan was the relatively more egalitarian landownership pattern due to land reforms initiated by the state. In contrast, in India the extent of land reforms was poor which contributed to the lower achievement of distributional gains of agricultural development by green revolution. However, historically regions in which ryotwari systems prevailed reaped higher growth and distributional benefits than the regions where zamindari systems of ownership prevailed. Micro studies based on primary data have established that per capita credit flows in the first decade of the green revolution were higher in the ryotwari regions. Policy emphasis therefore requires that use of new technologies should be combined with both land reforms and other forms of institutional development. In other words, while land reforms is necessary, equitable distribution of gains from technological development requires that such reforms should be backed by provision of credit, technical and marketing assistance, educational and health institutions, etc.

12.4.2 Impact on Employment

One of the approximate measures of overall employment effect is employment elasticity. Employment elasticity measures percentage increase in employment for every one percent of increase in output. Technologies may alter the employment elasticities affecting the extent of employment absorption. However, while capital intensive technologies may reduce direct employment absorption, the quantum of indirect employment may increase. For instance, demand for machineries may generate demand for additional labour in repairing services. Enhanced output also may require additional labour requirements in downstream sectors like harvesting and processing. Further, the cropping intensity by way of multiple cropping may become possible which in turn would lead to greater demand for labour over the year. In another dimension, the impact of mechanization on employment will depend on the extent to which its ***labour substituting effect*** is compensated by its ***land-augmenting effect***. An example for this is the United States where in the second half of the 19th century horse-based mechanization led to massive agricultural growth with large tracts of new lands brought under cultivation. The export markets in Europe provided a higher elasticity of demand for its output. However, such a situation cannot happen in land scarce countries like India except for some marginal changes in this regard. But with increased non-farm sector growth, even in such contexts labour can be productively redeployed both within agriculture as also in other sectors. However, a necessary condition for this to happen is that factors to induce the elasticity of final demand must prevail. In its absence, mechanization would lead to a reduction in agricultural employment even if extra land is available.

The experience of Punjab in the post- Green Revolution period reveals the complexity of the relationship between employment and new technologies. Here, in the early years of the green revolution, there was a sharp increase in demand for labour leading to a rise in real wages. This increased the demand for labour and the consequent immigration of labour from other states like Bihar. Simultaneously, the wage increases also incentivised movement towards use of more machinery by the land owners resulting in a decline in real wages in the subsequent period. Further, new technologies may favour certain kinds of labour like tractor drivers, combined harvester operators, displacing unskilled labour leading to segmentation in the labour market. Gender based differences are also likely to emerge.

New technologies can also effect changes to employment relations. If the yearly demand pattern for labour over the year changes, it may induce shift from attached labour to hired labour or in some cases, intensification in the use of attached labour. Such shifts too have implications for wage levels and worker's welfare.

12.4.3 Across Economic Classes

New technologies can also bring about changes in the distribution of income between the different economic classes like: landlord-tenant, employer-labour, etc. When a new technology is introduced, there would also be a new class of entrepreneurs willing to cash-in on the opportunity. This could lead to an increase in land-rent making the class of landlords who earn through leasing their land earn more rental income. Likewise, new technology might require hiring of more skilled workers or training the old workers to work on the new technology. In both these situations, there would be a change in the wage bill of employers as higher skills would attract higher wages. Correspondingly, the income shares accruing to capitalist investors (rich landlord/farmers in agriculture) will change. Land augmenting technological change like green revolution technology (i.e. by way of an increase in the cropping intensity and increased yield per unit area), would also alter the income shares of economic classes in favour of the rich farmers. However, the actual outcome in the distribution of income would depend upon the demand for the output and growth in the supply of complementary inputs vis-à-vis the state of development of an economy. In the industrialized countries, for instance, there has been a decline in land rents over time. But there is as yet not enough evidence to indicate such a trend in India.

Technological change would also have implications for wage-share due to changes in demand for labour in ways other than skilled-unskilled case mentioned above. For instance, yield augmenting technology in agriculture may require the use of more intensive labour during times such as harvesting (in the absence of mechanization in harvesting). This would increase the bargaining power of labour and hence the wage rate and consequently the labour's share of wages. Further, when wage rate increases, it may also lead to wage-saving measures by the employers, reducing thereby the wage-share of the employers. In countries like India, where the labour supply is usually much more than the demand, the possibility of a decline in wage share is likely for the unskilled workers particularly when wages are set at the subsistence level. In such a situation, improved productivity may yield more profits for the capitalist farmer as the increase in demand for labour may not lead to increase in the wage-share of employers.

