CHAPTER I

Agriculture and Technology in India
1.1 Nature and Significance of Agriculture:

So long as the farmer continues to assume the role of a basic industry in some degree or the other in every country. Agriculture as a primary industry plays a significant role in the process of the economic development of a country. But the contribution of the agricultural sector to the overall economy varies from country to country depending upon the level of economic development. In the early stages of economic development, normally agriculture is the major contributor to national income and it provides employment to a majority of people. At later stages of a fairly high level of economic progress, the importance of agriculture gradually declines. However agriculture with its fundamental importance has its own contribution to make through the unending process of economic development. Economic development may be defined as transformation of an economy which is predominantly agricultural and traditional into a large industrial and modern one. The agricultural and non-agricultural sectors in the former remains separate, presenting economic dualism, while in the latter they get integrated together. In the overall economic development, the role and functions of agricultural sector have figured prominently in theories of development, practically since World War II.

Historical records clearly show that no country has moved from the stage of chronic stagnation to the take-off stage of economic development without first achieving a substantial increase in agricultural production. In the earlier stages of economic development of modern advance stage, a high rate of
agricultural production has played a crucial role in furthering overall economic growth. For example in United Kingdom, agriculture did provide cheap and sufficient food in the early decades of the industrial Revolution and did provide self-finance for more efficient agriculture. The Take-off periods of France, Belgium, Germany and Sweden also rested upon a firm base of a raising agricultural productivity. Economic development of Russia, China, and Japan reveals the basic role played by agriculture in the earlier stages. Communist China also recognized the importance of achieving an agricultural surplus in the process of economic development. In India too, during the planning era some of the state governments have recorded high priority to agriculture. With reference to India, Coale and Hoover* view is “Very substantial progress in the most backward part of the economy (agriculture) was a prerequisite to successful development of the Indian economy as a Whole”. In emphasizing the role of agriculture in the development of the Indian economy, it is observed that “If one sector limits the growth of the other, it is more likely to be a case of agricultural growth, limiting non-agricultural sector than vice versa”.

The importance of agriculture in the economic development of any country is borne out by the fact that it is the primary sector of the economy which provides the basic ingredients necessary for the existence of mankind and also provides most of the raw materials which when transformed

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into finished products serve as basic necessities of the human race. In addition
to supplying food, agriculture must provide many of the raw materials for
industry. However, agriculture is not only a supplier of goods for domestic and
export needs, but also a supplier of production factors such as capital and
labour. Agriculture is called upon to save and finance a significant part of the
investment of an expansion of industrial plant, transport and other sector as
well. Most of the industries in India are agro-based industries.

We can thus, say that in the absence of developed agricultural sector, the
base for "Take Off" into a nature economy would be weak, and Indian
economy characterized by wide spread disguised unemployment and high rate
of population growth is expected to remain in a pitiable condition.

Role and Functions of Agriculture:

Agriculture development is important for many reasons. Agriculture
most primarily provides adequate food and nutrition supplies to the fast
growing population. In the early stages of economic growth, the income
elasticity of demand for food in underdeveloped countries is estimated to be 0.6
or higher which is twice or thrice as much as that in Europe, United States and
Japan. In an underdeveloped country like India, with low nutritional standards
any rise in income is most likely to increase the demand for food and more
diversified foodstuffs. More over, less developed countries are experiencing
population exploitation. In order to supply adequate food and nutrition to the
growing population, the rate of agricultural production should be higher than
the rate of growth of population, which in these countries varies from 2.0 per
cent to 3.0 per cent per annum. If the food supplies fail to expand in pace with the growth of demand, the result is likely to be a substantial rise in food price and consequent inflationary situation both in rural and urban sectors.

The farm sector has to supply the raw materials for growing manufacturing industries. Agricultural raw materials enter many industries. Nearly one-third of India's industrial output till recently depended upon the supply of agricultural commodities, such as raw cotton, jute, oilseeds and rice. In underdeveloped economies, the agricultural sector, with surplus labour can supply manpower to the growing manufacturing industry. The agricultural sector, with unlimited supply of manpower, has to release the labour force for industrialization. In the early stages of economic development, manpower for manufacturing sector can be drawn easily from agriculture.

The agricultural sector creates demand for more and new industrial goods. As agricultural development takes place, the per capita form income will improve. Then the farmers would be in a position to buy more of modern agricultural inputs and consumer goods from the industrial sector. The improved inputs enhancing productive efficiency in agriculture, leading to a move of marketable surplus can be exchanged for goods and services in the industrial sector.

Agriculture also contributes to capital formation, which is essential for economic growth. The contribution of agriculture to capital formation can take place in three ways: first, increased agricultural productivity leads to lower food prices, which in turn raise real income and promote saving. Second,
increased farm output may generate higher levels of farm income and a part of it may be saved. These savings may be utilized for further investment purpose for overall economic development. Thirdly, taxing the agricultural sector can derive capital. In China, Russia, and Japan farm tax revenue helped significantly in their economic growth. The system of agricultural taxation may be diverse in form, such as land taxes, agricultural income tax, export duty and irrigation tax.

