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T.Y.B.A.
RURAL DEVELOPMENT
PAPER -IV
AGRICULTURE AND ITS SIGNIFICANCE IN RURAL DEVELOPMENT

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August 2016, T.Y.B.A. Rural Development Agriculture and its Significance in Rural Development

Published by : **Incharge Director**
Institute of Distance and Open Learning,
University of Mumbai,
Vidyanagari, Mumbai - 400 098.

DTP Composed : Ashwini Arts
Gurukripa Chawl, M.C. Chagla Marg, Bamanwada,
Vile Parle (E), Mumbai - 400 099.

Printed by :

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1

INDIAN AGRICULTURE

Unit Structure :

1.0 OBJECTIVES

1) To understand the definition and nature of Indian agriculture.
2) To study the salient features of Indian agriculture.

1.1 AGRICULTURE IN INDIA : AN INTRODUCTION

At the time of Independence in 1947, Indian agriculture was traditional and stagnant in every respect. It was characterized by feudal land relations, primitive technology, and the resultant low productivity per hectare. The first task of Indian Government in the immediate post-Independence period was, therefore, to initiate growth process in agriculture on modern lines. Modernization of agriculture was salient required both in terms of technological and institutional changes. Abolition of intermediaries in agriculture, like zamindars and jagirdars, was accomplished soon after Independence.

The largest portion of the natural resources of India consists of land and by far the largest number of its inhabitants is engaged in agriculture. Therefore, in any scheme of economic development of the country, agriculture holds a position of basic importance. Although Indian agriculture is way back compared to the levels in developed countries, some notable development have occurred over the years since Independence in 1947. Large areas which suffered from repeated failures of rainfall have received irrigation, new crops have come to occupy a significant position in the country's production and trade, agricultural and the industrial economies in the country now exert a powerful influences on one another, problems of rural indebtedness and the exploitative practices of the village moneylender are much less, and finally there is already in the countryside an awakening and a desire for raising standards of living.

1.2 DEFINITION OF AGRICULTURE

The word agriculture comes from the Latin words ager, means the soil and culture, means cultivation.

"Agriculture can be defined as the cultivation and / or production of crop plants or livestock products."

Agriculture includes Crop Production, Animal Husbandry and Dairy Science, Agriculture Chemistry and Soil Science, Horticulture, Agril Economics, Agril Engineering, Botany, plant pathology, Extension Education and Entomology, which develops its separate and distinct branches of agriculture occupying now a days place in several Agril llniver sites in the country.

Conventional Agriculture:

"Conventional Agriculture is the term for predominant farming practices and systems of crop production adapted by farmer in a particular region."

Agriculture can be termed as a science, an art and business altogether.

Science : because it provides new and improved strain of crop and animal with the help of the knowledge of breeding and genetics, modern technology of dairy science.

Art : because it is the management whether it is crop or animal husbandry.

Commerce (Business) : Because the entire agril produce is linked with marketing, which brings in the question of profit or loss.

1.3 NATURE OF INDIAN AGRICULTURE

At the time of Independence, India's agriculture was in a state of back wardness. Productivity per hectare and per worker was extremely low. The techniques employed were age-old and traditional, there were only 7 tractors per lakh hectares of gross cropped area in 1950-51. The number of oil engines and irrigation pump sets per lakh hectares was only 62 and 16 respectively in that year. The use of fertilizers was also neglible being only 0.66

lakh tonnes in 1952-53. Because of low productivity, agriculture merely provided 'subsistence' to the farmers and had not become 'commercialized'. Approximately 45 per cent of the total consumption of farmers came from their own production in 1951-52. This highlights the importance of money in the village economy. All the factors described above when taken together describe the nature of India's agriculture. They reveal that Indian agriculture was back and qualitatively traditional in nature on the eve of the First Five Year Plan.

1) Feudal Relations of Production :

At the time of Independence, three types of land tenure system were prevalent in the country - Zamindari, mahalwari and ryotwari. Approximately 57 per cent area of the country was under the zamindari system. In terms of coverage, ryotwari came second with 38 per cent area, while mahalwari was restricted to only 5 per cent area. The zamindari system was based on exploitation since zamindars pressurized peasants in a variety of ways with the objective of extracting as much rent from them as possible. As we shall discuss in Chapter 16, the zamindari system was a major hindrance to agricultural development. Ryots in the ryotwari system also leased out their land to tenants for cultivation as prevalent under the zamindari system.

After Independence, the State governments enacted laws to abolish the intermediaries. However, these were entirely inadequate to have any drastic impact on the agrarian structure. The zamindars only changed their grab and became absentee landlords. These absentee landlords wield considerable economic power derived from land-ownership: (a) cultivation with the help of hired labourers; (b) leasing out of land to tenants; (c) usury; and (d) trading in grains and other commodities. This is the true ruling class in our country. As its predecessor, the zamindari class, this new class of absentee big landlords is also based on exploitation.

Obviously, the classes that are exploited by these landlords are the classes of tenants and agricultural workers. Though no exact estimates on tenancy are available, it has been estimated that around 50 per cent of the cultivated land is under written or oral tenancy. A large number of tenants come under the category of tenants-at-will and sub-tenants. These classes of tenants possess no security of tenure and enjoy cultivation rights only so long as the landlords allow them to do so. This exposes them to the exploitative practices of the landlords since their very existence hinges on the pleasure of the landlords.

The second exploited class is constituted of agricultural workers. This class is at the lowest rung of social ladder in rural areas. It can be divided into two categories - (i) attached labourers, and (ii) casual labourers. The former are attached to some cultivator household on the basis of a written or oral contract. Normally they are not free to work at any other place. As against this, casual labourers are free to work on the farm of any farmer. A large number of tenants have also been evicted under the guise of personal cultivation and have swelled the ranks of agricultural labourers. The growing number of labourers indicates the process of ‘ immiserisation’ of the rural poor.

2) Usurious Capital and Rural Indebtedness :

The control of usurious capital is very strong on the Indian agriculture and indebtedness is a common legacy of poor framers. During the pre-Independence period, moneylenders and mahajans ruled the roost as there was no other credit agency worth the name. Taking advantage of their position, these people exploited the farmers in a number of ways. After Independence, the government has initiated a number of steps to curb their activities - the most important policy measure being the development of co-operative credit institutions and the increasing participation of banks in providing rural credit. However, because of a number factor, the small and marginal farmers continue to depend on moneylenders for fulfilling their credit requirements to a large extent and thus become victims of exploitation by the latter. The phrase ‘once in debt, always in debt’ expresses the condition of these farmers graphically. The moneylenders charge exorbitant rates of interest, manipulate accounts to their advantage and often seize the land of the small and marginal farmers on one pretext or the other. This usurious capital and rural indebtedness in India is a result of the social system or the relations of production prevailing in agriculture, Since long the Indian peasant has been living the life of a bonded landslave. It is this wretched existence that is responsible for his economic bankruptcy and consequently for his continued indebtedness.

3) Labour Market Dualism :

Because of the excessive pressure of population on land, wages in the agricultural sector tend to be considerably lower as compared to the modern (industrial) sector. This leads to a labour market dualism. This dualism is explained by the fact that large number of workers remain sticking to traditional agriculture despite low wage due either to ignorance of better opportunities outside agriculture or to their inability to obtain a modern sector job despite wishing to do so or to the cost of moving being unacceptably high (including the cost of giving up the relative security of remaining at home) in relation to the expected wage premium. Low wages in the agriculture sector lead to low per capita income and this, in turn, results in low labour productivity.

The cheapness of labour in the traditional agricultural sector causes it to be used extensively there. That is, extra labour is employed to perform tasks which would be unprofitable at the modern wage rate. Moreover, cheap labour leads to the adoption of labour - intensive methods of production such as cultivation by hand rather than mechanically.

4) Outmoded Farming Techniques :

Most of the Indian farmers continue to use outmoded farming techniques. The traditional agriculture depends on the biological sources of energy (human and animal labour), rains and dung manure. Returns to farmers under this technique of production are very meagre and the nature of farming is appropriately described as 'subsistence farming'. However, with the advent of the new agricultural strategy in 1966, modern techniques of production were initiated in certain selected regions of the country like Punjab, Haryana and Western Uttar Pradesh. As a consequence of the adoption of modern techniques of production and new high yielding varieties of seeds, agricultural productivity registered substantial increases in these areas. However, since large areas of the country continue to use outmoded agricultural techniques, a sort of technological dualism has emerged in the country.

5) Fluctuations and Instability in Crop Output :

The Indian agriculture has rightly been called a 'gamble in monsoons.' Gross cropped area in 1950-51 was 131.9 million hectares whereas gross irrigated area was only 22.6 million hectares. Thus, only 17 per cent of gross cropped area had irrigation facilities. In 1993-94, the gross cropped area was 186.4 million hectares of which 68 million hectares was irrigated. Thus 36 per cent of gross cropped area had irrigation facilities in 1993-94. This shows that even now as much as 64 per cent of gross cropped area continues to depend on rainfall. This shows that nature continues to play a major role in determining the level of agricultural production. If anything, the use of bio-chemical technology in the post 1965 period (often known as High Yielding Varieties Programme) has increased the sensitivity of output (except wheat) to variations in rainfall. The analysis carried out by C.H. Hanumantha Rao, Susanta K. Ray and K. Subbarao for the period 1959 to 1985 shows a steady upward trend in the sensitivity of total foodgrains output to variations in rainfall.[5] Irregular or uncertain monsoon in some years leads to large fluctuations and instability in agricultural production.

6) Diversities in the Agricultural Sector and the Problem of Generalisation :

India is a large country having substantial agricultural diversities. Different regions exhibit entirely different characteristics so that no one Plan can be conceived for all agricultural regions of the country. The nature of soil, the magnitude of rainfall, availability of water, etc. differ considerably between different regions. For instance, take the case of rainfall. While Western Raj as than and a part of the Thar desert have a very uncertain rainfall of 4 to 5 inches in a year, Cherrapunji in Assam has an annual rainfall of more than 450 inches. While considerable areas face drought conditions in a particular year, some areas encounter the fury of floods. Some areas face the problems of waterlogging and salinity. Practically the entire cultivated area of the country suffers from deficiency of nitrogen. Elements of phosphates and potash also differ significantly in different areas. It is not infrequent to find plots of land of highly different productivity existing side by side in a particular village. Not only this, relations of production are different in different States, There are substantial regional inequalities also in regard to sub-division and fragmentation of holdings.

The presence of large diversities in the agricultural sector makes it imperative to devise separate agricultural policies for different regions. It is not possible to generalize and formulate a single agricultural policy for the nation as a whole as such generalization is bound to gloss over inter-regional differences and fail to deliver the goods.

1.4 SALIENT FEATURES OF INDIAN AGRICULTURE

Some of the outstanding features of Indian agriculture are mentioned as follows.

1) Subsistence agriculture:

Most parts of India have subsistence agriculture. The farmer owns a small piece of land, grows crop with the help of his family and consumes almost the entire farm, produce with little surplus to sell in the market.

This types of agriculture has been practised in India for the last several of hundred years & still prevails in the spite of the large scale changes in agricultural practices after independence.

2) Pressure of Population on Agriculture:

The Population in India is increasing at rapid pace and exerts heavy pressure on agriculture. Agriculture has to provide employment to large section of work force and has to feed the teeming millions. While looking into the present need of food-grains we require an additional 12-15 million hectares of land to cope with the increasing demand. Moreover there is rising trend in urbanization.

Over one-forth of the Indian population lived in urban areas in 2001. It is estimate that over one-third of the total population of India would be living in urban areas by 2010. This requires more land for urban settlements which will ultimately encroach upon agricultural land.

3) Dependant upon Monsoon :

Indian agriculture is mainly dependant upon monsoon which is uncertain, unreliable and irregular. Inspite of the large scale expansion of irrigation facilities since, independence, only one third of the cropped area is provided by perennial irrigation and the remaining two-third of the cropped area has to bear the brunt of the vagaries of monsoons.

4) Variety of Crops :

India is a vast country with varied types of relief, climate and soil conditions. Therefore, there is a large variety of crops grown in India. Both the tropical and temperate crops are successfully grown in India. Very few countries in the world have variety of crops comparable to that produced in India's.

5) Importance of Animals:

Animals' force has always played a significant role in agricultural operations. Such as ploughing, irrigation, threshing and transporting the agricultural products. Complete mechanization of Indian agriculture is still a distant goal and animals will continue to dominate the agricultural scene in India for several years to come.

6) Predominance of Food Crops:

Since Indian agriculture has to feed large population, production of food crops is the first priority of the farmers almost everywhere in the country. More than two-thirds of the total cropped area is devoted to the cultivation of food crops. However, with the change in cropping pattern, the relative shares of food crops came down from 76.7% in 1950-51 to 58.8% in 2002-03

7) Insignificant place to given fodder crops:

Although India has the largest population of live stock in the world, fodder crops are given very insignificant place in our cropping pattern. Only 4% of the reporting area is devoted to the permanent pastures and other grazing lands. This is due to pressing demand of land for food crops.

8) Seasonal patterns :

India has three major crop seasons.

i) Kharif season starts with the on set of monsoons & continues till the beginning of winter. Major crops of this season are rice, maize, Jowar, Bajara, Cotton, groundnut and pulses such as moong, Urad, etc.

ii) Rabi season starts at the beginning of the winter and continues till the end of winter or beginning of summer. Major crops of this season are Wheat, barley, jowar, gram & soil seed such as linseed, rape & mustard.

iii) Zaid is Summer cropping season in which crops like rice, maize, groundnut, vegetables and fruits are grown.

1.5 EXERCISE

1) Explain the concept of agriculture and state nature of Indian agriculture.
2) What is agriculture? Discuss the salient features of Indian agriculture.

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2

SCOPE AND ROLE OF AGRICULTURE IN INDIAN ECONOMY

Unit Structure :

2.0 OBJECTIVES

1) To study the scope of agriculture in Indian Economy.
2) To understand the significance of agriculture in Indian Economy.
3) To study the necessity for the development of agricultural sector.

2.1 INTRODUCTION

Indian agriculture had reached the stage of development and maturity much before the now advanced countries of the world embarked on the path of progress. At that time, there was a proper balance between agriculture and industry and both flourished hand in hand. This situation continued till the middle of the eighteenth century. The interference from the alien British government and its deliberate policy of throttling the village handicrafts and cottage industries destroyed the fibre of balance and the economy of the country was badly shattered. Britishers pursued a typical colonial policy in India and did nothing to develop (or restore) agriculture. Instead, they created a class of intermediaries known as zamindars who sucked the very blood out of the rural poor. A substantial part of the produce was taken away by this parasitic class the actual cultivator was left only with subsistence income. The cultivators had neither the resources nor the incentive to invest in agriculture. Therefore, Indian agriculture in the pre-independence period can be correctly described as a ‘subsistence’ occupation which yielded ‘too little to live on and too much to die on’. The zamindars and money-landers usurped a large part of land on the pretext of settlement for debts taken by cultivators and a number of cultivators were thus left landless. This gave birth to the class of landless labourers or agricultural workers who worked on the land of others for wages which were often too meagre to keep the body and sow together. A majority of farmers were just able to eke out a level of subsistence from agricultural activities.

2.2 SCOPE OF INDIAN AGRICULTURE

Proverbially, India is known as "Land of Villages". Near about 67% of India's population live in villages. The occupation of villagers is agriculture. Agriculture is the dominant sector of our economy and contribute in various ways such as :

1) National Economy :

In 1990-91, agriculture contributed 31.6% of the National Income of India, while manufacturing sector contributed 17.6%. It is substantial than other countries. For example in 1982 it was 34.9% in India against 2% in UK, 3% in USA, 4% in the Canada. It indicated that the more advanced stage of development the smaller is the share of agriculture in National Income.

2) Total Employment :

Around 65% population is working and depends on agriculture and allied activities. Nearly 70% of the rural population earns its livelihood from agriculture and other occupation allied to agriculture. In cities also, a considerable part of labor force is engaged in jobs depending on processing and marketing of agricultural products.

3) Industrial Inputs :

Most of the industries depend on the raw material produced by agriculture. So, agriculture is the principal source of raw material to the industries. The industries like cotton textile, jute, paper, sugar depends totally on agriculture for the supply of raw material. The small scale and cottage industries like handloom and powerloom, ginning and pressing, oil crushing, rice husking, sericulture fruit processing, etc. are also mainly agro-based industries.

4) Food Supply :

During this year targeted food production was 198 million tons and which is to be increased 225 million tons by the end of this century to feed the growing population of India i.e. 35 crores in 1951 and 100 crores at the end of this century. India, thus, is able to meet almost all the need of its population with regards to food by develop intensive program for increasing food production.

5) State Revenue :

The agriculture is contributing the revenue by agriculture taxation includes direct tax and indirect tax. Direct tax includes land revenue, cesses and surcharge on land revenue, cesses on crops and agril income tax. Indirect tax induces sales tax, custom duty and local octroi, etc. which former pay on purchase of agriculture inputs.

6) Trade :

Agriculture plays an important role in foreign trade attracting valuable foreign exchange, necessary for our economic development. The product from agriculture-based industries such as jute, cloth, tinned food, etc. contributed to 20% of our export. Around 50% of total exports are contributed by agril sector. Indian agriculture plays an important role in roads, rails and waterways outside the countries. Indian in roads, rails and waterways used to transport considerable amount of agril produce and agro-based industrial products. Agril products like tea, coffee, sugar, oil seeds, tobacco, spices, etc. also constitute the main items of export from India.

2.3 ROLE OF AGRICULTURE IN INDIAN ECONOMY

Agriculture is the main sector of Indian economy which is amply powered by the following points :

1) Share in National Income :

The contribution from agriculture has been continuously falling from 55.1% in 1950-51 to 37.6% in 1981-82 & further to 18.5% in 2006-07. But agriculture still continues to be the main sector because it provides livelihood to a majority of the people.

2) Largest Employment providing sector :

In 1951, 69.5% of the working population was engaged in agriculture. This percentage fell to 66.9% in 1991 & to 56.7% in 2001. However, with rapid increase in population the absolute number of people engaged in agriculture has become exceedingly large.

3) Provision of Food surplus to the Expanding population :

Because of the heavy pressure of population in labor-surplus economies like India & its rapid increase the demand for food increase at a fast rate. Therefore, unless agriculture is able to continuously increase its surplus of food-grains a crisis is likely to emerge. Experts foresee that by the end of 11^{th} Five year plan (i.e. 2007-2012) the demand for foodgrains is expected to increase to 280.6 million tons. Meeting this demand would require 2% growth per annum. The challenge facing the country is clear as during the last 10 years the foodgrains have been growing at a meagre 0.48%.

4) Contribution to capital formation :

There is a general agreement on the importance of capital formation in economic development. Unless the rate of capital formation increases to a sufficient high degree economic development cannot be achieved. Agriculture can play a big role in pushing the capital formation in India. Rural sector can transfer labor & capital to the industrial sector which can be effectively used to increase the productivity in the latter.