12.4.4 Across Farm Sizes

Another important dimension of distribution of gains from new technology is across size classes of farms. There is a debate on the farm-size-productivity on which you have studied briefly in unit 5 (section 5.4.2) of this course. The predominance of small scale agriculture in several low income countries including India makes this dimension particularly important. Given the capital bias in most technological changes including in agricultural technology, farmers who can access capital more easily are likely to be the gainers. Thus, the differences in the ability of farms/farmers to access capital strongly influences the nature of benefits/income distribution. If access to institutional credit is less for small farmers, the gains will also clearly be relatively less for the small farmers, reinforcing the accentuation of rural inequalities owing to technological development.

In the absence of concerted state policy for assisting farmers with smaller size of land, large farmers will be regarded as more credit-worthy and hence can have better access to institutional credit. The cost of servicing a loan to a small farmer may be as much as that for a large farmer even though the amount lent could be smaller. This increases the transaction costs for the banks creating in the process an inherent bias against small farmers in respect of institutional credit. It has been observed in the context of several low income countries that small farmers are forced to rely more on informal credit markets who tend to charge exorbitant rates of interest. On the other hand, the large farmers, even in the absence of well developed credit markets, would be able to mobilize capital from their own savings while small and marginal farmers ability to do so would be extremely limited. A well developed small farmer-centric credit policy is, therefore, a must for technological development to yield benefits of an equitable nature in countries like India.

Further, many technologies are subject to scale economies in which case larger farms tend to gain more than the smaller ones. The tractor is a good example for this. It is technically more efficient to design a large rather than a small machine. However, small farms can also benefit by renting-in such machinery. This, however, requires appropriate development of institutions like hiring services on easy terms suitable to the small farmer's ability to cope. With the onset of the green revolution, it was expected that the differences in credit access and scale economies would be dealt with, in course of time, by the establishment of support services required for its effective implementation in regions not already endowed with such services. In other words, it was expected to support the 'inverse relationship hypothesis' by enabling even the small farmers to get the benefit of GR technology. This tendency which can be mitigated by improving the access to the required services for small farmers was, in fact, met with some degree of success at some places. However, this did not happen to the expected degree/scale with large areas remaining outside its beneficial reach. Nonetheless, small farms have certain advantages over large farms in production like if new technologies require more supervision of labour, small farmers can do it better than large farmers. However, due to intense fragmentation of land holdings, the landholding size of a large number of small farmers in the country has fallen far shorter than the optimal farm size. This has therefore caused the need for newer methods of coping with such situations like cooperative farming. Cooperative farming has, however, failed due to several institutional problems. Farmers' groups or collectives are seen as more helpful to small farmers in meeting the needs of technology, credit and marketing.

12.4.5 Between Producers and Consumers

When the cost of production of a crop is reduced due to adoption of new technologies (in terms of improvement in yield per unit of land), it implies a downward shift in the cost function and hence an upward shift in the commodity's supply function. This will result in an increase in economic welfare through consumption of a larger quantity at a lower cost. The distribution of the gains in economic welfare between producers and consumers, however, depends on price elasticities of demand and supply for the commodity. Under conditions of perfect elasticity of demand, which means increasing demand with increasing supply, producers can reap all the gains of new technology adoption. When demand is inelastic, increased supply would result in reduced prices and consumers tend to gain. Since demand is inelastic for several agricultural goods, consumers may gain more than the producers in the short run. In addition, in case of agriculture several goods are perishable and hence producers (particularly the small producers) in the absence of proper storage facilities tend to sell the goods as soon as they are harvested. Such sharp increases in supply tend to bring down prices affecting small producers although for the consumers there would be a gain. However, when production is dominated by large farmers or large companies like plantations, they are likely to have access to storage facilities and can hold onto their output till prices rise again after harvesting season. The poor spend a larger proportion of their income on food than the rich. Hence, when food prices fall their real income increases proportionately more than that of the rich. Though the poor may gain from the price decline as consumers, poor farmers face the prospect of losing both as producers when they sell their produce immediately after harvest at lower prices and buy at a later stage some of their requirements when prices are relatively high.