If agricultural production is large enough to yield an exportable surplus, it will earn the much-needed foreign exchange for imports of essential equipment, technical known-how and industrial raw materials. Observes Simon Kuznets*, "Agriculture was a major source of exports and that the resulting command over the resource of the more develops countries played a strategic role in facilitating modern economic growth".

For instance, the post-Meiji industrialization of Japan was crucially assisted by the rapidly expanding agricultural exports.

The agricultural sector contributes to industrial development by way of:

a) Providing food to the growing industrial workers,

b) Providing raw material to industrial development of both large - scale as well as Small scale-industries,

c) Providing labour to the industries,

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d) Creating demand for industrial products,
e) Helping capital formation required for industrial development.

Therefore agriculture and industry are not conflicting alternatives, but complementary ones. Agriculture and industry compete for national resource. However, it may be taken as the general consensus that "an agrarian revolution preceding and running parallel with industrial revolution is a sound strategy that could take a country along the golden path of economic development.

1.2 Importance of Agriculture in the Indian Economy:

The importance of agriculture in India can be judged mainly from its contribution to national income and employment. Agriculture continues to be a major source of income and employment to a vast majority of (about 65 per cent) People in India. Official estimates of national income and its components are available on a regular basis in India since 1948-49. V.K.R.V Rao estimated that the proportion of agriculture to the total output was 57 per cent during 1925-29 and 53 per cent for 1931-32. For 1948-49, official estimates that placed the share of agriculture in the net domestic product were reckoned to be about 56 per cent and during the following ten years, it remained about 50 per cent. After this, the percentage share of agriculture was about 45 per cent in 1970-71, 40.2 per cent in 1980-81, 31.7 per cent in 1991-92 and 27 percent in 1999.

According to the decennial census reports the proportion of cultivation and agricultural labourers to main works was 72 per cent in 1951, 71.8 per cent in 1961, 69.8 per cent in 1971, 66.5 per cent in 1981 and 65.0 per cent in 1991.
It is clear that the dependence of the workers on agriculture, though slightly decreasing, continues to be significantly higher.

The agricultural sector in India supplies food to the fast-growing population and raw material to the manufacturing industry. The agricultural sector with surplus labour is in a position to supply manpower required for the industrial sector in urban areas. The agricultural sector creates demand for industrial products with the advent of the Green revolution, there has been a considerable increase in farm incomes in areas with relatively better irrigation facilities.

Farmers in areas like Punjab, Haryana, and Coastal Andhra etc are able to contribute to capital requirements for the overall economic growth in India. Through agricultural taxation, some state Governments are able to raise considerable amounts. The contribution of the agricultural sector to foreign exchange resources is significant. The agricultural sector's contribution of 21 per cent to the total exports will be higher if the exports of agro-based manufacturers are taken into account. In 1991-92, the contribution of agricultural commodities to exports was Rs. 8228 crores and it increased to Rs. 25040 crores in 1996-97.

There is a close interdependence between agriculture and industry. In 1994-65, out of total agricultural production, about 12.5 per cent went from agriculture, while nearly 23 per cent was utilized by the industries, the rest went directly to final consumption. The value of agricultural inputs (Rs.2085 crores) formed about 20.6 per cent of the total value of industrial output
(Rs.10,106 crores) in the year. After the advantage of the new farm technology, agriculture depends largely on industry for modern inputs like Chemical Fertilizers, Pesticides, Pump sets, Tractors, Power tiller etc. For instance, between 1990-91 and 1993-94 the consumption of fertilizers was around 12 million tonnes. It was increased to 14.3 million tonnes in 1996-97. The use of pump sets, both electric and diesel, increased from about one million in 1965-66 to 60 million in 1996.

Even with a dismal slid in food grain production, the country accounted for the highest buffer stock in recent times. The year witnessed the paradox of “Grain Mountains and starving million”. The production level in the previous year (1999-2000) was 208.87 million tonnes, which was the highest ever achieved. The year 2000-2001 experienced adverse weather condition. The overall rainfall during the monsoon was defected by 8 per cent.

The agricultural development in the country should be put on a faster track to meet the food grain demand. “There is no room for complainency” say experts, who recommended drawing up an innovative, farmer-friendly policy. On the inputs supply, the certified quality seeds distribution touched a new high of one million tonnes during the year 2000-2001.

Agri-clinics, Agri-business centers and urban food parks linking the rural producers and urban consumers can make a major contribution in elevating and stabilizing crop yields provided, we enlarge the space for remunerative self-employment. For that, need a new deal for self-employed youth. Our agricultural strengths include vast human resources nearly 100
million people in addition to the diversity of soil and growing conditions. The
in efficient use of inputs particularly water, nutrients and pesticides is
increasing the cost of cultivation without any corresponding yield dividend.