5) Providing Raw Material of industries :

Agriculture provides raw materials to various industries of national importance. Sugar industry, jute industry, cotton textile industry, vanaspati industry are examples of some such industries which depend on agriculture for their development.

6) Market for industrial products :

Since more than two-thirds of the population of India lives in rural areas, increased rural purchasing power is a valuable stimulus to industrial development.

7) Importance in International Trade :

Agriculture constitutes about 75% of the total exports of the country such is the importance of agriculture as far as earnings of foreign exchange are concerned.

8) Importance of agriculture products in the consumption basket :

The per capita income in India is very low. Consequently, a large part of this income is spent on fulfilling the basic consumption requirements of the people. It has been estimated that in India approximately 60% of household consumption and 85% of household commodity consumption is agricultural products.

The above discussion brings out clearly the role and importance of agriculture in the Indian economy. In fact, development of agriculture is a virtual pre-condition of sectoral diversification and hence of development itself. A growing surplus of agricultural produce is needed in the country to- (i) increase supplies of a food and agricultural raw materials at non-inflationary prices. (ii) widen the domestic market for industrial good through increased purchasing power within the rural sector. (iii) Facilitate inter-sectoral transfers of capital needed for industrial development (including infrastructure) and (iv) increase foreign exchange earnings through agricultural exports.

2.4 NECESSITY FOR THE DEVELOPMENT OF AGRICULTURAL SECTOR

After analyzing the Role of agriculture in the economic development, now, let us discuss the factors which determine the necessity for the further development of agriculture the brief analysis of the factor is as stated below :

1) To Remove Poverty and Hunger :

Agriculture is considered to be the dominant sector in the economy of India. Therefore, a strong foundation of agriculture is necessary condition of sustained and rapid economic progress so far as the problem of poverty and hunger is concerned. It is acute in those countries having more density of population. It is further aggravated by the inequalities of income. These features are also present in India economy which are termed as the obstacles in the path of agriculture development. Therefore, under such circumstances the development of agricultural sector is not possible so long as poverty and hunger are not removed.

2) Proper utilization of Resources :

Proper utilization of resources is indispensable to increase the level of production. The increase in production depends on the use of improved farm technology. Moreover, irrigation facilities also go a long way to enable the farmers to put more area under multiple crops. Therefore, efforts should be made to get the maximum productivity from the area were expensive infra-structures of irrigation have been created.

3) Increasing the Growth Rate :

The positive nature of the interdependence between agriculture and industry facilitates to stimulate the further development of these two sectors when agricultural sector starts to development on modern scientific lines, it will require more inputs than before. These inputs are supplied by the industrial sector in this way the development of agricultural sector is relied upon the development of industrial sector. Contrary to this, when agriculture sectors starts to produce more foodgrains and raw material for industrial sector the expansion of industrial sector will in turn increase the demand for agricultural products and thereby increase the employment and incomes of the agro-based population. The increase in the income further create the demand for consumption goods supplied by the industrial sector and thus, stimulate the growth of industrial sector.

4) Creation of surplus of investment :

As it is known the modernization of agriculture requires a huge amount of capital for investment command area development programme initiated for the development of agricultural sector also required capital for investment. Moreover, processing, marketing and storage and all other activities connected with agriculture need capital investment. In such circumstances, surplus are required to increase savings and enable investment. The creation of surplus is possible only through modernization and technological improvement in agriculture.

5) Surplus for wage goods :

In future greater and planned efforts will have to be made to expand wage employment through both industrial and urban job creation to provide employment to the unemployed people. Besides, employment programme in rural areas for building up infrastructure and off form facilities to absorb the growing labour force would be undertaken. Thus, it will be necessary to generate a large surplus of wage good for sustained supply to the working population at reasonable and stable prices so that there is sufficient economic stability for planned development.

6) Reduction in imports :

Import of foodgrains has become a peculiar feature of Indian economy. Therefore, the country has to get rid of imports of food-grains. Self-sufficiency in foodgrains as well as in cash crops would help to elimate the burden of Foreign exchange resources. Moreover, it would reduce the uncertainties generally associated with the procurement of supplies from international sources and their adverse impact on internal availability, prices and economy as a whole.

7) Diversification of employment opportunities :

The low level of rural incomes and the low standard of the rural population are the results of serious under employment as well as open unemployment in rural areas. Crop production alone cannot give adequate employment. Therefore, it pre-requisite to diversify rural employment opportunities by developing suitable subsidiary occupations such as dairy, rearing of poultry etc.

8) Provision of Food and Nutrition :

Agriculture sector has a great responsibility of providing food and nutrition not only for rural population but also for urban population. Even to maintain the present levels of intake food production has to be stepped up significantly apart from adequate production of foodgrains as well as supplementary protective foods are necessary for improving the productivity of labour. The productivity of labour can only improve when the human capital is endowed with health and vigour. Therefore, through the adequacy of food the capacity to work and earn substantially be increased which in turn increases production welfare happiness and thus economic development of the country.

9) Provision of Raw material for industrial sector :

Agriculture sector has to meet the increasing demand of raw material required by the industrial sector. The industries sector, the industries like cotton and jute textiles, dairy products, vegetable, oils, tea, coffee, leather and leather products all depend on the production performance of agricultural sector. The expansion and utilization of the existing capacity in these and other similar industries would depend on the internal availability of raw materials. Therefore, internal production of the agricultural raw materials would augment the functioning of these industries.

10) Useful for Allied sector :

Agricultural sector has to pay more attention on the development of allied sector. As the improvement of nutrition is a basic aim of development thus increased production in these fields assume particular importance. Besides the development of allied activities is in advantage of nation since agro climate conditions in many areas do not make crop production advantageous.

11) Contribution to Foreign exchange :

Agricultural sector can make a positive contribution to Foreign exchange earnings by reducing the agricultural imports. Food alone constitute a large proportion of current agricultural imports. Therefore, self-sufficiency in food, animal husbandry products and important raw materials will substantially result in the saving of foreign exchange. Therefore, agricultural sector has to develop its self-sufficiency in food articles and other agricultural products to avoid imports and thus to save the foreign exchange earnings.

2.5 EXERCISE

1) Explain the scope of Indian agriculture in rural development.
2) Discuss the role of Indian agriculture in Indian economy.
3) State the necessity for development of agricultural sector in India.

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3

PRODUCTIVITY OF INDIAN AGRICULTURE

Unit Structure :

3.0 OBJECTIVES

1) To understand the concept of agricultural productivity.
2) To study what are the various causes of low agricultural productivity in India.
3) To suggest some remedial measures to increase agricultural productivity and production.

3.1 INTRODUCTION

'Agricultural Productivity' has been defined by several scholars with reference to their own views and disciplines. Agriculturalists, agronomists, economists and geographers have interpreted it in different ways. Agricultural productivity is defined in agricultural geography as well as in economics as 'output per unit of input' or 'output per unit of land area', and the improvement in agricultural productivity is generally considered to be the results of a more efficient use of the factors of production, viz. physical, socio-economic, institutional and technological.

Singh and Dhillion (2000) suggested that the 'yield per unit' should be considered to indicate agricultural productivity. Many scholars have criticized this suggestion pointing out that it considered only land as a factor of production, with no other factors of production. Therefore, other scholars have suggested that agricultural productivity should contain all the factors of production such as labor, farming experiences, fertilizers, availability and management of water and other biological factors. As they widely accept that the average return per unit does not represent the real picture, the use of marginal return per agricultural unit was suggested.

3.2 CONCEPT OF AGRICULTURAL PRODUCTIVITY

Agricultural productivity may be defined as the "ratio of index of local agricultural output to the index of total input used in farm production". It is, therefore, a measure of efficiency with which inputs are utilized in production, if other things being equal. Agricultural productivity here refers to the returns from arable land or cultivable land unit. “Agricultural efficiency as productivity expressing the varying relationship between agricultural produce and one of the major inputs, like land, labor or capital, while other complementary factors remaining the same". This expression reveals that the productivity is a physical component rather than a broad concept. Saxon observed that productivity is a physical relationship between output and the input which gives rise to that output.

Productivity of land is a very important factor of agriculture because it is the most permanent and fixed factor among the three categories of input- land, labor and capital. Basically, land as a unit basis articulates yield of crop in terms of output to provide the foodstuff for the nation and secure employment opportunities for the rural community. Productivity of land may be raised by applying input packages consisting of improved seeds, fertilizers, agro-chemicals and labour intensive methods.

Productivity of labour is important as a determinant of the income of the population engaged in agriculture. In general, it may be expressed by the man-hours or days of work needed to produce a unit of production. Shafi has mentioned that the labour productivity is measured by the total agricultural output per unit of labour. It relates to the single most important factor of production, is intuitively appealing and relatively easy to measure. On the other hand, labour productivity is a key determinant of living standards, measured as per capita income, and this perspective is of significant policy relevance. However, it only partially reflects the productivity of labour in terms of the personal capacities of workers or the intensity of their efforts. In agricultural geography, the labour productivity has two major important aspects. First, it profoundly affects national prosperity and secondly : principally determines the standard of living of the agricultural population.

Capital, in terms of purchase of land, development of land, reclamation of land, drainage, irrigation purpose, livestock, feeds, seeds, agricultural implements, and machineries, crop production chemicals is being given priority as a factor for enhancing agricultural productivity.

3.3 CAUSES OF LOW AGRICULTURAL PRODUCTIVITY

Agricultural Productivity is still very low when compared with other countries and vis-a-vis the potential productivity. In this topic we propose to discuss the institutional and technological factors that account for low productivity in agriculture.

A) The Institutional Factors :

The most important institutional factors that have traditionally kept agricultural production and productivity low in India are: (i) the exploitative land tenure system, (ii) uneconomic size of holdings, (iii) underdevelopment of credit institutions, and (iv) defects in marketing structure.

1) The exploitation land tenure system :

Perhaps the most important reason for low agricultural productivity in India has been the zamindari system. This system created a unique agrarian structure in the countryside, which conferred the right of sharing the produce of land without participating personally in the production process. The system itself was based on exploitation as it conferred unlimited rights on the zamindars to extract as much rent as they wished. According to Bhawani Sen,[1] approximately 25 per cent of the produce was taken away by the intermediaries in the form of rent. This would mean that out of the income of Rs. 4,800 crore from agriculture in 1949-50, the share of intermediaries was as high as Rs. 1,200 crores. The grabbing of such a high proportion of income by a parasitic class was not only socially unjust but also highly detrimental to capital formation and economic development. The actual cultivator was left with no surplus to invest in better implements, improved seeds or fertilizers and neither was there any incentive for him to increase agricultural production and productivity. Thus, according to Thorner, a built-in 'depressor' continued to operate in the countryside characterized by low capital intensity and antiquated methods. [2] The tillers showed no interest in modernization of agriculture partly because they were deprived of resources to invest in agriculture by the zamindars (who, in turn, used the acquired wealth only on conspicuous consumption and on items to sustain their profligate lifestyle) and partly because they knew that any gains in agricultural production and productivity would be siphoned off by the zamindars while they would continue to live in conditions of abject poverty.

In large areas of the country, actual cultivation was done by tenants whose tenancy, in most areas, was insecure and depended on the mercy of the landlords. This made them prone to various exploitative practices adopted by the latter. They were forced to pay exorbitant rates of interest which ranged from 34 to 75 per cent in different areas of the country.[3] Naturally this left little for reinvestment on land. In fact, the toiling tenants could hardly make both ends meet. Moreover, since their tenancy rights were insecure, the tenants were not even interested in investment on land as they could be evicted out by the landlords almost at will. Even where law provided for security of tenure, tenants were not in a position to take advantage of it because most of the leases are oral and informal. It has been estimated that about 82 per cent of tenancies in the country in 1961 were insecure.

Obviously, under such exploitative land tenure systems, agricultural production and productivity was bound to be low. After Independence, the State governments passed legislations to abolish zamindari and improve the position of tenants. However, all critics agree that the above measures have been unsuccessful in achieving their objectives. Zamindars continue to exist in the garb of large landowners. They have acquired large areas of land for personal cultivation on which cultivation is done with the help of hired agricultural labour. In the States where a ceiling has been fixed as to the amount of land a former zamindar can hold, the ceiling has been kept so high that very few zamindars have been affected. Flaws in the legislations have also enabled them to transfer land to other members of their families and thus escape the ceiling law. For example, Daniel Thorner found that in post-reform Bihar, there existed estates of 500, 700 or even 1000 acres and the older structure of landowner, raiyat, under-raiyat, and bataidar (cropsharer) continued even after the so-called zamindari abolition. Bihar remained a stronghold of large landholders and hierarchical property rights, where "leasing, sub-leasing and evictions are all common."[5] As far as tenants are concerned, they have no strength to match the force of landlords and often evict the land under the pressure of the latter voluntarily. In any case, since most of the tenancies are insecure and oral, the actual tenants are not in a position to obtain the protection of law.

2) Uneconomic size of holdings :

The average size of holdings is very small in India. It was merely 1.57 hectares in 1990-91. 59 per cent of the holdings were less than 1 hectare in 1990-91 and can, consequently, be regarded as uneconomic. Not only this, even these small holdings are scattered and fragmented into a number of units. According to the 8th round of the National Sample Survey (conducted in 1953-54) an operational holding in India was divided into five units. It was also found that with an increase in the size of holdings, the average number of fragments also increased.

Small and fragmented holdings impede agricultural progress and adversely affect agricultural production and productivity. This is due to the following reasons: (1) Because of sub-division and fragmentation of holdings, the size of plots becomes so small that sometimes it is not possible to cultivate on them. Substantial land is also wasted in drawing boundaries and hedges between small, tiny plots. (2) Because of the small size of farms, it is not possible to make use of new technological innovations in the field of agriculture. The application of new methods of production requires ample doses of fertilizers, which in turn, require sufficient irrigation facilities. However, because of fragmentation, it is frequently not possible for the farmer to make proper arrangement of irrigation in all plots belonging to him. As a consequence, adoption of new agricultural technology is hindered. (3) In addition to the problems in adopting new agricultural technology, sub-division and fragmentation of holdings makes it difficult for the farmers to manage all their plots efficiently. Inefficient management leads to low agricultural productivity.

3) Underdevelopment of credit institutions :

In the pre-Independence period, the only source of credit worth the name was the village moneylender. Even in 1951, non-institutional sources (moneylenders, traders, landlords, relatives, friends etc. provided as much as 93 per cent of rural credit while the institutional sources (government, co-operative credit societies and commercial banks) provided only 7 per cent of rural credit. In the category of non-institutional sources, the most important were moneylenders who provided as much as 72 per cent of rural credit in 1951. This heavy dependence of the farmers on the moneylenders enabled the latter to dictate terms and exploit the former in a number of ways. For instance, moneylenders charged exorbitant rates of interest ranging from 19 per cent to 50 per cent or even more. They often manipulated accounts to their advantage by not entering the money returned and interest paid into the account. They also forced the farmers to sell the agricultural produce to them at low prices. On account of all these practices of moneylenders, the farmers were left with no resources to invest in programmes to increase agricultural production and productivity. Most of the farmers were under heavy burden of debt and all their lives they could not get out of it. The position of the average farmer was expressed in the following phrase graphically "the Indian farmer is burden of debt and all their lives they could not get out of it. The position of the average farmer was expressed in the following phrase graphically "the Indian farmer is born in debt, lives in debt and dies in debt." Naturally the Indian agriculture was only a subsistence agriculture in these conditions with very low levels of production and productivity.

The most important move to free the agriculturists from the clutches of the moneylenders in the post-Independence period was the expansion of institutional credit to agriculture. For this purpose, the government has helped the co-operatives in a number of ways to expand their operations. In an important move, 14 major commercial banks were nationalized in 1969 and this was followed by the nationalization of 6 more banks in 1980. One of the important objectives of this measure was the expansion of rural credit. In 1975, the government established an institution to meet specifically the requirements of rural credit— Regional Rural Banks. This was followed by the setting up of the National Bank for Agriculture and Rural Development (NABARD) in 1982. On account of all these efforts undertaken by the government, the institutional sources have increased their participation in rural credit considerably. Millions of first generation depositors and borrowers have been introduced to the banking system and they have shifted their loyalties from the non-institutional moneylenders and pawnbrokers to the banking institutions and co-operatives. However, this is only one part of the story. As noted by the Agricultural Credit Review Committee (1989), "the dual 'economy' has melted substantially, but the moneylender has not gone away". Non-institutional sources of agricultural credit still remain and they offer credit at high rates of interest which are, however, lower than before. Despite the phenomenal growth in the deposits and advances of institutional agencies, the latter have not made much dent in the rural economy. Only about 30 per cent of the rural families have demanded or have obtained access to the institutional credit system. Another serious matter of concern is the fact that the small and marginal farmers - the target group of the credit system- continue to be inadequately attended to. In 1951-52, they depended mainly on non-institutional sources. But, even in 1988, households with an asset holding of less than Rs. 10,000 depended on non-institutional sources for 67-90 per cent of their credit needs.

4) Defects in marketing structure :

For a considerable period of time, the Indian agricultural marketing structure has suffered from a number of defects. As a consequence, the Indian farmer has been deprived of a fair price for his produce. A considerable part of the total produce is sold by the farmers to the village traders and moneylenders. Most of the farmers are under heavy burden of debt and the moneylenders compel them to sell their produce to them (lien moneylenders) often at prices considerably lower than the market prices. The transportation facilities are not properly developed and many farmers therefore sell the produce in the village market itself after harvesting. The villages do not possess adequate warehousing facilities and substantial quantities of the produce are unloaded in the village markets immediately after harvesting. Supply in the village markets increases substantially and the farmers are not able to get a fair price for their produce. Farmers who go to mandies to sell their produce face a chain of middlemen like kutcha arhativas, pucca arhativas, brokers, wholesalers, retailers etc. Thus, the farmers receive only a small part of the actual price of their crop. Moreover, the farmers are required to pay a number of charges like arhat to the arhatiyas, tulai for weighing the produce, palledari to unload the bullockarts and for doing other miscellaneous types of allied works and garda for impurities in the produce. In addition, the farmers are also required to pay a number of other undefined and unspecified charges. In many mandies use of wrong weights and measures was rampant till quite recently. Many mandies do not posses grading facilities and the practice usually prevalent in these mandies in the one known as Jara sales wherein heaps of all qualities of produce (good as well as bad) are sold in one common lot. Thus, the farmer producing better qualities is not assured of better prices. As a consequence, there is no incentive to use better seeds and produce better varieties. Naturally, under the marketing conditions described here, agricultural production and productivity are bound to be low.

B) The Technological Factors :

The most important technological factors resulting in low agricultural production and productivity are : (i) inadequate irrigation facilities, (ii) use of outmoded techniques of production, (iii) limited use of fertilizers, (iv) inadequate plant protection measures, and (v) restricted use of high yielding varieties of seeds.