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

1) Which two factors are most crucially needed to ensure a more equitable distribution of gains from technological development?

....

....

....

....

2) What is a necessary condition by which the likely adverse impact on employment by technological change can be effectively prevented?

....

....

....

....

3) In what way a new technology could result in the segmentation of labour markets?

....

....

....

....

4) Give two examples to indicate how technological development would impact the labour market in terms of the relative wage-share of employees and employers.

....

....

....

....

5) How would you say that in the matter of advancing institutional credit to small farmers there could be an inherent bias against them?

....

....

....

....

6) At a certain point, the farm-size hypothesis has got itself negated in India in the context of GR-technology spread/diffusion. Why?

....

....

....

....

12.5 GENETICALLY MODIFIED CROPS AND POTENTIAL DISTRIBUTION OF GAINS

The most recent phase of technological change in agriculture involves genetic manipulation of the seeds so as to maximize the more productive characteristics of the plant and minimize its susceptibility to diseases and pests. These are referred to as genetically modified (GM) crops. It is this change in technology that we referred to in the previous unit as shift from green to gene revolution. While the actual impacts on the distribution of gains are not very clear at this stage, based on the above discussion, we are in a position to infer some possible trends. These may be stated as below.

The first GM crops were commercialised in the US in 1995. By 2004, in less than a decade, GM crops were being grown by more than 8 million farmers in seventeen countries covering an area of 81 million hectares. Such rapid diffusion of any new crop technology is considered unprecedented. The most widely used GM technology involves herbicide tolerance (HT) applied in soya bean and canola, and insect resistance based on genes isolated from Bacillus thuringiensis (Bt), applied in maize and cotton.

There are three major institutional, environmental and agro-ecological differences between the GM and HYV revolution. These are:

i) The supply of HYV seeds and other linked inputs in developing countries was dominated by the public sector. Impetus for GM crop development, on the other hand, has not come from farmers or governments, but from large private corporations based in advanced capitalist economies. As a result, intellectual property rights (IPR) become important and any use that violates the IPR is seen as illegal.

ii) The environmental and other risks associated with GM technology are still unclear. It is possible that the gains realised by one set of farmers may be off-set by the adverse health or environmental effects on consumers and other sets of producers.

iii) Unlike the HYV technology which required favourable conditions like assured irrigation to work well, GM technology can be used to improve the productivity of crops even in poor agro-ecological environments.

It is said that the GM technology provides an opportunity to increase productivity of many neglected secondary crops that have been by-passed by HYV technology like millets, sorghum and ragi that contribute to the food security needs of many poor households in Asia and Africa. Till date however, there are only few GM crop species that have been made commercially available. Soybean, maize, cotton, and canola account for over 99% of the total GM crop species so far released and these are also crops that are predominantly grown in the U.S. The reasons for such a narrow focus are clear. Given the dominance of private capital, profitability considerations become more important than improving the livelihoods of poor farmers in low income countries or ensuring food security among the poor. *Biotechnology research is highly capital intensive and therefore the market size becomes an important criteria in choosing crops for introducing GM technology.*

Since multinationals have little incentive to develop GM crops for small or uncertain markets, technologies suitable for developing countries are unlikely to emerge unless targeted public sector activities are increased considerably. Moreover, suitability at the national level needs to be considered as the GM crop technology needs to be adapted to local conditions before it can be used. Possible barriers to its further diffusion due to protection of intellectual property rights (IPR) also needs to be addressed. Safety concerns by many activist bodies, notably on the environmental front, have also been raised. It is said that consumption of GM crops increases the risk from allergens. The technology has to be therefore approved by national bio-safety and food safety authorities.

If we look at the list of countries where GM crop technologies are commercially available, we find that the poorer countries in Africa and Asia are missing. There are widespread concerns that the proliferation of IPRs would limit the access of poor countries to modern biotechnologies. In practice, only a few middle income countries with a strong national agricultural research system like China, India, or Brazil have so far undertaken research in this domain. The prevailing model for GM crop innovation in developing countries has been one where multinational firms commercialize their products that were initially developed for rich country markets, either directly or in cooperation with local seed producers.