It is the time we assess our variability in global trade in the changing
economic environment. Development of high yielding inputs efficient,
resistant as well as biotech stressed and better quality breeds can offset the cost
of production to be globally relevant. Mixed farming of crops, Agro-forestry
and live stock has been an effective strategy of the Indian farmers. This
concept based on multiple uses of inputs and recycling principals is being
enlarged in its scope by incorporating fish, poultry, pigs, ducks, silk worms,
mushroom, vermi culture etc. We need markets, jobs, and investment. About
65 to 70 per cent of our people depend on agriculture for their live hood. To
achieve a desirable rate of 7 per cent growth in the economy, agriculture must
register a growth of not less than 4 per cent. Now it is around 2 per cent and is
declining. This needs to be reversed.

To achieve these twin goals of "reducing pressure on land with wider
opportunities for better employment and improving farm production
efficiency", our policy efforts must be directed at the development of skill of
the rural people through education and training and widening the scope of non-
farm employment by attracting capital flow to the rural sector. For achieving
rapid progress our strategy must focus on conserving natural resources
enhancing efficient usage increase productivity and profitability and improving
quality and competitiveness through reduced unit cost of production. We can
use biotechnology effectively for producing seeds, selecting of choice plant especially for export.

1.3 Growth, performance of agriculture in the Post-Independent period.

Indian agricultural growth in the post Independent period can be distributed in four distinct phases – Pre-green revolution phase, First phase of green revolution, Second phase of green revolution and Liberalization phase. The decade of 1980s is treated as the second phase of green revolution and the decade of 1990s as the liberalization period. The first phase of green revolution maintained the growth rate of output achieved in the growth rate of area. In other words, this period could maintain the growth rate of the pre-green revolution period by achieving significant improvement in crop yields. This can be seen from the fact that the growth rate of aggregated output improved, through marginally from 2.8 per cent to 3.0 per cent, despite a decline in the growth rate of gross cropped area from 1.2 per cent to 0.6 per cent. Similarly the growth rate of food grain production accelerated marginally from 2.5 to 2.8 per cent despite a deceleration in the growth rate of area under food grains from 1.0 to 0.4 per cent. (Rao and Desphande 1986)*. While this is the positive side of the green revolution. On the negative side, the first phase witnessed accentuation of inter-regional and inter crop imbalances because of

the restriction of HYV seeds for only rice and wheat in the initial years and the adoption of these varieties only in the weed-endowed regions (RaO 1994)*.

The second phase of green revolution (1980) appears to be the best period for Indian agriculture with significant acceleration in output growth and reduction in regional inequalities because of the introduction of HYVs for other crops, spread of green revolution to eastern region and emphasis on water shed programs in dry areas.

For instance the growth rate of aggregate output accelerated from 2.5 percent in the first phase to 2.9 per cent in the second phase similarly, the growth rates of pulses accelerated from 0.3 and 2.3 per cent and growth rate of oilseeds accelerated from 2.3 to 2.9 per cent. The early 1990 also experienced continuation of the trends observed in the 1980s.

The output index of all crops increased at 3.4 per cent per annum in the 1980s as well as in the early 1990s. The net domestic product from agriculture grew at 3.2 per cent (Swant 1997)**. However, when the entire period of 1990s is considered, there is clear evidence of deceleration in agricultural growth. The growth rate of GDP from agriculture declined from 4.2 per cent in the 1980s to 3.7 percent per annum in the 1991s. The growth rate of crop output decelerated steeply from 3.4 to 2.2 percent.


** Sawant S.D (1997):"Regional variations in Agricultural performance. Indian Journal of Agricultural Economics, Vol: 52, No.3 July-September
Since independence, considerable progress has been made in the sphere of agricultural development in the country in terms of increase in crop production and productivity, technological developments, and crop diversification. There were, however, periods of ups and downs in the growth of agriculture during the initial years (up to the mid-sixties) it had slowed down, during the subsequent years, gathered momentum again during the eighties, and has decelerated considerably in the nineties is more pronounced in the case of food grains and it raises concerns from the point of view of food security. Moreover, it casts doubt regarding the future growth prospects of the economy which depends largely upon the growth performance of agriculture.

There has been an impressive growth in the production of food grains output recorded a four-fold rise from 50.8 million tonnes in 1950-51 to 198.2 million tonnes in 1996-97. Per capita availability of food grains improved from 395 grams per day in 1951 to 507 grams per day in 1995. More impressive has been the growth of non-food grains production of major non-food grains and all crops rose by 2.64 per cent, 3.15 per cent, and 2.84 per cent per annum, respectively between 1951-52 and 1995-96.