1) Inadequate irrigation facilities : Increase in agricultural production and productivity depends, to a large extent, on the availability of water. Hence, the importance of irrigation. However, the availability of irrigation is highly inadequate in India. For example, gross irrigated area as percentage of cropped area was only 18.3 per cent in 1960-61. Despite massive investments on expansion of irrigation facilities during the planning period, gross irrigated area as percentage of cropped area had risen to only 36.0 per cent in 1993-94. Thus, we can say that, almost 65 per cent (i.e. a little less than two-thirds) of cropped area continues to depend upon rainfall. Productivity on this land is considerably lower than the productivity on irrigated land. According to an estimate of the Planning Commission, the productivity on unirrigated land is just about one-half the productivity on irrigated land.[7] B.D. Dhawan has observed that land productivity on irrigated lands averaged about 22 quintals per crop hectare in 1983-84 whereas it was less than 9 quintals per crop hectare on unirrigated lands.[8] Since almost two thirds of agricultural land is unirrigated, this shows that the general level of agricultural production and productivity is very low in India. Another point worth mentioning in this context is that multiple cropping is not possible on unirrigated lands as 80 per cent of the annual rainfall in India is received in less than four months. Provision of irrigation facilities over large areas can make possible the growing of two or three crops in a year in these areas. This will considerably enhance agricultural production and productivity.

2) Use of outmoded techniques of production :

In India, traditional techniques of production continue to be adopted on a large scale in agriculture. The farmers use primitive and simple agricultural implements for carrying out farm operations and these implements require biological sources of energy (viz., human labour and animal labour) for their operation. As against this, advanced countries of the West use mainly mechanical sources of energy (viz., tractors, threshers, harvester combines, pumpsets etc.) for carrying out agricultural operation. The mechanical sources of energy increase the speed of carrying out operations and also increase the efficiency of resource use. Labour productivity increase as less labour is required than before to produce the same level of output. It is often observed that under traditional agriculture based on wooden (or iron) ploughs, bullocks and other primitive implements, agriculture is a mere subsistence occupation (even though the farmers might sell a portion of their produce in the markets). Introduction of tractors, harvesters, threshers, pumpsets for irrigation etc. changes the very nature of traditional agriculture and transforms it into a commercial occupation. This leads to an increase in the economic surplus (the difference between total production and consumption of agricultural output) and, consequently, the incomes of farmers increase. This, in turn, enables the farmers to invest more in the land and carry our permanent improvements on it. The use of better seeds, more fertilizers, pesticides etc. also increases and all these factors lead to an increase in agricultural production and productivity.

3) Limited use of fertilizers :

The consumption of fertilizers in India was a meagre 66.000 tonnes in 1952-53. This limited use of fertilizers kept the productivity of land at very low levels. With the adoption of the New Agricultural Strategy in 1966, the consumption of fertilizers increased by leaps and bounds as this strategy depended on fertilizers considerably for its success. As a consequence of this strategy, the consumption of fertilizers rose considerably touching the level of 22 lakh tonnes in 1970-71, 55 lakh tonnes in 1980-81 and 162 lakh tonnes in 1997-98. However, even now the per hectare use of fertilizers in India is considerably lower as compared with many other countries. For example, amount of fertilizers used per hectare was only 81.8 kgs in India against 370.7 kgs. in China, 135.4 kgs in Bangladesh and 345.5 kgs in Egypt in 1995-96. What is more, there are substantial inter-state disparities in per hectare fertilizer consumption which ranged from 9.5 kg in Assam to 174.7 kg in Punjab in 1994-95 (average for the country being 75.7 kg in that year. In fact, the five States of Punjab, Haryana, Uttar Pradesh, Andhra Pradesh and Tamil Nadu together account for more than half of the total fertilizer consumption in the country. Moreover, rainfed areas which constitute 65 per cent of the cultivated area account for only about 20 per cent of the total fertilize; consumption. All this shows that large parts of the country have a very low level of consumption of fertilizers and this is one of the main reasons for their low productivity. Many regions of the country are deficient in nitrogen, phosphorous and potash and this deficiency can be made good by an increased use of fertilizers.

4) Inadequate plant protection measures :

It has been estimated that in India monetary loss in agriculture due to weeds, diseases, insects, nematodes, storage pests, rodents and birds runs into about Rs. 6,000 crores per annum.[9] Most of the farmers in the countryside were unaware of the pesticides and insecticides to manage this problem till quite recently. As a result, the consumption of pesticides was very low. After the adoption of the New Agricultural Strategy in the mid-sixties, the consumption of pesticides has increased at a fairly rapid rate. In 1995-96, the consumption of pesticides was 73,650 tonnes. However, the use of pesticides brings with it a number of problems. For example, pesticides are by their very nature poisonous and can kill non-target organisms (including man). Moreover, after the continued use of some pesticides for some years, the pests and insects develop resistance to them and this leads to the use of stronger and stronger pesticides over a period of time. Thirdly, use of fertilizers and pesticides brings about physiological changes in plants leading to multiplication and proliferation of pests. Lastly, pesticides application needs a scientific approach and this approach is lacking in most: of our farmer. They are not aware of the actual quantity of toxicant needed to destroy a pest and tend to use more quantity than is necessary. The surplus used appears as a residue that may persist and accumulate within the ecoweb.

The above discussion shows that what is required is not just pest extermination but economical utilization of pesticidal chemicals with least ecological damages. The thrust, accordingly, has not to be on increased use of pesticides but on Integrated Pest Management (IPM). This approach implies the adoption of cultural mechanical, biological and chemical methods of pest control. The government has been adopting this approach over the past number of years. It is on account of IPM approach adopted by the government that the consumption of pesticides has actually come down from 82,000 tonnes in 1990-91 to 73,650 tonnes in 1995-96.

5) Restricted use of high yielding varieties of seeds :

Use of quality seeds is essential for achieving higher crop production. The traditional seeds that have been used in this country from times immemorial have low productivity. During the period of mid-1960s, high yielding varieties of seeds for wheat were imported by the government from abroad and the use of these seeds pushed up the levels of productivity of wheat to new heights in India. This was the starting point of the New Agricultural Strategy which led to, what is now known as, Green Revolution. The High Yielding Varieties Programme (HYVP) was launched in the country in the kharif season of 1966. Initially it was implemented in a total area of 1.89 million hectares. Over the years, area under this programme has been increased in phases and in 1997-98, it covered 76 million hectares. However, this is only about 40 per cent of the gross cropped area. Thus, almost 60 per cent gross cropped area continues to use traditional, low productivity, seeds. In this context, it is also pertinent to point out that the benefits of HYVP have, by and large, remained limited to wheat growing areas. The productivity of rice has also somewhat risen in recent years. In the case of most of the other cereals, pulses and other crops (excepting oilseeds), the productivity levels continue to be very low. The Economic Survey has expressed its concern on this issue in the following words, "The seed technology breakthrough that ushered in the green revolution in the seventies and even eighties has unfortunately lost its momentum in nineties. There has been no perceptible progress in evolving new seed varieties in the recent years particularly in respect of cereals and pulses, as also fruits and vegetables. Lack of any significant breakthrough in seed technology is perhaps one of the main reasons for slow growth in foodgrains output during the nineties.

3.4 MEASURES TO INCREASE AGRICULTURAL PRODUCTIVITY

The causes given above also suggest the measures to increase productivity. As would be clear, such measures would have to attack the problem from technical, institutional, social and economic angles. In particular, attempts will have to be made in the following directions.

1) Implementation of land reforms :

Though land reforms have been introduced in India in the post-Independence period with a view to eliminating the intermediary interests in land (especially zamindari), providing security of tenure and ownership rights to tenants and reorganising agriculture through land ceiling legislation, co-operative movement and consolidation of holdings, the progress registered is too unsatisfactory. Therefore, special attempts will have to be made by the State governments to implement the land reforms legislation forcefully so that the slogan 'land to the tiller' is translated into practice. Unless this is done, the tiller will have no incentive to invest in land and adopt new agricultural techniques. Therefore, land reforms are the first and foremost necessity.

2) Integrated management of land and water resources :

The total geographical area of the country for which information was available in 1989-90 was 304.9 million hectares of which only 264.0 million hectares possess potential for biotic production, of this, 'wastelands' account for 79.5 million hectares, leaving only 184.5 million hectares. However, even this area cannot be regarded as being in good health. According to the land use statistics, the total extent of lands that suffer from degradation, to a greater or less degree, is 175 million hectares. Since this figure obviously includes wastelands, it follows that the area of lands that are still productive but are suffering from degradation is 95.5 million hectares (175 million hectares minus 79.5 million hectares). Since this area of 95.5 million hectares must necessarily be a part of the 142.2 million hectares of land that is under agriculture, it means that nearly two-thirds of our agricultural lands are sick to some extent or another. This is quite alarming. In fact, as pointed out by B.B. Vohra, of the nearly two-thirds of our total land resources suffering from degradation, about 50 per cent have undergone such degradation that they have, for all purposes, ceased to be productive. This proves the urgency of an integrated management of our land and water resources. It is particularly important to control soil erosion which affects around 150 million hectares out of the country's total land area of 304.9 million hectares as it constitutes the biggest single threat to the sustainability of our agriculture.[11]

3) Extension of new agricultural strategy :

Adoption and extension of HYVP to new areas and regions is essential to enhance agricultural productivity. This requires- (i) more use of high-yielding varieties of seeds, (ii) more availability of fertilizers and (iii) judicious use of pesticides and adoption of plant protection measures. Improved seeds can play an important role in increasing productivity. This has been amply proved by the experience of many countries and by the demonstration of high-yielding varieties of wheat in Punjab, Haryana and Western Uttar Pradesh in our own country. Therefore, more and more farmers in more and more areas should be encouraged to use improved seeds. Improved varieties of seeds require heavy doses of fertilizers. In fact, the use of fertilizers in ample quantity (especially nitrogen, phosphorous and potash) can push up the productivity manifold. The new varieties of seeds are more prone to the attacks of pests and insects. Therefore, use of pesticides in judicious amounts is essential. As noted earlier, the focus should be on Integrated Pest Management.

4) Irrigation :

Use of improved seeds and fertilizers requires proper irrigation facilities. Irrigation can also make multiple cropping possible in a number of areas and hence enhance productivity. Attempts in this field will have to be undertaken in the following direction-modernizing irrigation systems in a phased manner, better operation of existing systems, efficient water management, adequate maintenance of canals and distribution systems, detailed surveys and investigation for preparation of new projects, developing a National Grid System to ensure water supply from water surplus areas to water deficit areas etc.

5) Farm mechanization :

It is generally believed that through farm mechanization agricultural productivity can be increased. Supporters of mechanization argue that it results in increase in productivity of land and labour, reduction of costs, saving of time and increase in economic surplus. However, it should be borne in mind that all estimates of productivity include the contribution of machines as well as other agricultural inputs like improved seeds, fertilizers, etc. and it is not possible to say how much of increase in productivity is due to mechanization alone. Nonetheless, it cannot be denied that mechanization saves labour time, which can be utilized elsewhere.

6) Provision of credit and marketing facilities

Use of improved varieties of seeds, fertilizers, pesticides, insecticides, agricultural machinery and irrigation facilities all require substantial money resources which small farmers do not usually possess. Therefore, it is necessary to strengthen the credit cooperative sector and free it from the clinches of large landowners so that it can meet the credit requirements of small farmers. The commercial banks should be encouraged to lend more to small farmers. Regional rural banks can play a special role in this regard. The marketing structure also needs a reorientation to serve the small and marginal farmers in a better way. Co-operative marketing societies should be promoted to ensure better prices to small farmers.

7) Incentives to the producer :

Incentives to the agriculturists can go a long way in encouraging them to increase productivity. Incentives can be in the following forms: (a) implementing land reforms rigorously and vigorously, (b) ensuring timely availability of agricultural inputs, (c) guaranteeing remunerative prices of produce to the farmer, (d) implementing crop-insurance scheme to cover the risk of damage to crops and other risks in agriculture, and (e) social-recognition and conferment of Awards, merit certificates, etc.

8) Better management :

Just as industry needs skilled management for Increased productivity, agriculture also requires better management for raising the level of productivity. For this purpose farmers have to be educated in more efficient use of their resources particularly land, irrigation facilities and agricultural implements. A related problem is the extension of science and technology in agriculture. This can be accomplished only if there is a vast network of managerial staff engaged in disseminating information about new agricultural techniques and methods of production. Other tasks of this extension staff could be to test die suitability of social and climatic conditions for different crops and advising the farmers on day-to-day problems confronted by them in carrying out agricultural activities.

9) Agricultural Research :

Agricultural research is presently being conducted by the Indian Council of Agricultural Research, various Agricultural Universities and other institutions for evolving high-yielding varieties of seeds for different crops. Considerable success has been achieved in the case of wheat. However, intensive efforts are required for achieving similar success in other crops. Research should also be conducted on a substantial scale at different regional centres for testing the quality of soil, suggesting measures for soil conservation and reclamation, examining the diseases affecting different crops, improving the quality of agricultural implements, avoiding wastage in agriculture especially damage to crops resulting from pests, insects, rodents, etc.

10) Emphasis on dry-land farming needed :

In India approximately 65 per cent of the cropped area is rainfed. It accounts for 44 per cent of the food and supports 40 per cent of India's population. It contributes 91 per cent, of the coarse cereals, 90 per cent of the pulses, 81 per cent of the oilseeds and 55 per cent of rice production. However, as we shall show in the Chapter on 'New Agricultural Strategy', the benefits of growth during the last three decades have gone mostly to areas having assured irrigation facilities (particularly Punjab, Haryana and Western Uttar Pradesh). Consequently, the rainfed areas have lagged considerably behind. Risks in such areas are high because rain is undependable. Soils are also degraded in quality and deprived of fertility. Economically, dry-land farmers are weak with low ability to withstand risk; their holdings are small and marginal which are unconsolidated and scattered.[12]

Given the above conditions, specific attempts are required to push up the productivity levels in dry-land farming areas. This requires an 'integrated' approach to avoid run off of the rainfall from the area of its incidence, prevention of soil erosion, extensive research on rainwater management, minimizing evaporation losses through greater rain water conservation, watershed management, integrated nutrient management etc. Effective and efficient dry-land farming practices can push up the productivity of coarse cereals, pulses, rice, cotton, oilseeds and many other crops. Not only will this help in pushing up overall productivity levels in Indian agriculture, it will also help in 'broad-basing' agricultural development and increasing the levels of income of small and marginal farmers.

3.5 EXERCISE

1) Explain the concept of agricultural productivity and state the various causes of low agricultural productivity in India.
2) What is agricultural productivity? Explain the measures to increase agricultural productivity in India.

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4

LAND AND CONSTITUENTS OF LAND

Unit Structure :

4.0 OBJECTIVES

1) To understand the various uses of land.
2) To understand the characteristics of land.
3) To study the various types of soils in India.

4.1 INTRODUCTION

Man along with all the plants and animals has been living on the surface of this earth for years together. He has been using the soil, water-bodies, forest, grasslands, animals, minerals etc. all related with land in various ways for his living.

Man gets the primary needs of living like food, clothing and shelter from the land itself. All human settlements, roads, agriculture, grazing of domestic animals, establishment of industries etc. are done on land. It is our most important primary natural wealth.

Land or the surface of the earth is not a like everywhere. Natural resources are also not equally available everywhere on the land surface. Man, too, does not utilize land equally at all times. Land has been being equally at all times. Land has been being used differently at different times with the growth of civilization. The primitive man when he was living in caves of hills, did not know anything about agriculture.

Almost the entire land surface was covered with forests. Man in those by gone days, used to earn his living by collecting fruits and roots from the forests and by hunting birds and animals. He began to live at one place permanently when he gradually became intelligent and knew agriculture so, human settlements, roads and various institutions were set up.

Therefore, land was mainly used for forests, pastures, farming, human settlements and such other useful purposes.

4.2 USES OF LANDS

India is one of the largest countries of the world. It ranks seventh in respect of population. The total land area of India is 32 lakh 87 thousand square kilometers. Three major types of lands are found in India in respect of its relief, such as, mountains, plateaus and plains. About 29% of our total land areas are mountains, 28% plateaus and 43% plains.

The mountains include the high Himalayan mountains in the north, the Aravalli ranges and the western Ghats in the west, the vindhyas and the satpura range at the centre, the Eastern Ghats in the east, the Agro, Khaki and Jacinta range in the north east. The plateaus include the Chhota Nagpur plateau, the Amarkantaka, Malawi,Karnataka and the Deccan plateaus. The plains include the Gangetic plains in the north, the Brahmaputra valley, the east and the west coastal plains and the flood plains of different river valleys of India.

About 80% of the total land area of India is utilized by man. This land utilization of man is influenced by the relief, climate, soil as well as man's social and economic conditions.

According to use, lands in India are utilized as forest lands, pasture and grazing lands, agricultural or farm lands, settlement and other such purpose.

1) FOREST LANDS:

India was covered with dense forests in primitive ages. More and more lands were needed for agriculture, settlement, industry, roads etc. with the growth of population. So man utilized land by cutting down and cleaning the forests in order to fulfill his growing needs. Now only about 22% of the total land area of our country is covered with forests.

The National Forest policy formulated in the year 1952 proclaims that about 33% of the country's total land area should be covered with forests in order to maintain ecological balance in our environment. It will control the country's climate and the country will be saved to a great extent from the ravages of flood, drought and cyclones. Therefore, there should be forests in about 60% of lands in hilly areas and 20% of lands in the plains.

According to law, these forests are of three categories. Such as, reserved forest, protected forests and unclassified forest. Valuable forests are taken as the reserved forests, for which about half of the total lands under forests have been conserved. Man gets many useful forest products from the forests.

Forests play vital role in checking soil erosion, controlling flood, increasing the amount of rainfall and creating favourable conditions in the local climate. That is why forests are on important natural wealth of the country. Forests of India are being destroyed owing to various natural as well as man-made courses so the extent of forests is gradually diminishing.

In some hilly areas of the country, the Advises adopt shifting cultivation by clearing forests. Such type of farming is known as "pod on tail' cultivation in Orissa. At some places forests are cut down to raise farm lands, settlements, industries, roads etc. Cattle also treat forests as their grazing ground, thereby the seedlings and finally the forests are destroyed.

Only 2% of the total forest land of the world is in India. But 15% of the total world population and 13% of the total cattle population depend on forests. It is known as biotic pressure. Such enormous pressure is and important reason of deforestation. Besides, floods, cyclones and land erosion etc. also diminish the forest areas of our country.

Various projects like afforestation, social forestry, farm forestry etc. are being worked out in order to increase the forest area and efforts are being made to bring more land under forests. Artificial forests are being raised on waste lands in village and town areas under the social forestry scheme.

Plantations are likewise in progress bunds and plots dividing boundaries under the Farm Forest Scheme. By means of afforestation, the destroyed forests of hills, mountains and plateaus are being developed and thereby the extent and density of forests are increasing.