Some studies on the economic impacts of GM crop technology reveal that on an average adopting farmers benefit from income increases through reduced pest control costs and higher effective yields. These studies also suggest that the farm-level benefits tend to be bigger in low income economies than in the advanced capitalist countries. However, as mentioned earlier, impact on local ecologies and health risks for consumers including the threat that it can also harm beneficial pests remain. Loss of bio-diversity is the major feared risk. On the economic front, there is a fear that the control of large corporations over seed supply and distribution can undermine the sovereignty of developing country farmers. There is also the concern that the GM technology may undermine the food security of the rural poor if it induces a shift in cropping pattern among small and marginal farmers from protein rich crops like beans to those rich in carbohydrates like rice or wheat. The ongoing debate on GM crops in general or the ones on Bt cotton or Bt brinjal could be appreciated in the light of different dimensions of GM technology discussed above.

Check Your Progress 3

1) Mention the three major differences between the GR-technology and the GM-crop technology?

....

....

....

....

2) Notwithstanding the feared anxieties about the GM-crop technology, what beneficial features do you see in its application in the developing economies?

....

....

....

....

12.6 LET US SUM UP

New technologies, despite their welfare improving effects also have negative implications for balanced regional development. They also tend to favour certain groups of economic actors like large farmers. Some of the biases in the distribution of gains arise from institutional factors like land tenure systems and lack of credit provisions for the small and marginal farmers. Certain adverse labour market features like gender based segmentation too may accrue contributing to structural weaknesses in the growth process. The GM-technology, a later development to the GR-technology, in spite of its positive features like reduced pest control costs and higher effective yields, is feared to be controlled by large private firms with profit as their primary motive. In such a situation, national concerns like ensuring food security among poor households or livelihood improvement among small and marginal farmers in resource scarce environments are not likely to receive the required priority. Unknown potential environmental risks too can create distortions in the welfare gains of such technologies. The policy strategy to address such biases are yet to shape up. However, for any technological gains to be equity centric, public intervention in asset distribution and progress on the tenurial/land reform fronts, along with credit, marketing and technical support, are of utmost importance. To mitigate some of the fears, there is a strong case for direct public investment in new crop technologies to ensure that research is directed towards areas that have greater implications for social welfare.

12.7 KEY WORDS

Embodied and dis-embodied technological characteristics : Inherent qualities to ward off pests and greater yield in seeds/plants are embodied

or needs technological characteristics. Specific training and extension services needed for the effective diffusion of a technology are dis-embodied technological needs.

GR and GM technology : GR technology is what was implemented widely with public investment and support in the entire Asian region in the 1960s to combat concern of food scarcity. GM technology, on the other hand, was a later development of 1980s, developed with private corporate initiative and therefore feared to result in unknown social and ecological disturbances.

Labour substituting effect : One of the much feared effects of any technological development referring to reduced employment particularly to the unskilled. However, there are views that there would be a net employment gain owing to growth of the sector in both the farm and the non-farm sector fronts.

Farm-size hypothesis : Implies smaller farms yield larger output. The inverse relationship means that 'larger the farm size lower will be the output'. However, a minimum or optimum size of a farm is also equally crucial. In the Indian context, intense fragmentation of land holdings has rendered the many actual farm sizes far shorter than the optimum-minimum.

12.8 SOME USEFUL REFERENCES

1. Hans P, Binswanger and Joachim Von Braun (1991), Technological Change and Commercialization in Agriculture: The Effect on the Poor, *The World Bank Research Observer*, Vol. 6, No. 1, pp. 57-80.

2. Hanumantha Rao, C. H. (1975), *Technological Change and Distribution of Gains in Indian Agriculture*, New Delhi: The Macmillan Company of India Limited.

3. Griffin, K. (1974), *The Political Economy of Agrarian Change: An Essay on the Green Revolution*, Harvard: Harvard University Press.

4. Matin Qaim (2001), Transgenic Crops and Developing Countries, *Economic and Political Weekly*, Vol. 36, No. 32, pp. 3064-3070.

12.9 ANSWERS/HINTS TO CYP EXERCISES

Check Your Progress 1

1) See 12.1 and answer.

2) See 12.2 and answer.

3) See 12.2 and answer.

4) See 12.3 and answer.

5) See 12.3 and answer.

6) See 12.3 and answer.

Check Your Progress 2

1) See 12.4.1 and answer.

2) See 12.4.2 and answer.

3) See 12.4.2 and answer.

4) See 12.4.3 and answer.

5) See 12.4.4 and answer.

6) See 12.4.4 and answer.

Check Your Progress 3

1) See 12.5 and answer.

2) See 12.5 and answer.