The cropping pattern has also undergone significant change which can be appreciated from the divergence in the growth rates of area, and production of food grains and non-food grains. The change was noticeable particularly after the mid-eighties (Table 1.1)
### Table 1.1
Annual Compound Growth Rates of Index of Area, production and Yield of Food grains, Non Food grains and All Crops

<table>
<thead>
<tr>
<th>Period</th>
<th>Food grains</th>
<th></th>
<th></th>
<th>Non-food grains</th>
<th></th>
<th></th>
<th>All crops</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area</td>
<td>Output</td>
<td>Yield</td>
<td>Area</td>
<td>Output</td>
<td>Yield</td>
<td>Area</td>
<td>Output</td>
<td>Yield</td>
</tr>
<tr>
<td>1951-52 To</td>
<td>1.41</td>
<td>2.91</td>
<td>1.49</td>
<td>2.36</td>
<td>3.50</td>
<td>1.08</td>
<td>1.62</td>
<td>3.13</td>
<td>1.49</td>
</tr>
<tr>
<td>1964-65 To</td>
<td>0.50</td>
<td>2.22</td>
<td>1.71</td>
<td>0.61</td>
<td>1.89</td>
<td>1.28</td>
<td>0.52</td>
<td>2.10</td>
<td>1.57</td>
</tr>
<tr>
<td>1980-81 To</td>
<td>0.28</td>
<td>3.97</td>
<td>3.70</td>
<td>0.92</td>
<td>3.43</td>
<td>2.50</td>
<td>0.42</td>
<td>3.77</td>
<td>3.35</td>
</tr>
<tr>
<td>1985-86 To</td>
<td>-0.19</td>
<td>2.96</td>
<td>3.16</td>
<td>2.24</td>
<td>5.54</td>
<td>3.21</td>
<td>0.41</td>
<td>3.92</td>
<td>3.49</td>
</tr>
<tr>
<td>1990-91 To</td>
<td>-0.65</td>
<td>1.63</td>
<td>2.29</td>
<td>2.06</td>
<td>3.68</td>
<td>1.58</td>
<td>0.08</td>
<td>2.44</td>
<td>2.35</td>
</tr>
<tr>
<td>1995-96</td>
<td>0.53</td>
<td>2.64</td>
<td>2.10</td>
<td>1.51</td>
<td>3.15</td>
<td>1.61</td>
<td>0.77</td>
<td>2.84</td>
<td>2.05</td>
</tr>
</tbody>
</table>

**Source:** Ministry of Agriculture, Govt. of India.

**Note:** The yield growth rates reported here would differ from those derivable from the yield indices given in the official publications.

The mid-sixties, which were marked by the beginning of the Green Revolution (GR), were something like a watershed in the growth of Indian agriculture. During the Pre-GR period (1951-52 to 1964-65) production of all crops recorded an impressive average growth rate of 3.13 per cent per annum. During the subsequent period (1964-65 to 1980-81), the growth rate remained subdued at 2.10 per cent. However, the area expansion was slowed down considerably. The output growth during this period was remarkably higher during the eighties. The production indices of food grains showed a steep rising trend throughout the decade except for a downward movement during...
1986-87 and 1987-88. The production of all crops recorded a growth rate of 3.77 per cent during the first half of the eighties, and it accelerated to 3.92 per cent during the second half of the decade, compared with 2.10 per cent during the TE 1964-65 to TE 1980-81. During the nineties (up to 1995-96) however, the growth rate of agricultural production slowed down considerably to 2.44 per cent, the growth of food grains decelerated, the absolute production levels of food grains remained far below the plan targets. Food grains output failed to keep pace with the population growth, and consequently the per capita availability of food grains which had reached a level of 510 grams per day in 1991, declined to an average level of 482 grams per day during the subsequent five years (1992-96).

Traditionally, the aggregate supply response is considered to be poor in agriculture although the responsiveness may be high in respect of certain individual crops. However as observed above the supply response in terms of area expansion, was appreciably positive up-till the end of eighties. Even though there would be a limit to the growth of net cropped area (NCA). The gross cropped area (GCA) seemed to have grown as expected, reflecting a rise in the nineties. The growth of GDP and population may not provide any indication of demand constraint. In terms of price, the overall terms of trade remained favourable, improving noticeably during this period.

During the nineties, the pace of creation of irrigation potential as well as the coverage of area under irrigation slowed down significantly. The pace of expansion of area under HYV and growth of fertilizer consumption also
decelerated with their attendant adverse consequences on productivity growth. Irrigation, however forms the core of physical infrastructure for agriculture development, and the reduced pace of development of irrigation is destined to have slowed down the rise in cropping intensity resulting in a subdued growth of GCA. The influence of irrigation on area is relatively greater in the case of non-food grains, and that its influence on yield is relatively large in the cultivation of non-food grains (primarily commercial crops) being relatively large. The farmers would prefer to grow them under conditions of assured water. This would possibly explain the greater influence of irrigation on the area under non-food grains in understandably reflective of the association of irrigation with the principal determinants of yield like HYV and fertilizer consumption. Admittedly, the analysis here is simplistic in that it does not incorporate other variable which are supposed to influence crop production and productivity, never helves, it can be said that the results are indicative of the role of irrigation in shaping the growth of agriculture.