2) PASTURES AND GRAZING LANDS:

There are pastures and grazing lands of about 4% of the total land area of India. These are mainly seen in hilly areas. We don't have any definite grassland areas. So pastures are almost mingled with the forests of hilly areas and dwindled forests of the foot-hills of the Himalayan Mountains, the Eastern and the Western Ghats and the north-eastern mountain areas.

It has been very much necessary to grow more food by adopting farming on more and more lands owing to the growth of population and for want of rains for about eight months a year as a result of which it is not possible to spare definite land areas for grazing purposes. Himachal Pradesh has the maximum land under pastures and grazing lands in India.

3) LAND FOR AGRICULTURE OR FARM LANDS:

India is primarily an agricultural country. About 55% of the total land areas are used for growing food crops, vegetables, cash crops and fruit food crops are grown an about 45% of land out of the total 55% under cultivation. Vegetables and fruit are grown on the rest of the lands and some lands are left without any cultivation occasionally.

India has more form lands according to its land area as compared with the other countries of the world, but it is strange that the agricultural products are less. Plains, river - valleys, flood-plains and delta areas are mostly used for agriculture. Very limited farming is done on the plateaus and mountain - slopes. Shifting cultivation or pod cultivation is carried on by clearing the forest areas.

Only paddy is cultivated on about three-fourths of the total land under food crop cultivation, as rice is the staple food of the people in most parts of India. Wheat is grown on less amount of land than this the area of farm lands is increasing year after year as more people depend on agriculture. The area of land under food crop production in 1951 has by now increased by one and a half times. but the per capita holding of arable land has been decreasing gradually because of rapid growth of population.

4) LAND UNDER HUMAN SETTLEMENT ETC:

About 19% of the total lands in India are being used for settlement of villages, towns, roads and rail - roads, airports factories and for educational, health and administrative organizations. As per 1981 census, there were 3,949 towns'. 557,137 villages having human settlements and 48,087 villages having no human settlement.

A major portion of lands is also being used in construction of roads and rail - roads for communication among those towns utilized for establishing industrial organizations and setting up schools, colleges, universities, dispensaries and various offices.

4.3 CHARACTERISTICS OF LAND

The term 'land' in economics is often used in a wider sense. It does not mean only the surface of the soil, but it also includes all those natural resources which are the free gifts of nature.

It, therefore, means all the free gifts of nature. These natural gifts include :

i] Rivers, forests, mountains and oceans:

ii] Heat of sun, light, climate, weather, rainfall etc. which are above the surface of land:

iii] Minerals under the surface of the earth such as iron, coal, copper, water etc. According to Marshall, “By land is meant.... materials and forces which nature gives freely for man’s aid in land, water, air, light and heat, “Therefore, land is a stock of free gifts of nature.

Characteristics of Land :

Land possesses the following characteristics:

1) Free Gift of Nature:

Man has to make efforts in order to acquire other factors of production. But to acquire land no human efforts are needed. Land is not the outcome of human labour. Rather, it existed even long before the evolution of man.

2) Fixed Quantity:

The total quantity of land does not undergo any change. It is limited and cannot be increased or decreased with human efforts. No alternation can be made in the surface area of land.

3) Land is permanent:

All man-made things are perishable and these may even go out of existence. But land is indestructible. Thus, it cannot go out.

4) Land is a Primary Factor of Production:

In any kind of production process, we have to start with land. For example, in industries it helps to provide raw materials and in agriculture, crops are produced on land.

5) Land is a Passive factor of Production:

This is because it cannot produce any thing by itself. For example wheat can not grow on a piece of land automatically. To grow wheat, man has to cultivate land. Labour is an active factor, but land is a passive factor of production.

6) Land is Immovable:

It cannot be transported from one place to another. For instance, no portion of India’s surface can be transported to some other country.

7) Land has some original Indestructible Powers:

There are some original and indestructible power of land, which a man cannot destroy Its fertility may be varied, but it cannot be destroyed completely.

8) Land Differs in Fertility:

Fertility of land differs on different pieces of land. One piece of land may produce more than the other.

9) Supply of land is Inelastic:

The demand for a particular commodity makes way for the supply of that commodity, but the supply of land cannot be increased or decreased according to its demand.

10) Land has Many Uses:

We can make use of land in many ways. On Land, cultivation can be done, factories can be set up, roads can be constructed, buildings can be raised and shipping is possible in the sea / rivers.

4.4 TYPES OF SOILS IN INDIA

Soil is a valuable resource of India. Much of the Indian agriculture depends upon the extent and qualities of soil. Weathering prepares loose materials on the surface of the Earth and mixed with decayed organic matters it forms soil.

India is a large country and witnesses diverse range of climatic and other natural conditions. The nature of soil in a place is largely influenced by such factors as climate, natural vegetation and rocks.

The various types of soil found in India includes Alluvial soil, Laterite soil, Red soil, Black soil, Desert soil and Mountain soil. They are each discussed below.

Major types and characteristics of soils India:

Indian soils may be divided into six major types based on their character and origin:

1) Alluvial soil: Materials deposited by rivers, winds, glaciers and sea waves are called alluvium and soils made up of alluvium are alluvial soils. In India alluvial soils are mainly found on the Indo-Ganga Brahmaputra Plains, Coastal Plains and the broad river valleys of South India. They are also found along the river basins of some plateau and mountain regions.

In the Indo-Ganga plain two other types of alluvium are found. The old alluviums are clayey and sticky, have a darker color, contain nodules of lime concretions and are found to lie on slightly elevated lands. The new alluviums are lighter in color and occur in the deltas and the flood plains.

In comparison to old alluvial soil, the new alluvial soils are very fertile. The alluvial soil is regarded as the best soil of India for its high fertility and the rich harvest, it gives rice, wheat, sugarcane, jute oil-seeds and pulses are the main crops grown on this soil.

The alluvial soil is spread all over the plains of north India. They are also found in the four delta regions of the south. Strips of alluvium occur along rivers in the plateau as well as in the mountains.

Alluviums are mainly loams, i.e. mixtures of sand and clay. New alluvial loams are very fertile. In the younger stage of the riverine plains, sandy soils are more common. While in the beds of the rivers, it consists generally of pure sands. These soils cannot retain water. 'Zaid' types of crops grow here, such as watermelons. Near the river mouths, the soil is usually clay. It retains water but does not allow root growth.

2) Laterite and Lateritic soils: Laterite is a kind of clayey rock or soil formed under high temperature and high rainfall. By further modification laterite is converted into red colored lateritic soils charged with iron nodules. Laterite and lateritic soils are found in South Maharashtra, the Western Ghats in Kerala and Karnataka, at places on the Eastern Ghat, in some parts of Assam, Tamil Nadu, Karnataka and in western West Bengal (particularly in Birbhum district). These soils are generally infertile. Some plants like tea, coffee, coconut, areca nut, etc. are grown in this soil.

Laterite soils in India are found in the Eastern Ghat of Orissa, the Southern parts of Western Ghat, Malabar Coastal plains and Ratnagiri of Maharashtra and some part of Andhra Pradesh, Tamil Nadu, Karnataka, Meghalaya, western part of West Bengal.

Laterite soils are said to farraginous aluminous rock. They are formed by decomposition; because of they are found in black soil regions having heavy rainfall. The rocks are completely leached out having a high proportion of iron and aluminium as residue. High temperature and heavy rainfall transformed the black soil into laterite.

3) Red Soils: Red soils develop on granite and gneisses rocks under low rainfall condition. The dissemination of red oxides of iron gives the characteristic red color of the soil. These soils are friable and medium fertile and found mainly in almost whole of Tamil Nadu, South-eastern Karnataka, North-eastern and South-eastern Madhya Pradesh, Jharkhand, the major parts of Orissa, and the Hills and Plateaus of North-east India. But these have capacity to grow good crops after taking help of irrigation and fertilizers. Wheat, rice, millets, gram, pulses, oil-seeds and cotton are cultivated here.

Red soils are formed by weathering of the ancient crystalline and metamorphic rocks. Their color is red due to their very high iron content. They are found in areas of low rainfall and is obviously less leached than laterite soils. They are sandier and less clayey soils.

Red Soil in India are poor in phosphorus, nitrogen and lime contents. The red soils covers a large portion of land in India. It is found in Indian States such as Tamil Nadu, southern Karnataka, north-eastern Andhra Pradesh and some parts of Madhya Pradesh, Chhattisgarh and Odisha.

4) Black Soils or Regur soils: The regur or black soils have developed extensively upon the Lava Plateaus of Maharashtra, Gujarat, Madhya Pradesh mainly Malwa. Black soils have also developed on gneisses of north Karnataka and north and west of Andhra Pradesh. The regur is clayey, becomes very sticky when wet. Its special merit lies in its water holding capacity. These soils are very fertile and contain a high percentage of lime and a moderate amount of potash. The type of soil is specially suited to the cultivation of cotton and hence sometimes called 'black cotton soil'. Sugarcane, wheat, and groundnut are also cultivated.

5) Desert soil: The soils of Rajasthan, Haryana and the South Punjab are sandy. In the absence of sufficient wash by rain water soils have become saline and rather unfit for cultivation. In spite of that cultivation can be carried on with the help of modern irrigation. Wheat, bajra, groundnut, etc. can be grown in this soil.

The Great Indian Desert (also Thar Desert, Rajasthan plains):

The extends through the Jaisalmer, Bikanir, Jodhpur, Barmer districts of India and Khairpur, Bahawalpur districts of Pakistan. The area of the Great Indian Desert is more than two lakh square kilometers.

Located to the south-west of north Indian plain and to the west of Aravalli Mountain the region is also known as Rajasthan plain.

6) Mountain soil: Soils are varied in mountains. Alluvium is found at the valley floor, brown soil, rich in organic matter, in an altitudinal zone lying between about 700-1800 m. Further up podzol soils, grey in color and acidic in reaction, are found associated with coniferous vegetation. In the Alpine forest belts the soils are thin and darker in color. This type of soil is suitable for the cultivation of potatoes, fruits, tea, coffee and spices and wheat.

The mountain soils are mainly found in Jarnmu and Kashmir, U.P., West Bengal, in the Himalayas submontane tracts. The Himalayas, the North-eastern Hills, and other mountains and hills in India show a variety of soils. In the drier areas of deciduous forest belt, brown soils are found. They are rich in humus and deep. They are very good for orchard crops. In coniferous forest belts in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, etc., brown forest soils called Podzol are found. These soils grow maize, barley, wheat and fruits. In the Alpine Zone of the Himalayas lie Alpine Meadow soils.

Good crops of paddy, wheat, soybean and even sugarcane are grown in mountain soils.

4.5 EXERCISE

1) Explain the various uses of land.
2) Discuss the characteristics of land.
3) Describe the various types of soil India

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5

SOIL EROSION

Unit Structure :

5.0 OBJECTIVES

1) To study the concept of soil Erosion.
2) To understand the various factors affecting on soil Erosion.
3) To study the impact of soil erosion on Environment.
4) To understand the various remedial measures on soil erosion.

5.1 INTRODUCTION

Soil erosion is one form of soil degradation. Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year. Soil erosion may be a slow process that continues relatively unnoticed or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks.

While erosion is a natural process, human activities have increased by 10-40 times the rate at which erosion is occurring globally. Excessive (or accelerated) erosion causes both 'on-site' and 'off-site' problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems world-wide. Intensive agriculture, deforestation, roads, anthropogenic climate change and urban sprawl are amongst the most significant human activities in regard to their effect on stimulating erosion.[3] However, there are many prevention and remediation practices that can curtail or limit erosion of vulnerable soils.

5.2 PHYSICAL PROCESSES

1) Rainfall and surface run-off :

Rainfall and the surface runoff which may result from rainfall, produces four main types of soil erosion: splash erosion, sheet erosion, rill erosion, and gully erosion. Splash erosion is generally seen as the first and least severe stage in the soil erosion process, which is followed by sheet erosion, then rill erosion and finally gully erosion.

In splash erosion, the impact of a falling raindrop creates a small crater in the soil, ejecting soil particles. The distance these soil particles travel can be as much as 0.6 m (two feet) vertically and 1.5 in (five feet) horizontal on level around.

Soil and water being splashed by the impact of a single raindrop

If the soil is saturated or if the rainfall rate is greater than the rate at which water can infiltrate into the soil, surface run-off occurs. If the run-off has sufficient flow energy, it will transport loosened soil particles (sediment) down the slope. Sheet erosion is the transport soil particles by overland flow.

Rill erosion refers to the development of small, ephemeral concentrated flow paths which function as both sediment source and sediment delivery systems for erosion on hill slopes.

Generally, where water erosion rates on disturbed upland areas are greatest, rills are active. Flow depths in rills arc typically of the order of a few centimeters (about an inch) or less and along-channel slopes may be quite steep. This means that rills exhibit hydraulic physics very different from water flowing through the deeper, wider channels of streams and rivers.

A spoil up covered in rills and gullies due to erosion processes caused by rainfall : Rammu. Estonia

Gully erosion occurs when run-off water accumulates and rapidly flows in narrow channels during or immediately after heavy rains or melting snow, removing soil to a considerable depth.

2) Rivers and streams :

Valley or stream erosion occurs with continued water flow along a linear feature. The erosion is both downward, deepening the valley and headward, extending the valley into the hillside, creating head cuts and steep banks. In the earliest stage of stream erosion, the erosive activity is dominantly vertical, the valley have a typical V cross-section and the stream gradient is relatively steep. When some base level is reached, the erosive activity switches to lateral erosion, which widens the valley floor and creates a narrow floodplain. The stream gradient becomes nearly flat, and lateral deposition of sediments becomes important as the stream meanders across the valley floor. In all stages of stream erosion, by far the most erosion occurs during times of flood, when more and faster-moving water is available to carry a larger sediment load. In such processes. It is not the water alone that erodes : suspended abrasive particles, pebbles and boulders can also act erosively as they traverse a surface, in a process known as traction.

Bunk erosion is the wearing away of the banks of a stream or river. This is distinguished from changes on the bed of the watercourse, which is referred to as scour. Erosion and changes in the form of river banks may be measured by inserting metal rods into the bank and marking the position of the bank surface along the rods at different times.

Thermal erosion is the result of melting and weakening permafrost due to moving water. It can occur both along rivers and at the coast. Rapid river channel migration observed in the Lena River of Siberia is due to thermal erosion, as these portions of the banks are composed of permafrost-cemented non-cohesive materials.[15] Much of this erosion occurs as the weakened banks fail in large slumps. Thermal erosion also affects the Arctic coast, where wave action and near-shore temperatures combine to undercut permafrost bluffs along the shoreline and cause them to fail. Annual erosion rates along a 100-kilometre (62-mile) segment of the Beaufort Sea shoreline averaged 5.6 metres (18 feet) per year from 1955 to 2002.

3) Floods :

At extremely high flows, kolks or vortices are formed by large volumes of rapidly rushing water. Kolks cause extreme local erosion, plucking bedrock and creating pothole-type geographical features called Rock-cut basins. Examples can be seen in the flood regions result from glacial Lake Missoula, which created the channeled scablands in the Columbia Basin region of eastern Washington.

4) Wind erosion :

Wind erosion is a major geomorphological force, especially in arid and semi-arid regions. It is also a major source of land degradation, evaporation, desertification, harmful airborne dust and crop damage especially after being increased far above natural rates by human activities such as deforestation, urbanization and agriculture.

Arbol de Piedra, a rock formation in the Altiplano. Bolivia sculpted by wind erosion.

Wind erosion is of two primary varieties: deflation, where the wind picks up and carries away loose particles; and abrasion, where surfaces are worn down as they are struck by airborne particles carried by wind. Deflation is divided into three categories : (1) surface creep, where larger, heavier particles slide or roll along the ground; (2) saltation, where particles are lifted a short height into the air, and bounce and saltate across the surface of the soil; and (3) suspension, where very small and light particles arc lifted into the air by the wind and are often carried for long distances.

Saltation is responsible for the majority (50-70%) of wind erosion, followed by suspension (30-40%), and then surface creep (5-25%).

Wind erosion is much more severe in arid areas and during times of drought. For example, in the Great Plains, it is estimated that soil loss due to wind erosion can be as much as 6100 times greater in drought years than in wet years.

5.3 FACTORS AFFECTING SOIL EROSION

Climate :

The amount and intensity of precipitation is the main climatic factor governing soil erosion by water. The relationship is particularly strong if heavy rainfall occurs at times when, or in locations where, the soil's surface is not well protected by vegetation. This might be during periods when agricultural activities leave the soil bare, or in semi-arid regions where vegetation is naturally sparse. Wind erosion requires strong winds, particularly during times of drought when vegetation is sparse and soil is dry (and so is more erodible). Other climatic factors such as average temperature and temperature range may also affect erosion, via their effects on vegetation and soil properties. In general, given similar vegetation and ecosystems, areas more precipitation (especially high-intensity rainfall), more wind, or more storms are expected to have more erosion.

In some areas of the world (e.g. the mid-western USA), rainfall intensity is the primary determinant of erosivity, with higher intensity rainfall generally resulting in more soil erosion by water. The size and velocity of rain drops is also an important factor. Larger and higher-velocity rain drops have greater kinetic energy, and thus their impact will displace soil particles by larger distances than smaller, slower-moving raindrops.

In other regions of the world (e.g. Western Europe), run-off and erosion result from relatively low intensities of stratiform rainfall falling onto previously saturated soil. In such situations, rainfall amount rather than intensity is the main factor determining the severity of soil erosion by water.

2) Soil structure and composition

The composition, moisture and compaction of soil are all major factors in determining the erosivity of rainfall. Sediments containing more clay tend to be more resistant to erosion than those with sand or silt, because the clay helps bind soil particles together. Soil containing high levels of organic materials are often more resistant to erosion, because the organic materials coagulate soil colloids and create a stronger, more stable soil structure. The amount of water present in the soil before the precipitation also plays an important role, because it sets limits on the amount of water that can be absorbed by the soil (and hence prevented from flowing on the surface as erosive run-off). Wet, saturated soils will not be able to absorb as much rainwater, leading to higher levels of surface run-off and thus higher erosivity for a given volume of rainfall. Soil compaction also affects the permeability of the soil to water, and hence the amount of water that flows away as run-off. More compacted soils will have a larger amount of surface run-off than less compacted soils.

3) Vegetative cover

Vegetation acts as an interface between the atmosphere and the soil. It increases the permeability of the soil to rainwater, thus decreasing run-off. It shelters the soil from winds, which results in decreased wind erosion, as well as advantageous changes in microclimate. The roots of the plants bind the soil together and interweave with other roots, forming a more solid mass that is less susceptible to both water and wind erosion. The removal of vegetation increases the rate of surface erosion.

4) Topography

The topography of the land determines the velocity at which surface run-off will flow, which in turn determines the corsivity of the run-off. Longer, steeper slopes (especially those without adequate vegetative cover) are more susceptible to very high rates of erosion during heavy rains than shorter, less steep slopes. Steeper terrain is also more prone to mudslides, landslides and other forms of gravitational erosion processes.