1.4 Technological Change in Agriculture:

Generally Technology has been defined as "The Knowledge being applied by human beings to improve production of marketing process", in other words it is the operative knowledge used to produce goods and services. The term technology is derived from 'technique' and 'ology'. They are quite different. Technique has been in use with us for a long time in handicraft, agriculture and other allied fields. Technology on the other hand has a logical structure of language, similar to that of science more logical transformation of
science that can produce technology. Technology is a roaring exercise of the human imagination and conceptually technology is a problem solving process. The dimensions of the technology are many and the important ones are functions, fabrication, fuel, communication and control and algorithm.

The technology that is well suited for a particular industry or firm at a particular point of time may become outmoded at another time when new inventions and innovation take place. Innovation, a prime mover of capital accumulation, takes place due to various reasons which can be classified into two broad categories.

a) To reduce cost, increase output and profit.

b) To provide substitutes for the factors which are scare and priced heavily.

Technological change may be broadly divided into two parts Viz. embodied technological change and disembodied technological change. Embodied change is the introduction of change in physical capital inputs. Disembodied change is not embodied in the physical capital. These changes are of organizational structure. For example better information which tends to increase the marginal ability of the form-firm operator.

Technology and technical process have enabled man to utilize the human and natural resources rapidly and effectively so as to generate new products, process and organization system for comfortable living. The purpose of technology has been to make man towards what he wishes to be. Technology is one of the most important forces that alter the structure of any economy.
Growth in agriculture productivity is essentially created by advances in knowledge and progress of inter-industry division of labour which have accompanied with industrialization. It is seen that despite differences in climate, weather conditions and input mix, major variations in land and labour productivity among countries are associated with the differences in the level of industrial inputs used in agriculture. They are found to be relatively more important as compared with the original endowments of land.

Besides these terms like land-augmenting, labour saving, capital saving and neutral technological changes are known to be part of technological changes. In case of land-augmenting technological change is known as supply of land is inelastic in its supply. So some techniques might help to augment land availability. Multiple cropping, consumption of fertilizers and pesticides, usage of high yielding variety seeds are such techniques. Thus the biological chemical and technical changes introduced in agriculture are referred as land-augmenting technological changes. In this term, the constant factor prices call for less labour and more capital after technical change. This kind of change tends to increase the marginal product of capital more than marginal product of labour. The term capital saving technological change is in the case of capital saving technological change. In the case of neutral technological change the capital - labour ratio remains constant after technological change.

The adoption of new technology by farmers among other things shows an effect on income. The quicker and the greater the raise in income resulting from the use of new technology, the greater is the probability of its being
adopted by cultivators. The technological break through in agriculture which the nation witnessed during late sixties benefited the farming community to a considerable extent. It helped in increasing the farm income, which ultimately affected the consumption and saving pattern of the farm families. The study of income, savings and investment in agriculture assumed great significance in view of the Government's new policy, where in it is clearly stated that investment in agriculture would receive the highest priority in the economic development of the country, and besides the farmers would be motivated to increase the efficiency of production and make such adjustment in their investment pattern so as to meet fully the consumer's demand.

Technological advance in agriculture and the constraints though imposed by in elastic supply of primary factors, raise agricultural productivity even in the case of shortage of primary factors. Technological progress results in not only general economic progress but also in the better standard of living in those areas where greater changes in technology have occurred. More time has been available for recreation and personal improvement. Even when farmers work for long hours, physical exertions are less.

Modern technology may influence agricultural production in three ways: first, it may help in increasing efficiency that is greater production for a given quality of one or more resource or unchanged production with a reduction in resource use. Second, agricultural technology may contribute a change in production characteristics. Finally, modern agricultural technology which may reduce production risks such as related to the production process as well as to
markets and price. Modern technology may be divided into four important
types: biological, chemical, mechanical and management. Biological
technology includes new crop varieties and other technology, which
incorporates materials of the biological nature. Chemical technology includes
chemical fertilizers, chemical means for pest or weed control and similar
materials, while mechanical technology includes farm machinery equipment.
Management technology includes the knowledge concerned with decision-
making and management of farming activities without directly involving the
use of new materials.

Technology refers to knowledge used in production to improve the
returns. Agricultural technology therefore, refers to the knowledge used in
improved agricultural productivity. Agricultural technology may be reflected
in a given mix of men and machines, seeds and fertilizers, animal labour and
management inputs. Further technological knowledge refers to the knowledge
of using a technology. The use of new technology warrants new knowledge
among the users and any reformed technology may remain idle, obviously,
spread of education and extension services are essential to let farmers catch up
with the changing technology.

The modernization of agriculture means the application of science and
technology in agriculture to undertake forming with the most advanced
agriculture science and technology and to mechanize agricultural production so
as to raise the productivity of farm labour and satisfy the needs of the people
and society food and other agriculture products. Agriculture embraces
agronomical practices, which involve the proper utilization of land, application of pesticides and insecticides to crops and industrial raw materials, the technology and the application of fertilizers and employment of irrigation practices where ever appropriate.

Technological change is one of the most crucial factors determining the pattern and pace of agricultural growth. It includes all the available means, which improve the efficiency of converting scare resources into products, which satisfy human wants. It manifests itself in the use of new inputs and knowledge leading to an upward shift in the production function in the long run.

More often technological change takes place when, with changing resource base, a completely new input come into use and change the total input-output relation. New agricultural technology has facilitated the saving of important resources taken individually (land, labour and capital). Major technological changes which have come to play a vital role in Indian Agriculture can be grouped under six broad heads 1) introduction of new plants, 2) plant breeding, 3) use of fertilizers and pesticides, 4) irrigation, 5) the use of inanimate power on the farm that is use of tractors, electric motors and pumping engines and lastly 6) improved cultivation practices.

The technological changes have been able to contribute relatively to the maximum in the increased agricultural production so far achieved. By far the most revolutionary impacts of technological developments in agriculture have been the use of chemical fertilizer and the impact of science of breeding. Yet
another improved technique in agriculture is the science of farm planning and soil and water conservation practices. But there is a wide gap between the technological development and its actual adoption by the cultivators. Improving the literacy standard amongst the masses can narrow this down.

The cultivators with a size of holding more than a fixed maximum should be considered for coverage and the extension agency should concentrate its efforts primarily on these selected areas to the cultivators with more than the medium size holding. The farm plan program needs to be identified, as this is only means, which could ensure optimum utilization of the nutrients and other benefits of technological changes for maximum production. This selective approach should be strengthened by effective legislation when ever necessary.

**Technological Change in Indian Agriculture:**

Spectacular changes in food grain production and productivity were recorded in the wake of the technological break through in Indian Agriculture since the mid-sixties. The bulk of the increase in total agricultural production resulted form increased productivity per hectare. The improvement in agricultural productivity can be traced to development in a number of directions. The most significant one was the use of HYVs of seeds of different crops particularly wheat, paddy, jowar and bajra. Along with the use of HYVs, increased use of irrigation water, fertilizers and manures, insecticides, fungicides and weedicides have also been responsible for raising cultivable wastelands under the plough. Improvements have taken place in the methods of soil and water management and in agricultural practices like seed treatment,
inter-cultivation and weeding. The changes are many, we discuss below some of the crucial steps of the new farm technology in India.

**New Agricultural strategy:**

The new agricultural strategy was introduced in India during the third five-year plan i.e. during sixties. The farmers started to respond favorable to HYV seeds and adequate fertilizer. The theoretical back ground of new agricultural strategy is to be traced to Chicago School Thesis “It underpins that farmers everywhere capable to produce the right things in right place, in the right quantity and at low costs in terms of resources, if they receive the proper economic signals”.

The pride place goes to agricultural research conducted by Indian Council of Agricultural Research (ICAR) and the farm universities like Agricultural University at Ludhiana (Punjab) and at Pant Nagar (UP). It is the development of HYV seeds, which have brought about the revolution.

Improved variety of seeds, greater intensity of cropping, extension of irrigation package of inputs, guaranteed minimum prices, modern farm machinery, and role of public institutions agricultural machinery and improved implements, multiple cropping program and plant protection measures are the important features of new agricultural strategy.

**Green Revolution:**

The Green Revolution, which is the New Agricultural Strategy (NAS), is composed draft of High Yielding Varieties (HYV), fertilizers, pesticides and new efficient water management techniques etc. These are the result of scientific development. This scientific development was made possible by
Revolution implies two things, one is a fast change in some phenomena, and the change is so fast that is well marked. Another one is impact of the change is felt over period of time and brings about certain fundamental change. When we add the prefix “Green”, to the word “Revolution” and coin the phrase “Green Revolution”. Thus it refers to well worked improvement in agro production in a short period.

The new technology was tried as a pilot projects in some seven districts as Intensive Agro District Program (IADP) in 1960-61. Therefore Green Revolution is the direct out come of new agricultural strategy adopted since mid sixties. In broad sense, it means a transformation of agriculture, reduction in food shortages and under nourishment, and elimination of the traditional agriculture sector as a bottleneck to progress. In a narrow sense, it means “Increase in production due to plant improvement to solve the food problem and nothing more than that”.

Indian farmers will have to be more competitive and quality oriented to find an establishment berth in the global market. Given the support of sound government policies, good infrastructure facilities, technological innovations and clean post harvest management practices millions of small and marginal farmers will stand up to meet the demand of the international market. Production by the masses, the spirit of co-operation and zest for quality
standards should be the hallmarks of Indian agriculture when it enters the
Global trade.

Information and Communication Technology (ICTs) For Modernizing
Indian Agriculture:

To say that we live in the information era is to repeat a truism. ICTs are
transforming our lives, creating wealth, and impacting every aspect of human
endeavour. The 2001 Nobel Prize Economists - George Akerlof, Michael
Spence and Joseph Stiglitz are showing how information is of utmost
importance to society and well-functioning economies.