5.4 HUMAN ACTIVITIES THAT INCREASE SOIL EROSION

1) Agricultural practices :

Unsustainable agricultural practices are the single greatest contributor to the global increase in erosion rates. The tillage of agricultural lands, which breaks up soil into finer particles, is one of the primary factors. The problem has been exacerbated in modern times, due to mechanized agricultural equipment that allows for deep plowing, which severely increases the amount of soil that is available for transport by water erosion. Others include mono-cropping, farming on steep slopes, pesticide and chemical fertilizer usage (which kill organisms that bind soil together), row-cropping and the use of surface irrigation. A complex overall situation with respect to defining nutrient losses from soils, could arise as a result of the size selective nature of soil erosion events. Loss of total phosphorus, for instance, in the finer eroded fraction is greater relative to the whole soil. Extrapolating this evidence to predict subsequent behaviour within receiving aquatic systems, the reason is that this more easily transported material may support a lower solution concentration compared to coarser sized fractions.[39] Tillage also increases wind erosion rates, by dehydrating the soil and breaking it up into smaller particles that can be picked up by the wind. Exacerbating this is the fact that most of the trees are generally removed from agricultural fields, allowing winds to have long, open runs to travel over at higher speeds. Heavy grazing reduces vegetative cover and causes severe soil compaction, both of which increase erosion rates.

2) Deforestation :

In an undisturbed forest, the mineral soil is protected by a layer *of leaf litter* and an *humus* that cover the forest floor. These two layers form a protective mat over the soil that absorbs the impact of rain drops. They are porous and highly permeable to rainfall, and allow rainwater to slow percolate into the soil below, instead of (lowing over the surface as run-off. The roots of the trees and plants hold together soil particles, preventing them from being washed away. The vegetative cover acts to reduce the velocity of the raindrops that strike the foliage and stems before hitting the ground, reducing their kinetic energy. However, it is the forest floor, more than the canopy, that prevents surface erosion. The terminal velocity of rain drops is reached in about 8 metres (26 feet). Because forest canopies are usually higher than this, rain drops can often regain terminal velocity even after striking the canopy. However, the intact forest floor, with its layers of leaf litter and organic matter, is still able to absorb the impact of the rainfall.

Deforestation causes increased erosion rates due to exposure of mineral soil by removing the humus and litter layers from the soil surface, removing the vegetative cover that binds soil together and causing heavy soil compaction from logging equipment. Once trees have been removed by fire or logging, infiltration rates become high and erosion low to the degree the forest floor remains intact. Severe fires can lead to significant further erosion if followed by heavy rainfall.

Globally one of the largest contributors to erosive soil loss in the year 2006 is the slash and burn treatment of tropical forests. In a number of regions of the earth, entire sectors of a country have been rendered unproductive. For example, on the Madagascar high central plateau, comprising approximate ten percent of that country's land area, virtually the entire landscape is sterile of vegetation, with gully erosive furrows typically in excess of 50 metres (160 ft) deep and 1 kilometre (0.6 miles) wide. Shifting cultivation is a farming system which sometimes incorporates the slash and burn method in some regions of the world. This degrades the soil and causes the soil to become less and less fertile.

3) Roads and urbanization :

Urbanization has major effects on erosion processes. First by denuding the land of vegetative cover, altering drainage patterns, and compacting the soil during construction; and next by covering the land in an impermeable layer of asphalt or concrete that increases the amount of surface run-off and increases surface wind speeds. Much of the sediment carried in runoff from urban areas (especially roads) is highly contaminated with fuel, oil and other chemicals. This increased run-off, in addition to eroding and degrading the land that it flows over, also causes major disruption to surrounding watersheds by altering the volume and rate of water that flows through them and filling them with chemically polluted sedimentation. The increased flow of water through local waterways also causes a large increase in the rate of bank erosion.

4) Climate change :

The warmer atmospheric temperatures observed over the past decades arc expected to lead to a more vigorous hydrological cycle, including more extreme rainfall events. The rise in sea levels that has occurred as a result of climate change has also greatly increased coastal erosion rates.

Studies on soil erosion suggest that increased rainfall amounts and intensities will lead to greater rates of soil erosion. Thus, if rainfall amounts and intensities increase in many parts of the world as expected, erosion will also increase, unless amelioration measures are taken. Soil erosion rates are expected to change in response to changes in climate for a variety of reasons. The most direct is the change in the erosive power of rainfall. Other reasons include: a) changes in plant canopy caused by shifts in plant biomass production associated with moisture regime; b) changes in litter cover on the ground caused by changes in both plant residue decomposition rates driven by temperature and moisture dependent soil microbial activity as well as plant biomass production rates; c) changes in soil moisture due to shifting precipitation regimes and evapo-transpiration rates, which changes infiltration and run-off ratios; d) soil erodibility changes due to decrease in soil organic matter concentrations in soils that lead to a soil structure that is more susceptible to erosion and increased run-off due to increased soil surface scaling and crusting: e) a shift of winter precipitation from non-erosive snow to erosive rainfall due to increasing winter temperatures: f) melting of permafrost, which induces an erodible soil state from a previously non-erodible one; and g) shifts in land use made necessary to accommodate new climatic regimes.

Studies by Pruski and Nearing indicated that, other factors such as land use unconsidered, it is reasonable to expect approximately a 1.7% change in soil erosion for each 1% change in total precipitation under climate change.

5.5 GLOBAL ENVIRONMENTAL EFFECTS

Due to the severity of its ecological effects and the scale on which it is occurring, erosion constitutes one of the most significant global environmental problems we face today.

1) Land degradation :

Water and wind erosion are now the two primary causes of land degradation; combined, they are responsible for 84% of degraded acreage.

Each year, about 75 billion tons of soil is eroded from the land -a rate that is about 13-40 times as fast as the natural rate of erosion. Approximately 40% of the world's agricultural land is seriously degraded.

According to the United Nations, an area of fertile soil the size of Ukraine is lost every year because of drought, depreciation and climate change. In Africa, if current trends of soil degradation continue the continent might be able to feed just 25% of its population by 2025, according to UNU's Ghana-based Institute for Natural Resources in Africa.

The loss of soil fertility due to erosion is further problematic because the response is often to apply chemical fertilizers, which leads to further water and soil pollution, rather than to allow the land to regenerate.

2) Sedimentation of aquatic ecosystems :

Soil erosion (especially from agricultural activity) is considered to be the leading global cause of diffuse water pollution, the excess sediments flowing into the world's waterways. The sediments themselves act as pollutants, as well as being carriers for other pollutants, such as attached pesticide molecules or heavy metals.

The effect of increased sediments loads on aquatic ecosystems can he catastrophic. Silt can smother the spawning beds of fish, by filling in the space between gravel on the stream bed. It also reduces their food supply and causes major respiratory issues for them as sediment enters their gills. The biodiversity of aquatic plant and algal life is reduced and invertebrates arc also unable to survive and reproduce. While the sedimentation event itself might be relatively short-lived, the ecological disruption caused by the mass die off often persists long into the future.

One of the most serious and long-running water erosion problems worldwide is in the People’s Republic of China, on the middle reaches of the Yellow River and the upper reaches of the Yangtze River, from the Yellow River, over 1.6 billion tons of sediment flows into the ocean each year. The sediment originates primarily from water erosion in the Loess Plateau region of the northwest.

3) Airborne dust pollution :

Soil particles picked up during wind erosion of soil are a major source of air pollution, in the form of airborne participates-'dust'. These airborne soil particles are often contaminated with toxic chemical such as pesticides or petroleum fuels, posing ecological and public health hazards when they later land or are inhaled / ingested.

Dust from erosion acts to suppress rainfall and changes the sky color from blue to white. Which leads to an increase in red sunsets. Dust events have been linked to a decline in the health of coral reefs across the Caribbean and Florida, primarily since the 1970s.[67] Similar dust plumes originate in the Gobi desert, which combined with pollutants, spread large distances downwind or eastward, into North America.

5.6 REMEDIAL ON SOIL EROSION

Surface cover is a major factor to control erosion because it reduces the impact of raindrops falling on bare soils and wind removing soil particles. It also reduces the speed of water flowing over the land. Erosion risk is significantly reduced when there is more than 30% soil cover. Total cover is achievable for many grazing and cropping systems. Run-off concentrates as it flows downslope. By the time rivers draining large catchments reach the coast, they are usually just a few hundred meters wide. Even though surface cover encourages run-off to spread, run-off concentration is inevitable. Co-ordination across the catchment is important when implementing run-off control measures. Run-off may pass through several properties and cross several roads (sometimes railway lines) as it passes from the most remote part of a catchment to a major drainage line or creek.

1) Keep soil covered year-round : Bare soil is far more vulnerable to erosion than soil with ground cover. Aim for atleast 30% ground cover on all grazing land, ideally 40% or more.[8] After harvesting crops, leave the residue on the soil as a mulch or plant hardy winter crops.

2) Plant trees to prevent landslides : Tree roots are powerful tools when soil is too eroded or steep to plant. Plant native trees on steep slopes and riverbanks to reduce soil loss. Bare ground around the tress still needs to be covered in mulch or grass for best results.

3) Reduce tillage : Deep, frequent tillage creates a layer of compact soil vulnerable to water erosion, topped by loose soil easily removed by wind.[10][11] Consider a zero-tillage approach using a coulter or other deep planting device.[12] If this is not feasible, try a ridge-till or mulch-till system that leaves the lower soil levels untouched. These conservation tillage techniques also reduce the amount of vehicle traffic and therefore soil compaction.

4) Protect weak crops with strip cropping : Crops with weak roots or that need to be sparsely planted are more vulnerable to erosion. Plant these in strips, alternating with strips of an erosion-resistant crop such as dense grass or legumes. Plant the crops so they contour the slope. Plant these crops perpendicular to the prevailing wind if possible.

5) Practice wet season spelling : Grazing land cannot remain healthy and erosion-resistant if cattle are allowed to graze year-round. For best results, close off a paddock for the entire wet season to allow grasses to reestablish themselves. This may not be effective if the other paddocks cannot support the spelled cattle. If possible, keep cattle away from riverbanks and heavily eroded soil at all times.

6) Control downhill run-off with flumes : Run-off concentrated into a narrower area as it travels across lands. The points where the concentrated run-off reaches a slope are particularly vulnerable to erosion. Build a paved flume or lined channel, to lead the water to a safe drainage system. Build these at gully heads as well.

7) Plant grass and shrubs : Plant roots hold the soil together, while their leaves lessen damage caused by rain. Turf, ornamental grass, and low, spreading shrubs work best, since they leave no areas of bare soil. These have a good chance of controlling erosion by themselves, as long as the ground grade is less than 3:1 (3 units horizontal for each 1 unit rise). For steeper slopes, see below for additional work.

8) Add mulch or rocks : Use these to cover any remaining patches of bare soil. Plant-matter mulch such as grass clippings or bark chips are especially effective.[3] These will also protect grass seeds and young plants from animals and water run-off, giving them time to grow. Mulch deteriorates over time, but ideally the soil should no longer need protection by the time it does. You may want to reapply mulch anyway, if your plant varieties and climate require it.

9) Use mulch matting to hold vegetation on slopes : Fiber mulch mats or erosion control mats are a layer of mulch held together in a fiber mesh. This structure holds them together in areas where normal mulch would be washed or blown away. After planting vegetation, lay these over sloped ground, with a grade between 3:1 and 2:1. In areas with heavy wind or water, use liquid mulch binder to keep the mulch on the ground.

10) Build retaining walls or terraces for steep slopes : Eroding slopes with a 2:1 grade or steeper rarely support vegetation. Build a retaining wall to slow erosion while the vegetation takes hold. Give the wall a roughly 2% slope direct water flow. Tall hills can be transformed into terraces with several walls and soil grading. You may build the wall from concrete blocks, rock or wood. Only use wood treated with a preservative to prevent rot. Use retaining walls around flowerbeds and other raised soil areas as well. You may need local government approval to build these structures.

11) Improve drainage : All buildings should have gutters or pipes that can drain water effectively out of your garden and into water collection systems. Without adequate drainage, heavy rain could potentially wash away *a* whole layer of topsoil. Areas with heavy water run-off may require installing an underground perforated drainage pipe.

12) Reduce watering if possible : Over-watering your garden can speed up erosion. Consider a less frequent watering schedule or install a drip irrigation system to reduce the amount of water runoff.

13) Avoid soil compaction : Foot and vehicle traffic compresses soil, making it less porous and more vulnerable to water run-off. Take steps to minimize this effect. Establish permanent walkways with paving stones, stepping stones, or cleared paths.

Water erosion and surface water run-off are problematic. One of the main causes of soil erosion is water erosion, which is the loss of topsoil due to water. Removal of vegetation is another cause or soil erosion and so is the removal of keystone species such as elephants from an area, when they are unable to fulfill their niche in the local ecology.

5.7 EXERCISE

1) Explain the concept of soil erosion and state the various factors affecting on soil erosion.
2) State the various causes and consequences of soil erosion.
3) Suggest some remedial measures an soil erosion in rural area.

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6

ACQUISITION OF LAND

Unit Structure :

6.0 OBJECTIVES

1) To understand the concept and purpose of Land acquisition.
2) To study the various issues and consequences of land acquisition.
3) To understand proposed amendments and alternative for land acquisition.

6.1 INTRODUCTION

Land acquisition in India refers to the process by which the Union or a State Government in India acquires private land for the purpose of industrialisation, development of infrastructural facilities or urbanisation of the private land and provides compensation to the affected land owners and their rehabilitation and resettlement.

Land acquisition in India is governed by the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR) and which came into force from 1 January 2014. Till 2013, land acquisition in India was governed by Land Acquisition Act of 1894. On 31 December 2014, the President of India promulgated an ordinance with an official mandate to "meet the twin objectives of farmer welfare; along with expeditiously meeting the strategic and developmental needs of the country". An amendment bill was then introduced in Parliament to endorse the Ordinance. Lok Sabha passed the bill but the same is still lying for passage by the Rajya Sabha. On 30 May 2015. President of India promulgated the amendment ordinance for third time. Union Government of India has also made and notified the Right to Fair

Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Rules, 2014 under the Act to regulate the procedure. The land acquisition in Jammu and Kashmir is governed by the Jammu and Kashmir Land Acquisition Act, 1934.

6.2 PURPOSE OF LAND ACQUISITION

As per the Act, the Union or State Governments can acquire lands for its own use, hold and control including for public sector undertakings and for 'public purpose', and shall include the following purposes :

1. For strategic purposes relating to naval, military, air force and armed forces of the Union, including central paramilitary forces or any work vital to national security or defence of India or State police, safety of the people;
2. For infrastructure projects as defined under the Act;
3. Project for project affected families;
4. Project for housing for such income groups, as may be specified from time to time by the appropriate Government;
5. Project for planned development or the improvement of village sites or any site in the urban areas or provision of land for residential purposes for the weaker sections in rural and urban areas;
6. Project for residential purposes to the poor or landless or to persons residing in areas affected by natural calamities or to persons displaced or affected by reason of the implementation of any scheme undertaken by the Government, any local authority or a corporation owned or controlled by the State. The land can be acquired for private bodies for certain purposes:

7. For public private partnership projects, where the ownership of the land continues to vest with the Government, for public purpose as defined in the Act;
8. For private companies for public purpose.

6.3 ISSUES OF LAND ACQUISITION

Some of the important issues surrounding the Land Acquisition are discussed below. The major land acquisition and conflicts happen in the densely populated areas of the countryside.

6.3.1 Eminent Domain :

The power to take property from the individual is rooted in the idea of eminent domain. The doctrine of eminent domain states, the sovereign can do anything, if the act of sovereign involves public interest. The doctrine empowers the sovereign to acquire private land for a public use, provided the public nature of the usage can be demonstrated beyond doubt. The doctrine is based on the following two Latin maxims- 1) Salus populi suprema lex (Welfare of the People Is The Paramount Law) and 2) Necessitas publica major est quam (Public Necessity Is Greater Than Private Necessity). In the history of modern India, this doctrine was challenged twice once when land reform was initiated and another time when Banks were nationalized.

The Constitution of India originally provided the right to property (which includes land) under Articles 19 and 31. Article 19 guaranteed that all citizens have the right to acquire, hold and dispose of property. Article 31 stated that "no person shall be deprived of his property save by authority of law." It also indicated that compensation would be paid to a person whose property has been taken for public purposes.

In India, with this introduction of 'social' elements to the property rights, a new phase had begun. K. K. Mathew, justice of Kesavananda Bharati vs State of Kerala stated this precisely : "Property in consumable goods or means of production worked by their owners were justified as necessary condition of a free and purposeful life; but when property gave power not only over things but through things over persons also, it was not justified as it was an instrument of servitude rather than freedom."

6.3.2 Legislative changes :

The 2013 Act focuses on providing not only compensation to the land owners, but also extend rehabilitation and resettlement benefits to livelihood looser from the land, which shall be in addition to the minimum compensation. The minimum compensation to be paid to the land owners is based on a multiple of market value and other factors laid down in the Act. The Act forbids or regulates land acquisition when such acquisition would include multi-crop irrigated area. The Act changed the norms for acquisition of land for use by private companies or in case of public-private partnerships, including compulsory approval of 80% of the landowners. The Act also introduced changes in the land acquisition process, including a compulsory social-impact study, which need to be conducted before an acquisition is made.

The new law, also has some serious shortcomings as regards its provisions for socio-economic impact assessment and it has also bypassed the constitutional local self governments by not recognizing them as ‘appropriate governments’ in matters of land acquisition.

6.3.3 Monetary compensation :

Major Indian infrastructure projects such as the Yamuna Expressway have paid about INR 2800 crores (US$500 million) for land or over US$25,000 per acre between 2007 and 2009. For context purposes, this may be compared with land prices elsewhere in the world:

- According to The Financial Times, in 2008, the farmland prices in France were Euro 6,000 per hectare ($2,430 per acre; IN Rs. 1,09,350 per acre).
- According to the United States Department of Agriculture, as of January 2010, the average farmland value in the United States was $2140 per acre (IN Rs. 96,300 per acre). The farmland prices in the United States varied between different parts of the country, ranging between $480 per acre to $4,690 per acre.

A 2010 report by the Government of India, on labor whose livelihood depends on agricultural land, claims that, per 2009 data collected across all States in India, the all-India annual average daily wage rates in agricultural occupations ranged between IN Rs. 53 to 117 per day for men working in farms US$354 to 780 per year), and between IN Rs. 41 to 72 per day for women working in farms (US$274 to 480 per year). This wage rate in rural India study included the following agricultural operations common in India : ploughing, sowing, weeding, transplanting, harvesting, winnowing, threshing, picking, herdsmen, tractor driver, unskilled help, masonry, etc.

The compensation for the acquired land is based on the value of the agricultural land, however price increases have been ignored. The land value would increase many times, which the current buyer would not benefit from. Secondly, if the prices are left for the market to determine, the small peasants could never influence the big corporate tycoons. Also it is mostly judiciary who has awarded higher compensation then bureaucracy.

6.3.4 Delayed projects

Delayed projects due to mass unrest have caused a damaging effect to the growth and development of companies and the economy as a whole. Earlier States like Maharashtra, Tamil Nadu, Karnataka, and Andhra Pradesh had been an attractive place for investors, but the present day revolts have shown that land acquisition in some States pose problems.

6.4 CONSEQUENCES OF LAND ACQUISITION

The consequences of land acquisition in India are manifold. The empirical and theoretical studies on displacement through the acquisition of land by the government for development projects have so far focussed on the direct and immediate adverse consequences of land acquisition. Most of the analytical as well as the descriptive accounts of the immediate consequences of land acquisition for development projects draws heavily from Michael Cernea's 'impoverishment risk model', which broadly enumerated eight 'risks' or 'dimensions' of development-induced displacement. These eight risks are VERY much direct and basic in nature which are- i) landlessness, ii) Joblessness. iii) marginalization iv) loss of access to common property resources, v) increased morbidity and mortality, vi) food insecurity, vii) homelessness and viii) social disarticulation. Recently L.K. Mahapatra has added 'loss of education' as another impoverishment risk in situations of displacement.

But apart from these direct and immediate effects of land acquisition there are more subtle and indirect effects of this coercive and centralized legal procedure, which have a bearing on various decentralized and participatory democratic processes and institutions of the State power. Land reforms and the Panchayati raj institutions are the two most important areas, which are being vitiated by land acquisition. Of all the States of India, the consequences and controversies around land acquisition in West Bengal has recently gained a lot of national and international attention. The peasant resistances against governmental land expropriation in Singur (a place in the Hoogly district) and Nandigram (a place in the East Medinipur district) has finally led to the fall of the Communist Party (Marxist) led government in West Bengal, which ruled the State through democratic election for 34 years. The Communist led left front government of West Bengal under the economic liberalization policy adopted by the Central Union government of the country shifted from its pro-farmer policy and took to the capitalist path of industrial development, which at the micro-levels endangered the food security of the small and marginal farmers as well as sharecroppers who formed the vote bank of the Left Front Government of West Bengal. The new anti-Communist Trinamul Congress led government of West Bengal which came to power in the State in 2011 through a massive electoral victory is yet to develop any comprehensive resettlement and rehabilitation policy for the thousands of families affected by various development projects. The new government has enacted a law on 14 June 2011, in the West Bengal Assembly named 'Singur Land Rehabilitation and Development Act, 2011 '. With this law, the West Bengal government has reacquired Narmada was planned on acquired land, though the project was later cancellled by the World Bank.

The Land Acquisition Act of 1894 allowed the government to acquire private lands. It is the only legislation pertaining to land acquisition which, though amended several times, has failed to serve its purpose. Under the 1894 Act, displaced people were only liable for monetary compensation linked with market value of the land in question, which was still quite minimal considering circle rates are often misleading.

6.5 PROPOSED AMENDMENTS

The current Narendra Modi lead National Democratic Alliance (India) government driven Land Acquisition Amendment Bill in the Lok Sabha on 10 March 2015 has seen a tough resistance from key position parties in India who have called the proposed amendments “anti-farmer’ and ‘anti-poor’. The proposed amendments remove requirements for approval from farmers to proceed with land about 1000 acres of farmland from the Tatas which was given to the company for building a small-car manufacturing factory in 2006 by the then Left Front government. The Trinamul government's intention was to return 400 acres of farmland to the 'unwilling' farmers around whom the agitation against the Left Front government was organised by the Trinamul Congress Party. However, now the whole issue seems to have fallen into a long legal battle between the present State government and the Tatas, as the latter has challenged the 'Singur Land Rehabilitation and Development Act' in the court. As a result, the Trinamul government has not yet been able to return the land to those 'unwilling farmers' nor have they received any compensation (The Statesman, 12 January 2012). In another case of governmental land acquisition for housing at North 24 Parganas district of West Bengal, the farmers began to cultivate their farmland which were acquired but remained unutilised. According to media report these farmers were assured by the Trinamul Congress party leaders before the election that their land, which is about 1687 acres would be returned to them if the party could come to power. However, now these farmers are turning their backs to the Trinamul Congress, since the party has not kept its pre-election promise (The Statesman, 11 February 2012). Under the above disturbing episodes, it may be worthwhile to narrate the glaring incident of the opposition levelled by Mamata Banerjee, the present Chief Minister of West Bengal to the draft Land Acquisition (Amendment) Bill 2007 in the Lok Sabha. At that time Miss Mamata Banerjee was the Railway Minister of the Central Government. She opposed to a clause of the bill which empowered private companies to acquire up to 70 per cent land directly from farmers and landowners. The remaining 30 per cent could be acquired by the State government. Miss Banerjee wanted private companies to buy 100 per cent of the land, according to a report (The Statesman, 26 July 2009). It seemed that Miss Banerjee would have allowed the amended Bill to be passed if the; Lok Sabha agreed to modify the 70/30 proportion to 100 per cent purchase by the companies under the principle of willing-buyer-willing-seller.

The process of land acquisition in India has proven unpopular with the citizenry. The amount reimbursed is fairly low with regard to the current index of prices prevailing in the economy. Furthermore, due to the low level of human capital of the displaced people, they often fail to find adequate employment.

The draft of the government's National Policy for Rehabilitation states that a figure around 75% of the displaced people since 1951 arc still awaiting rehabilitation. However, it should be noted that displacement is only being considered with regard to ‘Direct Displacement’. These rehabilitation policies do not cover fishermen, landless laborers and artisans. Roughly, one in ten Indian tribals is a displaced person. Dam projects have displaced close to a million Adivasis, with similar woe for displaced Dalits. Some estimate suggests 40 per cent of displaced people are of tribal origins.

There have been a rising number of political and social protests against the acquisition of land by various industrialists. They have ranged from Bengal, Karnataka, and Uttar Pradesh in the recent past. The acquisition of 997 acres of land by Tata Motors in Bengal in order to set up a factory for the cheapest car in India was protested (Singur Tata Nano controversy). At least a decade before the Singur episode similar events occurred in West Bengal, although the opposition parties and other civil society organisations remained silent at that time. Similarly, the Sardar Sarovar Dam project on the river acquisition under five broad categories of projects. While the bill was passed in Lok Saibha, it still needs approval from the Rajya Sabha, where the current government does not have a majority, for the proposed amendments to become effective.

The following are the main disputation point -

- The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 defines 'consent' clause as "land can only be acquired with approval of the 70% of the land owners for PPP projects and 80% for the private entities. But the proposed amendments by the Narendra Modi government does away with consent clause for Industrial corridors, Public Private Partnership projects, Rural Infrastructure, Affordable housing and defense projects.
- The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 says the land unutilized for 5 years should be returned to the owner, but the amendment proposed by NDA government intends to change to 5 years or any period specified at the time of setting up the project.

- While the The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 allows private companies to acquire land, but the proposed amendment allows any private entity to acquire land.

- According to the new amendment, if any government official conducts any wrongdoing, he or she cannot be prosecuted without prior sanction from the government.
- The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 mandated the social assessment before land acquisition, but the NDA government's proposed bill does away with this requirement.

6.6 ALTERNATIVES FOR LAND ACQUISITION

One of the alternative proposals to land acquisition is leasing the land from landowners for a certain lease period. Proponents cite how land acquisition policies by Governments unwittingly encourage rampant land speculation making the projects expensive since huge portion of investment would be need to be allocated for land acquisition costs. According to them, policies of land acquisition gave way to political cronyism where land is acquired cheaply by securing favors from local governments and sold to industries at steep markup prices. Leasing land, may also support sustainable project development since the lands need to be returned to the landowners at the end of the lease period in a condition similar to its original form without considerable environmental degradation. When the land is leased then anybody who has to otherwise give up land or livelihood will be compensated for its growing valuation over time. In this model, the landowner lends her land to the government for a steadily increasing rent or through an annuity-based system as currently practiced in Haryana and Uttar Pradesh.

Some industries already follow the model of leasing lands instead of acquiring it. Energy development projects such as oil & gas extraction usually lease lands. Renewable energy projects such as Wind Power farms projects often lease the land from landowners instead of trying to acquire the land which could make the projects prohibitively expensive.

6.7 EXERCISE

1) Explain the concept of Land acquisition and describe the various purposes of land acquisition.

2) Describe the various consequences of land acquisition in rural area.

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7

ROLE OF AGRICULTURAL INPUTS - SEEDS, FERTILIZERS AND PESTICIDES

Unit Structure :

7.0 OBJECTIVES

1) To study the importance and characteristics of High Yielding Variety (HYV) seeds.
2) To understand various types of fertilizers and pesticides.

7.1 INTRODUCTION

India has succeeded in raising farm production in some of the major and high value crops, there are still a number of crops where production and hence, return to farm household is very low. There can, therefore, be no complacency in organising adequate input supports to the farming sector. Emphasis would have to continue on a package of specially for small and marginal farmers. The basic inputs which contributed for the development of agricultural sector mentioned as :

1) High yielding varieties of seeds.
2) Fertilizers
3) Pesticides.

7.2 SEEDS

7.2.1 High Yielding Varieties of seeds:

One of the basic pre-requisite of technical changes is the High Yielding Varieties of seeds (HYV). With this programme it becomes possible to lead intensive agriculture, yet the real impetus to these efforts was given by the adoption of new agricultural strategy in 1966-67. It was, thus, during mid-sixties that the high yielding variety of wheat were evolved since then a number of HYV seeds of wheat, paddy, maize and bajara have been developed and widely distributed in the country. In 1966-67, only 1.89 million hectares of land had been brought under HYV seeds which rose to 56.18 million hectares in 1980-87. During 1991-92, the area under high yielding varities of seeds from 1966-67 to 1993-94.

Area Under HYV (million Hectares)

Crop	**1970-71**	**1980-81**	**1990-91**	**1991-92**	**1993-94**
Paddy	5.6	18.2	28.1	28.0	28.9
Wheat	6.5	16.1	20.4	20.5	22.0
Jowar	0.8	3.5	6.7	5.6	6.8
Bajara	2.0	3.7	5.1	6.8	5.1
Maize	0.8	1.6	2.6	3.8	3.9
Total	15.4	43.1	62.9	64.7	66.6

The HYVP has been taken up for five crops. Among these the most striking success has been achieved in wheat. The average yield of wheat has been 634 kgs. per hectare. With high yielding strains (kalyan sona, sonalika, safed lerwa) the yield have been high in Punjab, Haryana, Western U.P plains and Northern parts of Gujarat. Elsewhere the yields have been low. The major factor which triggered the wheat revolution in Sutlaj-Yamuna plains was the introduction of high yielding, nitrogen responsive dwarf-strains of wheat from Mexico.

As regards the other crop production, yields have been rather low. As against the average yield of 1150 kgs of paddy per hectare, it increased to 1651 - 2050 kgs and 1251 - 1650 kgs. per hectare in the core vice region. The yield increase due to the increasing area under improved strains i.e., Taiching Natiri-1, Taiching 65, Taiaon-3, ADT -28, IR -8, Padma Jaya, Hansa, Pankay, Jagannath, Sabaramati, Jamuna, IR -28 and Kaveri -7 etc.

The productivity of Jowar did not show any appreciable increase. The national average was 685 kgs per hectare, it increased to as high as 1000 kgs. in Punjab, Haryana, Gujarat, Tamil Nadu and Andhra Pradesh to over 2000 kgs. on sandy soils of Marusthali. It has over 23000 kgs per hectare in Ferozpur districts of Punjab.

Average maize productivity has been 1467 kgs. per hectare. It increased to over 1150 kgs. per hectare due to increased use of improved seeds viz. Ganga 101, Ganga sated, Ganga - 3, etc.

7.2.2 Characteristics of HYV:

1) The fields in which HYV seeds are to be sown, should have proper drainage facilities.
2) All varieties are short duration ranging from 100-140 days in different parts of the country.
3) Under better irrigated conditions the HYV seeds are highly responsible.
4) These are coarse and therefore the market price is invariably lower than the other medium and fine varities.
5) These are all dwarf varieties and they are responsive to higher does of fertilizer application.

7.3 FERTILIZERS

The use of fertilizers is indispensable for accelerating the growth of agricultural output in the short period. The classical researches of Calonel Macarrison and B.V. Nath in India and Mackeridge and Bottomely proved that crops raised with organic manure are superior in their nutritive value then those with artifical manure. According to an estimate, the use of one tonne of plant nutrients would be equivalent to adding about 4 hectares crop land in terms of additional production. Thus, it is one of the profitable mean of land use and sustained agricultural production. In this regard National Commission on Agriculture has rightly said, "It has been the experience throughout the world that increased agricultural production is related to the increased consumption of fertilizers."

7.3.1 Types of Chemical Fertilizers:

Chemical Fertilizers are of three types as:

1) Nitrogenous Fertilizer.
2) Phosphatic Fertilizer.
3) Pottasic Fertilizers.

1) **Nitrogenous Fertilizers :** It comprises salt petre, mitre, ammonium sulphate, sodium nitrate and area, etc. It impart a green colour to leaves and encourages the development of foliage. As regards cereals, it tends to produce succulence or tenderness in the plant.
2) **Phosphatic Fertilizers :** It comprises of bones and rock phosphates. When powdered rock phosphate is applied to the soil, phosphoric acid becomes readily available. It helps in the root development of crops, hastens maturity of crops. In case of cereals, it increases resistence to disease and in proves the quality of crops.

3) **Pottasic Fertilizers :** These comprises of potassium chloride and potassium sulphate. It helps the transference of food materials from one part of the plant to another. It also provides green colour to the leaves and tend to increase plumpness in grains.

7.3.2 Time of Application of Fertilizers:

The time of application of fertilizer often makes a considerable difference in its utilization by the crop. Plants absorb a large quantity of nitrogen, phosphoric acid and potash during the early stage of growth. Therefore, fertilizers should be applied to the most of crops at before or the sowing times. These need not to be applied to annual crops in their latter stage of growth. A late application of nitrogen to a crop increases the nitrogen content. But crops of long duration require its application twice or thrice at suitable intervals. As regards the phosphatic fertilizer, it should be applied before or at the time of planting the crop. Potash is applied at the time of planting and to a limited extend.

7.3.3 Methods to Apply Fertilizers:

The following methods are generally used to apply fertilizers.

i) Broadcasting during the preparation of the soil;
ii) Placing in rows either before or at the time of planting;
iii) Side dressing the crop during growing season.
iv) Applying Liquid Fertilizers.

7.3.4 Production of Chemical Fertilizers:

Since 1950-51 Indian Fertilizer industry has continuously expanded. The total production capacity which was 0.31 million tonnes in 1950-51 has reached to 9.04 million tonnes in 1994-95. and further 10.1 million tonnes in 1994-95. In the production of Nitrogenous Fertilizer India ranks fourth largest producer in the world. In recent years. India’s fertilizer scenario has undergone a dramatic change. Since domestic production could not suffice to meet the entire demand, a substantially large part of domestic consumption till now was being meet by imports.

7.3.5 Consumption of Chemical Fertilizer:

Proper use of fertilizer alone can enhance the productivity of soil. But Indian soil is deficient in nitrogen and phosphorus and this deficiency can be removed by using more fertilizers. Thus, increased consumption of fertilizers is an important element of new strategy. However, the consumption of fertilizers has increased steadily. At the beginning of first plan the consumption was only 0.13 million tonnes as shown in table.

Consumption of Chemical Fertilizer	
Year	**Quantity (million tonnes)**
1950-51	0.13
1960-61	0.29
1966-67	1.10
1970-71	1.18
1980-81	5.52
1984-85	8.21
1986-87	8.74
1987-88	8.79
1988-89	11.04
1990-91	12.54
1991-92	12.73
1992-93	12.15
1993-94	12.83

The consumption of fertilizer during the first three years of seventh plan fell short of targeted level due to unfavourable weather and unprecedented drought in 1987-88. The fourth and fifth years of the plan have been very good years for development of crops as encouraged by the onset of good monsoon in time and farely even distribution of rainfall in the country. As a result, consumption of fertilizers increased both in sharif and rabi seasons to 12.43 million tonnes during 1980-81 and to 12.73 million tonnes in 1991-92 and further to 13.85 million tonnes in 1993 -94.

Despite the massive increase in fertilizer consumption the fact remains that fertilizer use per hectare of land is still much less in India as compared to many other countries of the world, on an average, India consumed 39.4 kg. of fertilizer per hectare of land during 1986-87, corresponding figure was 436 kg. in Japan, 508 kg. in Belgium, 1.144 kg. in New Zealand.

7.3.6 Constrains or Problems:

The major constrains of fertilizer use can be identified as below:

1) **Return Non-Remunerative** - The use of fertilizers is considered non-remunerative in the case of interior cereals.

2) **Non-Availability of Fertilizers -** A significant proportion of farmers have denied the use of fertilizers because of their non-availability.

3) **High Prices of Fertilizers -** The small and medium farmers do not use fertilizers due to its high prices. The cultivators lack sufficient capital to make this type of investment in fertilizer use.

4) **Risk Element -** Risk element implices the fear of heavy looses in case of failure of rains. This sort of fear is also experienced by big farmers.

7.3.7 Suggestions to increase consumption of fertilizer:

Some significant measures to increase the consumption of fertilizer are:

i) Fixation and operation of support price and procurement price of foodgrains.
ii) Regulation of fertilizer application by testing soils.
iii) Irrigation facilities should be created.
iv) Soil and moisture conservation techniques.
v) Minimization of damage by disease, insects, rodents, etc. in the field of storage.

7.4 PESTICIDES

It is beyond any shadow of doubt that new seeds have increased the per hectare yield of various crops. Biologically, the crops sown through use of new seeds are more prone to disease. The use of fertilizers for their production also increases the susceptibility of these crops to diseases.

It is estimated that every year nearly 10 per cent crops are damaged due to in sufficient plant protection measures. The adoption of HYV of seeds has further increased the importance of such measures. For instance, during 1976-77, about 20 per cent of the cropped area suffered from pests and diseases while area treated with pesticides was only 7.2 per cent. The crops that suffered most were groundnut 47%, cotton 28%, paddy 24% and sugarcane 25%.

Consumption of pesticides was almost negligible in the early fifties. At the beginning of first five year plan, consumption of pesticides in the country was only 100 tonnes. At per cent about 33,000 tonnes of pesticides per annum are consumed by the country. However, there are great inter-state differences in the level consumption.

In Tamilnadu more than 1.8 kg of formulated pesticides on each hectare of cropped area is consumed. While Madhya Pradesh consumes $1/10^{th}$ of 9 kg of formulated pesticides on one hectare of cropped area.

Effective adoption of plant protection measure in the country suffered from tow handicap viz. lack technical skills in the use of pesticides, in effectiveness of individual operation. In a view to tackle the problem it has been envisaged that during 1993-94 5,000 extension functionaries and 3,000 farmers have been planned to be trained in IPM for rice and cotton.