Mobilizing knowledge for development is also about addressing
information problems. India's operation flood is one of the most successful
attempts which led to put India is the first place in the production of milk in last
five years. It improves the functioning of milk markets by ensuring quality.
New information and communication technologies can accelerate broad-based
rural growth and by increasing awareness, help make it a central pillar of
overall development strategy.

Globalization of international trade technology transfers, information
exchange and capital flows will have profound implications for the agricultural
sectors of the developing countries. Globalization facilitates the technology
transfer needed for increasing productivity of Indian agriculture. The NAP
identifies the several technological changes such as biotechnology, remote
sensing and environmental technologies. Developments in modern
biotechnology can contribute to increasing and maintaining these high levels of
productivity. Advances in information technology can also help linking the farming community to new global increasing agricultural commodities and there by increasing the market efficiency, locally and at the international level.

1.5 ROLE OF COMMERCIAL CROPS:

Commercial crops have contributed very significantly to the growth of Indian economy. Commercial crops are about intensive and the total employment generated by the four major commercial crops Sugarcane, Groundnut, Cotton, and Potato is estimated at 3,392.2 Million Man-days in 1982-83. India is a traditional exporter of oil seed cakes and meals. Jute is one of the important agricultural exports and it was the largest exchange earner in early seventies. To-day India is not only surplus in raw cotton but also produces one of the finest varieties like Suvin. India is the world’s largest producer of Sugarcane. Thus commercial crops contribute significantly to the export sector. First the productivity of commercial crops is much lower than that in many other countries. All over the world high yields of Sugarcane, Cotton, Oil seeds, Tobacco and Jute have been obtained where they are grown with adequate inputs and under efficient farm management.

Commercial crops grown under rain fed conditions are high-risk crops. The farmers are naturally reluctant to increase their investment in such crops. The introduction of crop incurrence may encourage investment on quality seeds and other modern inputs. The input supply and transfer of technology systems should be able to support the farmers in unfavorable production situations.
Maintenance of buffer banks for alternate crop seeds and crop insurance may help in this regard.

Among commercial crops, Sugarcane and Cotton enjoyed a privileged position in terms of allocation of research resources. The development of high yielding hybrid cotton varieties and their rapid spread in the major cotton producing states helped cotton cultivation to turn the corner in the seventies. Frequently, the important policy of the government depressed the domestic prices. The market and environment should be conducive to encourage production in terms of reducing the supply, demand gap and stabilize prices. It is observed over the years that even ten per cent rise or fall in the output of oil seeds, cotton, tobacco and even sugarcane altered the market trends.

A right combination of price and import policy can help regularize the economy of commercial crops. All our efforts are to be mounted towards the transfer of technologies for dry farming, input support and provision of the infrastructure. Agriculture is a location-specific activity. Ecological, socio-economic institutional and technological factors all influence the rate of progress in agriculture productivity, watershed-based approach may be effective in the future. Introducing group insurance schemes and custom services for a whole group of farmers may be in order to promote the growing commercial crops in risky production environments. Price policy is an important factor in promoting production maintaining special procurement mechanisms and offering an incentive price are important parts of the strategy to encourage commercial crops.
There is a need to further improve the farmer’s share in the consumer rupee for various commercial crops. Infrastructure support in the form of warehousing and storage is important. Biotechnology as a tool to improve the productivity and to develop new varieties and hybrids of crop plant is emerging as an important discipline. Govt. policies should provide a favorable environment for promoting the commercial crop sector. Hence, we have to make break through in technological and organizational fronts to make the commercial crop sector an efficient one. From the foregoing discussion, it can be concluded that growth and stability in the production of commercial crops were complementary rather than competitive in intensively irrigated regions.

Features of some Important Commercial crops:

Sugarcane is one of the important commercial crop in Indian agriculture. It assumes an important position in the economy by contributing nearly 1.9 per cent of the national GDP. The crop sustains the second largest organized agro-industry. This has enabled us to be the largest producer of sugar and second largest producer of sugarcane in the world.

India is the largest producer of tea in the world. It accounts for 20 per cent of total area under tea in the world. The tea industry provides direct employment for one million workers of which a sizeable number are women. It contributes to the state and central earnings (Rs. 1.00 crores) that are the significant economic features of the Indian economy. A serious effort towards improving the quality image of Indian tea, with a thrust on orthodox production is being made quantitative restrictions were lifted from 1st April 2001.
Cotton is another important commercial crop in India. Cotton, a crop of prosperity, having a profound influence on men and matter, is an industrial commodity of worldwide importance. After a peak cotton production of 178.7 lakh bale in 1996-97 the production has declined to 145-196 lakh bales in the recent years. During the early 1990's CICR development an organic production technology with a visionary approach and translated it to the farmers, cotton continues to remain the back bone of the rural economy with 60 million people earning their live hood through its cultivation and trade.