A National Conference on IPM was held in March 1994 to finalise the IPM training / demo programmers with State authorities. Similarly, use of bio-pesticides is now being actively studied. Technical and Financial support of international agencies like FAO, UNDP and ADB - CABI is being sought to promote IPM in India.

7.5 EXERCISE

1) Explain the importance of agricultural inputs.
2) Discuss the importance of High Yielding varieties (HYV) seeds & fertilizers.
3) State the various problems of uses of fertilizers and pesticides.

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8

TOOLS AND EQUIPMENTS

Unit Structure :

8.0 OBJECTIVES

1) To study the traditional tools and equipments of agriculture.
2) To study the modern tools and equipment and their importance in agriculture.

8.1 INTRODUCTION

Modern agriculture depends heavily on engineering, technology and the biological and physical sciences. Irrigation, drainage, conservation and channeling are all important fields to guarantee success in agriculture and require the expertise of agricultural engineers. Agricultural chemistry deals with other issues vital to agriculture, such as the use of fertilizers, insecticides and fungicides, soil structure, analysis of agricultural products and the nutritional needs of farm animals. Plant breeding and genetics represents and invaluable contribution to agricultural productivity. Genetics has also introduced a scientific basis in animal husbandry. Hydroponics, a method in which plants thrive without soil by chemical nutrient solutions can solve other additional agricultural problems.

The packaging, processing and marketing are closely related activities also influenced by the development of science. The methods of rapid freezing and dehydration have increased the markets for agricultural products. Mechanization, the outstanding feature of agriculture in the late nineteenth and twentieth century has relieved much the work of the farmer. Even more significantly. mechanization has increased efficiency and productivity of farms. Planes and helicopters are used for agriculture purposes, such as planting transportation of perishable goods and fighting forest fires and crop fumigant to control insect pests and diseases. The radio and television transmit vital weather data and other information of interest to farmers.

8.2 TRADITIONAL TOOLS & EQUIPMENTS

A) Tool for ploughing :

Country plough : Tillage is the basic operation in farming. It is done to create favourable conditions for seed placement and plant growth. This is done mainly with a bullock drawn plough made of *Acacia* wood. Usually, small farmers and farm owners of scattered lands are unable to use tractors and in that case country ploughs are highly preferred. The basic components of the plough are a shoe. a share, a body, a handle and a beam. The handle is 0.6-1 m long, 5-7.5 cm thick and 7.5-12.5 cm wide and is fitted to the body of the plough. The shoe, used in the plough, can be of different shapes and sizes. The share is prepared from a mild steel bar. 0.6-7.5 m in length and 1.5-2.5 cm in width. The share is fixed to the shoe or body by means of a U-clamp or ring shaped clamp. The share point projects beyond the shoe by 5-7.5 cm Beams generally vary in length from 2.4-3 m. It needs some skill in driving bullocks, hence operated only by male labourers. Average life of the implement is 1 yr and costs Rs. 1000/unit. As country plough is a bullock drawn implement drudgery will be a burden on the animals.

B) Tools for intercultural operation :

1) Weeder : The tools is used for removing deep-rooted weeds along with their rhizome weeds like Agruampul (Hariyali grass) and other grasses were easily removed with the help of this weeder and mammutty. The tool made up of iron has a handle (length 50 cm and 8 cm diameter) and working area i.e. comb like structure has a length of 25 cm and 30 cm diameter). The farm labourers first pierced the soil with the help of this weeder and lift the soil upwards. Another attendant should remove the uprooted weeds from the soil using other farm implements called mammutty (spade). About 2 acre/day could be covered by the tool. Other advantages like loosening of the soil, earthing up are achieved during weeding operation. Male labourers mostly operate it. Average life is 10 yrs and costs Rs. 120/unit.

2) Dry land weeder : It is innovatively constructed with a front cycle wheel attached with gorru weeder blade at the back. With the help of hand bar farmer's drive the weeder from the back and one attendant pull the hand bar joined with a thread from the front. It is used for removing weeds. The weeder blade has a length of 30 cm and width of 3 cm. It is operated by two men labours. Average life is 5-6 yrs and costs Rs. 400/ unit.

3) Spade : It is used for formation of bunds, ridges and furrows and irrigation channels. Handle is made up of Acacia sp wood and the working area is made up of iron. Handle is of 65 cm length and working area has a length of 22 cm and breadth of 18 cm. Mostly operated by male labourers. Its average life is 5 yrs and costs Rs. 150/unit.

C) Harvesting tools

1) Sickle : Used in harvesting most of the crops like cereals, pulses and millets, pulses and millets. Sickle was designed ‘C’ shaped/ curved with the view to ease the harvesting operation. Hence, it is preferred more than other tools and implements. With the help of sickle the ear heads, branches or even whole plant could be harvested. Working area is made up of iron and handle is made up of wood of Acacia sp. Working area has 20 cm height and 3 cm width. Handle is of 15 cm height and 5 cm width. Operated by both male and female worker. Its average life is 5 yrs and costs Rs. 25 /unit.

2) Knife : It is very small and handy. Made up of iron was used in harvesting the pulses crop like black gram (Vigna mungo), green gram (Vigna radiate), horse gram (Macrotyloma uniflorum), Bengal gram (Cicer arietinum) and ear heads of millets like sorghum (Sorghum bicolor), cumbu (Pennisetum glacum), ragi (Eleusine coracana), etc. Working area has a curved surface of 8 cm and handle has a length of 5 cm. Operated both by male and female labourers. Its average life is 5 yrs and costs Rs. 10/ unit.

3) Tamarind Harvester : It is used in harvesting fruits like tamarind (Tamarindus indica), lemon (Citrus sp). amla (Phyllanthus emblica), etc. It consists of a wooden handle made of bamboo and a hook curved made of iron. Using this harvester, farmer can avoid climbing tree to harvest fruits. With the long wooden handle, without any drudgery, farmers can harvest the fruits easily. Length of bamboo stick is 200 cm and the working area is an iron knife having a curved surface of 10 cm. Mostly it is operated by both male and female labourers. Average life is 8 yrs and costs Rs. 30 / unit.

4) Lemon harvesting tool : Used for harvesting lemon (citrus sp) fruits and to collect the fallen fruits under the tree without thorn injury. The toll is made up of iron rod. Lemon harvesting tools consists of 3 parts is top one is hook, middle handle and lower cup like structure. Handle is a long iron rod of 10 cm to which hook and cup like structure are attached at the top and bottom end, respectively. Hook is a curved ‘C’ shaped structure of 10 cm attached to the hand at top most end facilitates harvesting of lemons from the trees. Cup like structure is of round in shape and has a diameter of 10 cm attached to the handle of the bottom end. Using hook harvesting of fruits at greater height in the trees could be possible and cup like structure help in collecting fallen lemon fruit underneath the trees safe without any thorn injuries. Both men and women operate it; its average life is 10 yrs and costs Rs. 125 / unit.

D) Post Harvest tools :

1) Grain separator: The tolls is used before winnowing horse gram (Macrotyloma uniflorum). After drying the plants are threshed with the help of tractors. After threshing, farmers with the help of kodun kol shake the plant materials forcibly so that the threshed materials and the grains are separated. Then the grains were collected from the ground and cleaned manually. The toll consists of long handle made up of wood attached with a single or double iron rod. Handle has a length of 200 cm and iron rod of length 10 cm. It helps in separating the threshed materials and grains making the winnowing operation easier. Also, farmers can handle this tool by standing straight without bending. Thus reduces drudgery. It is operated by both male and female labourers. Its average life is 20 yrs and costs Rs. 30 / units.

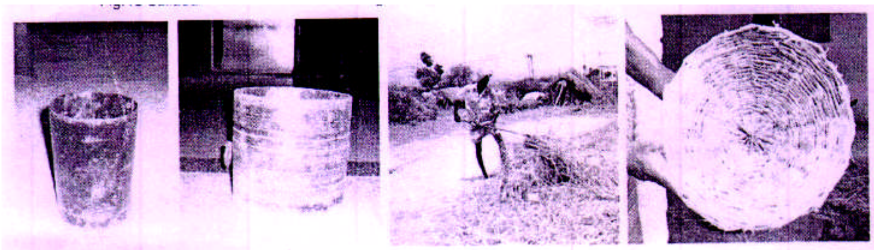
2) Wooden thresher : It is used for threshing operation in crops like black gram (Vigna mungo), green gram (Vigna radiate). horse gram (Macrotyloma uniflorum), etc. The tool, made up of wood has a handle of length 20 cm and flat rectangular working board of 20 cm length and 12 cm breadth. Wooden thresher cases the manual threshing operation. Both male and female labourers operate it. Average life is one yr and costs Rs. 15/ unit.

3) Stone roller : Stone roller is used in threshing of pulse crops like green gram (Vigna radiate), horse gram (Macrotyloma uniglorum) and black gram (Vigna mungo) and cereals and millets etc. It is a circular roller of length 95 cm and diameter of 30 cm. Threshing with stone roller is quicker and effective compared to manual threshing. Usually operated by male labour the average life is 20 yrs and costs Rs. 100/unit.

4) Bamboo winnower : It is used in cleaning and winnowing pulse grains. Highly preferred for its shape and varied utilities in crops such as pulses, cereals, millets and oilseeds. It is made up of bamboo stick is coated with cow dung paste to fill up the holes/ gaps. It is 'U' shaped and has a length, breadth and depth 35 cm $\times$ 25 cm $\times$ 3 cm. Operated generally by household women. Its average life is 2 yrs and costs Rs. 20 / unit.

5) Pulse siever : The tool is used for separating the unstilted full grains from the splitted pulse grains. Also removes stones and other wastes. It is made of iron. Working base area has 40 cm diameter and height 8 cm. The base has numerous rectangular grids of 0.3 mm diameter. Usually household women operate the tool leisurely. Its average life period is 10 yrs and costs about Rs 50/- unit.

6) Stone grinder : The tool being both cheaper and effective in grinding makes it preferable in rural areas. It is used for milling all kinds of cereals. Also used in crushing leaves during the preparation of leaf formulations and grinding rice (Oryza sativa), cotton seeds (Gossypium sp), etc. is made up of stone. It has a height of 140 cm and the diameter of working area is 15 cm. Usually operated by household women its average life is 10 years and costs Rs. 100/unit.



7) Milling tool: It is used for the process of milling, leaf extract preparation etc. Handle is made up of wood and working area is made up of iron. It has a length of 150 cm and diameter of 15 cm. Mostly women labourers operate it; its average life is 10 yrs and costs Rs. 200/ unit.

E) Measuring tools:

1) Pukka : It is made up of iron and used for measuring the grains of cereals, pulses and oilseed. It can measure a weight up to $1^{1/2}$ kg. It has a length of 18 cm and diameter of 16 cm. Both men and women operate it.

2) Marakaal : It is made up of iron used for measuring the grains of cereals, pulses and oilseeds. It can measure a weight of 4 kg. It has a length of 30 cm and diameter of 28 cm. Both male and women operate it. Average life is 20 yrs and costs Rs. 100/unit.

3) Naali : It is made up of iron and used for measuring the grains of cereals, pulses and oilseed. It can measure a weight of 1 kg. It has a length of 15 cm and diameter of 10 cm. Both male and women operate it. Average life is 20 yrs and costs Rs. 35/unit. Easy to measure grains without taking the help of weight units and can be handled easily.

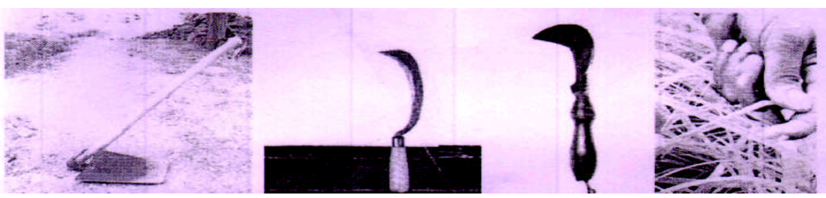
F) Other Tools:

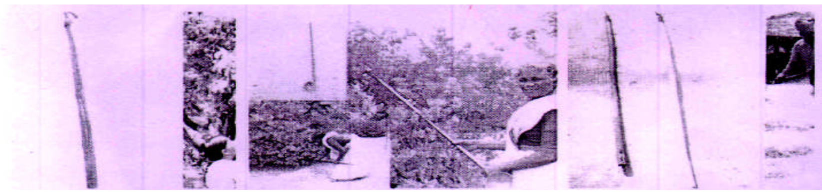
1) Floor cleaner : Easy in the separation of grains from plant materials and cleaning works in threshing floor. The tool is made up and used for cleaning the threshing floor. After the threshing operation in crops like horse gram, the plant parts are removed with the help of the floor cleaner leaving the grains alone in the floor. This tool has a long handle and comb like base to ease the separation of plant materials after threshing. Length of handle is 200 cm and the base comb like structure has 30 cm height and 20 cm width. Operated mostly by male labourers, its average life is 10 yrs and costs Rs. 140/unit.

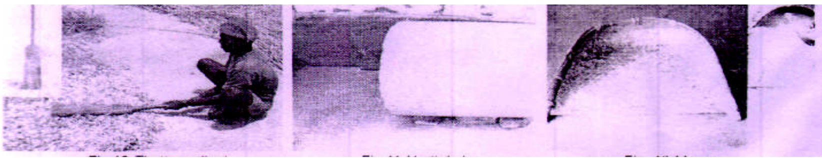
2) Bamboo Pan : It is made up of bamboo stick and used for the collection of plant products and broadcasting of seeds. It has a depth of 12 cm and diameter of 25 cm. Both men and women operate it. Handling and transportation of FYM and grains are made easier and quicker with help of the tool. Average life is 1-2 yrs and costs Rs. 25/ Unit

Summary:

Indigenous tools and implements are considered successful because these are economical, feasible and sustainable. It can spread quickly and easily from one region to another. Even these tools are common in use generally un-preferred since they lower the efficiency and increase tiredness of the operator. By using the modern wisdom, these traditional implements needed to be standardized keeping in mind the economy of rural poor. Proper designing in accordance with the farmers requirements surely popularize these tool and implements in near future.







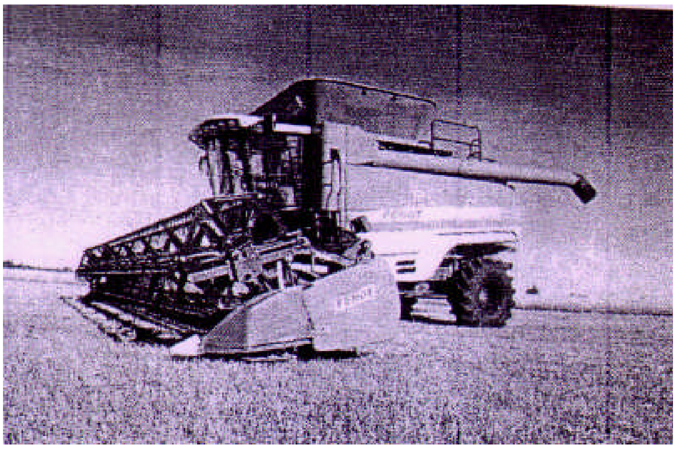
8.3 MODERN TOOLS AND EQUIPMENTS

The machines are elements that are used to direct the action of forces based energy work, for his part in the agricultural, motor mechanisms used in this work lighten the production and improve farming techniques. Among the most widely used agricultural machines working in the fields mentioned :

1) Tractor: is a very useful agricultural machine with wheels or designed to move easily on the ground and pulling power enabling successful agricultural work, even in flooded fields. It has two brake pedals and is preparing to pull sledges. There are two types of tractors: the track of stability and strength, and wheels, able to travel to by road, has a higher speed than the track.

2) Walking Tractor: agricultural machine is a single axle and is operated by handles, have median motor power and strength led to horticultural and ornamental work, can work in strong fields, but is preferably used in construction of gardens.

3) Combine: or mower is a powerful engine agricultural machine, comb cutter to cut plants mature grain and a long rake that goes before the machine and rotates about a horizontal axis.



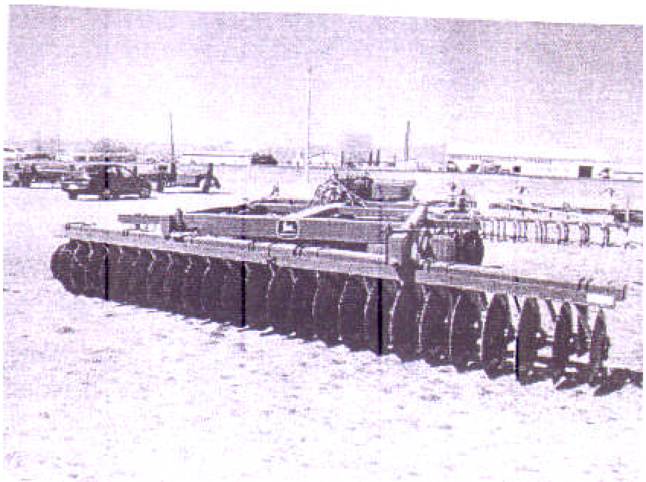
AGRICULTURAL EQUIPMENT

Farm equipment is a group of devices designed to open furrows in the ground, shredding, spraying and fertilizing the soil.

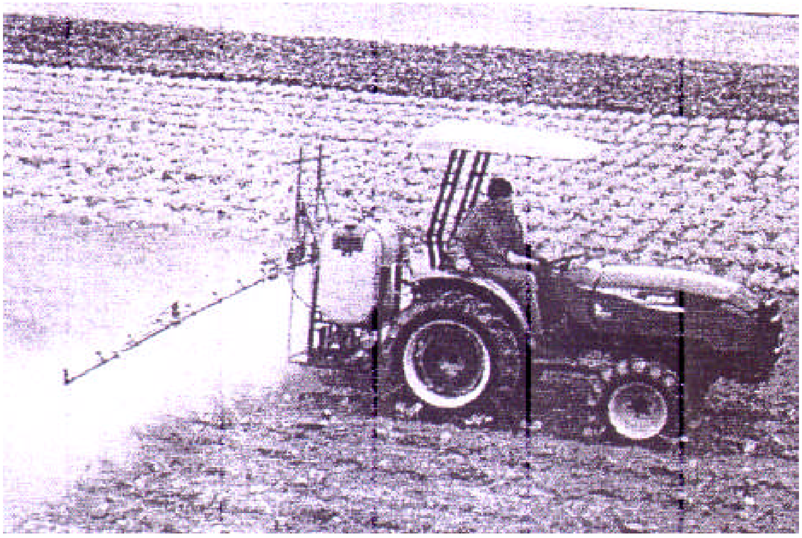
4) Plough: agricultural equipment is designed to open furrows in the earth consists of a blade, fence, plough, bead, bed, wheel and handlebar, which serve to cut and level the land, hold parts of the plough, set shot and to serve as handle. There are various types of ploughs but the best known are:

Mouldboard plough, formed by the grating blade and mouldboard disc plough, disc concave formed by deep grooves to open shallow ploughing to remove the topsoil. Subsoil plough to remove the soil depth.