Jute and Mesta together are called “raw jute” in the industry and trade circles. Jute is the most important natural fibre crop next to cotton. It plays a significant role in the agrarian and Industrial economy of some of eastern Indian states like West Bengal, Bihar, Assam, and Orissa. Jute and Mesta fetched around 49 crores during 2000 which is 10 per cent of total jute goods exports. There is a bright feature for this biodegradable, environment friendly, cheap and annually renewable natural fibre as the current trends suggest.

Tobacco is one of the world’s leading non food crops. Tobacco is by and large a rain fed, steady and short-duration crop and is less prone to insect pests and diseases. Tobacco is the lifeline for above 30 million people. Six million farmers are engaged in tobacco cultivation. Bidi-rollooing provides employment to four million, one million are involved in Tendu leaf plucking. Tobacco exports account for 3.5 per cent of India’s agri-exports. Tobacco provides 12 per cent of India’s total excise revenue (value Rs. 8,182 crores in 2001) cigarettes contribute 88 per cent of excise revenue.
A short duration crop, which produces more dry matter, sharp crop duration and wide flexibility in its planting and harvesting time, are 'Potato'. The per capita consumption is lower in many parts of the world, recognizing its superior nutritional quality it would prove to be a useful for fighting hunger and malnutrition. India has to keep pace with the new emerging trends in order to be globally competitive. The challenges faced by India are peculiar to the country since potato is grown here under diverse agro-clinic conditions unlike in the developed countries.

Our study “Technological Changes in the Production of Commercial crops”- a regional analysis is mainly based on two important commercial crops namely Sugarcane and Groundnut crops. A brief review of these two crops as follows.

SUGARCANE:

India is the world’s largest producer of Sugarcane. Sugarcane processing including the production of mill sugar, khandasari and gur is a major industry. In our country agriculture is not an agri-business, but a way of life, and sugarcane an agro-industrial crop and an important integral component of agriculture.

It assumes an important position in the economy by contributing nearly 1.9 per cent of the national GDP. Sugarcane is cultivated in over 4 million hectares spreading over a wide range of agro-ecological situations, both in tropical and subtropical regions. The crop sustains as the second largest organized agro-industry. Productivity of Sugarcane in India lies between 50
tonnes per hectare in Bihar to 105 tonnes per hectare in Tamilnadu. The average productivity of Sugarcane in the country is around 72 tones per hectare and obtains in 415 million tonnes of sugarcane from the cultivated area of about 4.2 million hectares. The productivity of Sugarcane has got to be raised to the level of 100 tonnes per hectare by 2020 A.D.

The major technology inventions is most critical input for enhancing the Sugarcane production during the times to come will be the developments are varieties with input resistance for insect sugar pest and diseases coupled with a high level of supply of Sugarcane on a sustainable basis. The selection of suitable variety and proper management of the crop are necessary for better remuneration through inter-cropping systems. An appropriate technology has been developed by the Indian Institute of Sugarcane Research Lucknow.

**GROUNDNUT:**

Groundnut, known as peanuts in some countries, is the most important source of vegetable oil in India, in terms of production, consumption as well as exports. Besides being used as a source of oil, groundnuts are consumed directly as selected or sweetened nuts in India. Groundnut oil is used either directly for cooking purpose or converted into margarine or hydrogenated oil, popularly known as vanaspati. Groundnut oil also serves as an excellent raw material in the manufacture of soaps and cosmetics and to a limited use in the manufacture of leather dressings, furniture, creams, compound lubricants etc. Significantly enough, groundnut and groundnut oil constitute the most important items of agricultural commodities from the export point of view.
The main groundnut producing states are Gujarat, Andhra pradesh, Tamilnadu and Maharashtra account for about 70 per cent of the area and therefore the overall production in the country is influenced by the trends in production in these states. A sandy and friable soil in a well-drained area highly suited on groundnut. But soil is not a limiting factor and the crop can be grown practically on all types of soil, the only one not suited being stiff are heavy clays. Groudnut is primarily a rain fed crop, groundnut cultivation is most suited to areas with a rainfall of 25 inches to 50 inches and a mean temperature of 70 to 80 Fareign heat.

Groundnut is a Khrif crop and is sown after the break of monsoon. Early varieties are harvested in September and October and late ones in November and December. The breeding work undertaken on groundnut in different states was directed mainly towards evolving varieties with high yield, oil content, and shelling percentage. As a result, improved varieties of the short-duration spreading groundnut (135-150 days) are available for cultivation in most of the states. From price policy for groundnut in the post-independence period, it can be stated that no direct measures have been initiated so far to keep the prices of groundnut and groundnut oil within reasonable limits. Moreover emphasis has been shifted recently from export of groundnut and groundnut oil to import of certain cheap varieties of edible oils- Soya bean oil, cottonseed oil, sunflower oil etc to supplement the internal supplies. To increase the production of groundnut various steps including package
programme approach implying simultaneous attention to the use of improved seeds, fertilizers, and plant protection etc are being adopted for oil seeds.