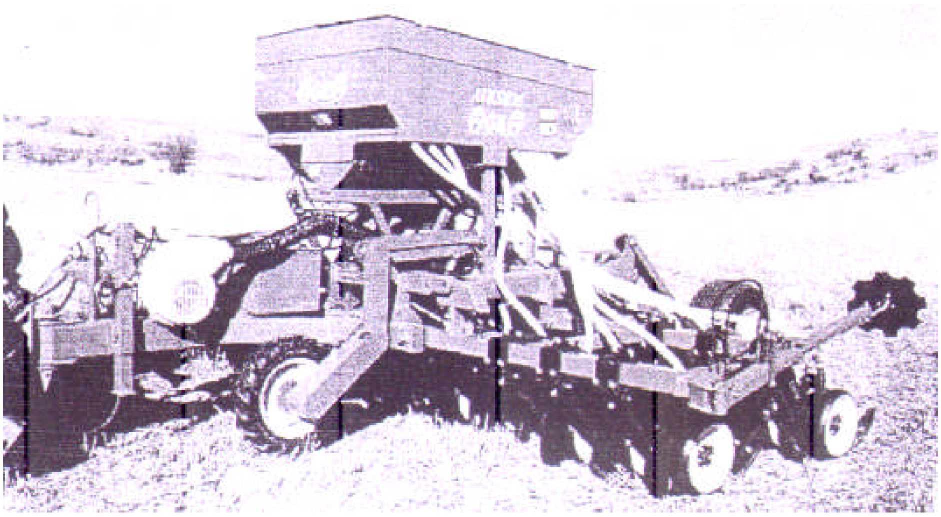
5) Drag: Agricultural equipment is designed to break up the parts and parcels of land that have been removed by the plough, are composed of a frame, which can be made of wood and metal teeth and the latch that attaches to tractor.



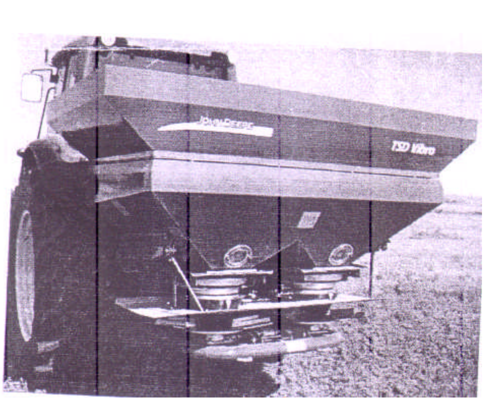
6) Sprayer: It is a farm equipment designed to spray, is composed of a liquid tank pressure pump. cap, mouth, tank and pressure valve, belts, hose faucet and nozzle where the liquid to spray out, is insecticide, fungicide or herbicide. The hand sprayer is placed in the back of the sprayer and this has placed in the mouth and nose a special mask to prevent strong odours dismissed by the substance that expels the sprayer will harm.



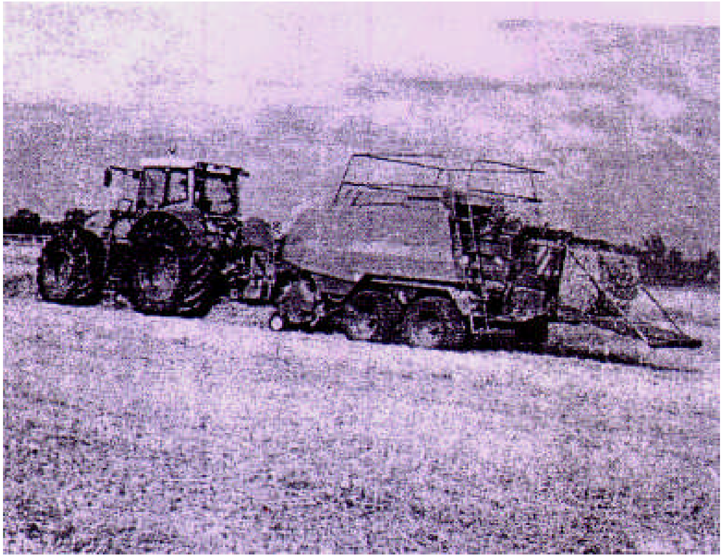
7) Tillage Planter: is a machine to place the seeds on the seedbed without prior tillage.



8) Fertilizer: agricultural equipment is designed to distribute fertilizer is composed of three main parts: the hopper of storage of fertilizer, the drop tube of fertilizer and fertilizer distributor.



9) Packing: agricultural equipment is designed for packing cereal straw or other baled forage grasses (also called bales or alpacas).



METHODOLOGY:

The methodology used will be active, participatory, with the use of simulations and case studies to facilitate the subsequent transfer of learning. The method used is inductive, based on knowledge and experience of the attendees. At the same time use focus groups.

8.4 EXERCISE

1) Explain the various traditional tools & equipments used for agriculture.

2) Describe the various modern tools & equipments and states its uses.

3) Explain the importance of agricultural tools and equipments for agriculture.

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9

IRRIGATION

Unit Structure :

9.0 OBJECTIVES

1) To study the various sources of irrigation.
2) To understand the importance of irrigation for agriculture.
3) To study the various methods of irrigation.
4) To study the advantages and disadvantages of drip and sprinkle irrigation.

9.1 INTRODUCTION

A hundred and fifty years ago, about 1850, two or three million acres of land were irrigated by large numbers of indigenous irrigation works. These works were in the nature of small tanks in southern India, inundation canals in northern India and reconditioned canals like the Cauvery delta system in Madras and the Yamuna canals. About five million acres were under well irrigation at that time mostly in northern India. The first major irrigation work constructed in India was The Ganga Canal in Uttar Pradesh, opened for irrigation in 1854. This was followed by the Upper Bari Doab canal in the Punjab and the Godavari delta system and the Krishna delta system in Madras. Then came the Sirhind canal in the Punjab, the Lower Ganga and the Agra canals in Uttar Pradesh and the mutha canals in Bombay, the last named being from a storage reservoir. A number of other large irrigation works were constructed towards the end of the last and beginning of the present century and again after the end of the First World War.

Subsoil waters have been used in India for irrigation from time immemorial by means of ordinary percolation wells. During recent years, electrically driven tube wells have opened up a new method of utilizing ground-waters on an extensive scale. Tube well irrigation is generally more costly than irrigation by gravity canals from diversion projects. But for areas not otherwise commanded it is a useful means of irrigation in regions with good underground supplies.

9.2 SOURCES OF IRRIGATION

9.2.1 Canals:

Although canal irrigation was introduced on a large scale only during the last century, it has already become the principal source of irrigation in the country because of its cheapness and the ease and certainly with which water is supplied. The irrigation canals of northern India rank amongst the greatest and most beneficent triumphs of modern engineering in the whole world. The canals in India are of two types, viz.

i) Inundation Canals, which are drawn directly from the rivers without making any kind of barrage or dam at their head to regulate the flow of the river and the canal. Such canals are intended to use the excess water of rivers at the time of floods. When the flood subside, the level of the rivers falls below the level of the canal heads and therefore, the canals dry up. The water supply of such canals is uncertain. They have, therefore, been converted into perennial canals.

ii) Perennial Canals are those which are constructed by putting some form of barrage across the river which flows throughout the year and diverting its water by means of a canal to the agricultural fields, both far and near. Most of the canals in India are of this type.

About half of India's net canal irrigated area lies in Uttar Pradesh, Punjab, Haryana and Andhra Pradesh, Bengal, Tamil Nadu, Bihar, Rajasthan, Madhya Pradesh, Karnataka, Assam, Maharashtra, Orissa, Jammu and Kashmir and Gujarat. In that order of importance account for most of the remaining about half.

9.2.2 Wells:

Wells provide the most widely distributed source of irrigation in India. A well is a device by means of which water is obtained from the subsoil. Well irrigation is of importance in: (i) that part of the Ganga valley which is in close proximity to the north-east and eastern extension of the Deccan, such as, the eastern districts of U.P. particularly Gonda, Basti, Bahraich, Faizabad, etc. (ii) In Bihar well irrigation is in vogue in Shahabad, Gaya, Patna, Saran etc. districts, as these areas lie beyond the command of canals, (iii) Submontane regions on the eastern and southern sides of the Western Ghats, particularly in Kolhapur, Solapur, Ahmednagar and Poona districts in Maharashtra, and in eastern part of Nilgiri and Cardamom hills, especially in Ramanathapuram, Madurai, Coimbatore and areas between Tiruchirapalli and Guntur. (iv) Region of black cotton soil especially where it is deep as in the Malwa tract of M.P. (v) In the valleys of Narmada and Tapti rivers. In other words, this method of irrigation is mostly used in the alluvial plains where soft nature of the soil helps in easy digging of wells. Some or the other type of lift is always required for using the well- water for irrigation whereas old methods like mot and reht are still practised widely in many areas, power driven pumps have become exceedingly popular in most parts.

9.2.3 Tube Wells:

Tube wells are common in areas where the water table is rather deep, say, over 15 metres. The sub-soil water is exploited through deep well pumping. Indo-Gangetic valley and in certain coastal deltaic areas tube well is common.

(1) The flow of water in the subsoil is adequate to meet the surface demand, thus ensuring a stable water table. (2) The depth of the water table below the ground does not ordinarily exceed 50 ft. (3) For lifting the water cheap power/ electricity is available over the tract which economises and popularises lifting operations. (4) The area should be in alluvial formations where water-bearing strata are found at various depths. (5) The soil should be of good quality so that high costs involved in the operation of tube well are compensated.

Area of Tube Well Irrigation:

Tube wells are usually been constructed in the Ganges plain, where a large basin with sufficient underground water supply with facilities of replenishment due to heavy rainfall in the Terai, exist. The water in this basin occurs as a continuous reservoir which is connected with the strata below the Terai.

Here tube wells have been developed both on the north having the depth of 90 to 150 metres and south of Ghagra. The States like Punjab, Haryana, Bihar and Gujarat have number of tube wells in different location.

These are also very popular source of irrigation in the alluvial plains of north India where groundwater is plentiful and construction of wells and tube wells easy. These sources predominate in Gujarat (78.4 per cent of net irrigated area), Uttar Pradesh (70.5 per cent), Goa (69.6 per cent), Rajasthan (67.9 per cent), Punjab (61.3 per cent) and Maharashtra (61.2 per cent). In Madhya Pradesh, Bihar, Haryana, Tamil Nadu and Orissa, wells and tube wells provides water to 40 to 55 per cent of net irrigated area.

9.2.4 Tank Irrigation:

Tank irrigation is the most feasible and widely practised method of irrigation all over the Peninsula, where most of the tanks are small in size and built by individuals or groups of farmers by raising bunds across seasonal streams.

In West Bengal, Orissa and Bihar tanks are mostly of excavated type and used also for raising fish besides irrigation. The drawbacks include high rate of evaporation and occupation of fertile land particularly as the depth of most of the tanks is shallow and the water spreads over a large area. Most of the tanks are non-perennial and supply water only for one crop in the year.

Areas of Irrigation:

Tanks irrigation is mostly practised in peninsular India including run on Maharashtra and Gujarat. Tanks are a special feature of the Deccan because: (i) The rivers of the Deccan are not snow-fed and they are not solely dependent upon the rain waters, (ii) There are many streams which become torrential during the rainy season but dry up in the season when the rain ceases, (iii) The undulating character of the region together with a rocky bed makes the construction prohibitive, (iv) Moreover, as the hard rock do not suck up water, we cannot dug wells. But the tanks can be easily made by means of making dams in hollow spaces in which rain-water is stored in large quantities for distribution in dry season, (v) Lastly, the scattered population of the tract also favours the system of tank irrigation to save rain-water which could have ultimately flowed to ocean.

Tank irrigation has reached its highest perfection in south, especially in Andhra Pradesh and Tamil Nadu. State of West Bengal and Rajasthan too have some irrigation tanks, particularly in their southern and south-eastern regions respectively. Punjab, UP, Bihar have also some tanks.

Significance of tanks as source of irrigation has declined and now only 6.1 per cent of net irrigated crops get water from tanks. It is easier to construct tanks in the undulating peninsular India. Tank irrigation is, therefore, confined to the southern States. Largest net irrigated area by tanks is 503 thousand hectares in Tamil Nadu according to 2009-10 data. Tank irrigation is also important in Orissa, Maharashtra, Karnataka, Kerala and West Bengal.

9.3 IMPORTANCE OF IRRIGATION

Irrigation:

Water along with HYV seeds and fertilizer forms a significant input to raise agricultural production. Thus availability of water is possible either from rain of surface flow or below ground. In India, availability of irrigation is highly scanty and more than 70 per cent of agriculture is depend on rainfall is confined to very few months i.e. June to September. Moreover, rainfall in most parts of country is very low. Where, it is high, the available soil moisture is not adequate to support multiple cropping. Hence, there is an urgent need for providing assured supplies of irrigation.

Importance of Irrigation:

The role of irrigation can be assessed from the following points.

1) To Reduce the Dependence on Rainfall:

As it is known that Indian Agriculture is the gamble of monsoon and more than 70% of the cropped area depends on rainfall. Morever, i.e. June to September while the other months remain dry, sometimes rainfall is delayed and sometimes it is prematured. In 60th cases, it is harmful. Therefore, proper irrigation facilities can help in solving the problem created by insufficient, uncertain and irregular rains.

2) To Raise Land Productivity: Assured water supply to land through irrigation makes possible to raise the land productivity. Besides, this method has a special significance as Indian modes of production are primitive and outdated with low yield per hectare. Sufficient water supply enable the application of other modern inputs like chemical fertilizer, high yielding varieties of seeds, etc.

3) To help correcting imbalance : The rainfall in our country is not properly organised resulting uneven distribution at different places. In fact, Indias climate geography is governed by its location in the tropical and subtropical zones while others are dry areas. This disparities can only be narrowed down by artificial means of irrigation.

4) Modernization of Agriculture: A traditional agriculture of India with assured water supply can go a long way to practice intensive agriculture. Such a change in farming techniques will help to impart stability to their work. As a result, outlook of the farmer will change and agriculture will be no longer be a gamble of rains.

5) Multiple Cropping Possible: Assured irrigation facilities makes possible to grow more than one crop in year in most parts of the country. Since India has a tropical and sub-tropical climate, it possesses more potentialities to grow more crops but due to irregular and uncertain condition of rainfall, it is not possible. Thus, irrigation ensures multiple cropping and further increasing at agricultural production.

6) Help to small Farmers: In our country, small and marginal farmers constitute big majority. They are dependent on agriculture sector for their livelihood. They can be helped if they are provided adequate assured water supply. They will raise their farm income.

7) To Release Land for Non-Crop use: Assured supply of irrigation would rise the production which in turn, imply lesser use of land. This would make available more land than present for such purpose like animal husbandry, forestry and horticulture.

8) To Avoid Imports of Food stuffs: In India, growing population demand food stuff for its consumption. In the absence of food grains, imports are to be made. That means, import of foodgrains makes the balance of payment unfavourable. To curb imports self-sufficiency in food stuff is highly needed. This can be achieved by raising agricultural production through increasing irrigation facilities.

9) To get Better Fruits of New Agricultural strategy:

The successful implementation of HYV programmes largely depends on timely availability of water supply. Besides, crops like rice, sugarcane and jute, etc. require regular and sufficient water supply.

Accordingly, irrigation is an important factor responsible for increase in rural employment also. This further adds to the importance of irritation as an agricultural inputs.

In overall economic development the agricultural sector will continue to play a vital role, since the sector still accounts for about 30 per cent of the GDP and almost two-thirds of the population still depend on this sector for livelihood. To accelerate GDP growth rate, a long term trend growth rate 3% in Indian agriculture should be desirable goal. To achieve it, a number of key problems in the agricultural sector will need to be resolved.

The declining trend in the rate of investment in agriculture in the recent years need to be reserved. Specific provisions are required for operations and maintenance of public capital assets. Public investment in irrigation, rural communication and schemes for prevention and control of land and water degradation will need to be increased. The resources for this purpose can be augmented only by scaling down the massive subsidies provided for water, electricity and fertilizer. To encourage, private investment in agriculture, thrust of reform policies should continue to improve relative incentives in favour of agriculture.

For raising rainfed / dry land crop yields more emphasis is required for the use of location specific varieties suited to such agro-climatic conditions. Progress of integrated watershed process development projects for promotion of water conservation and diversified production system need to be closely monitored. Arable land is shrinking due to continuous soil erosion. Land water conservation technologies need to be vigorously pursued to raise productivity in marginal land rented land holdings.

The seed revolution, which appears to have tapered off after encompassing only the cereal segment, has pulses, oil seeds, vegetables and fruits. This is especially important in the view of the rise in average income levels having pushed up demands for non-cereal food items. The marked seasonality in these commodities (fruits, vegetables, oils) needs to be moderated to ensure pressures. A pre-requisite for successful development of this sector is provision of adequate and more modern storage and warehousing facilities. Further more, investment and induction of new technology in the agro processing section requires to be accelerated.

The present system of agricultural credits needs to be substantially improved. To ensure adequate availability of funds of small and poor farmers, the high cost of intermediation will need to be moderated.

Emerging new post harvest technologies for agricultural products will require and improve data base for important tree crops, especially in view of their enhanced export potential. While tariff, trade and exchange rate reforms have strengthened incentives for agricultural exports. There are still many regulations in habiting exports of agricultural products, which need to be phased out. Appropriate policy for investment in technological upgradation for food processing merits a high priority.

9.4 DIFFERENT TYPES OF IRRIGATION METHODS

Agriculture is the nerve of any country as it is needed for survival of living beings. For growing crops, irrigation is major process. Irrigation is described as the artificial application of water to the land or soil. It is the substitute or supplement of rainwater with another source of water. It is used in dry areas and during periods of insufficient rainfall. It is considered as basic infrastructure and vital input required for agricultural production. Major aim of irrigation systems is to help out in the growing of agricultural crops and vegetation by maintaining with the minimum amount of water required.

9.4.1 Type of Irrigation Technique in India :

In India, the irrigated area consists of about 36 per cent of the net sown area. There are various techniques of irrigation practices in different parts of India. These methods of irrigation differ in how the water obtained from the source is distributed within the field. In general, the goal of irrigation is to supply the entire field homogeneously with water, so that each plant has the amount of water it needs, neither too much nor too little. Irrigation in India is done through wells, tanks, canals, perennial canal and multipurpose river valley projects.

1) Surface Irrigation:

In this technique water flows and spreads over the surface of the land. Varied quantities of water are allowed on the fields at different times. Therefore, flow of water under surface irrigation comes under wobbly flow. Consequently, it is very difficult to understand the hydraulics of surface irrigation. However, suitable and efficient surface irrigation system can be espoused after taking into consideration different factors which are involved in the hydraulics of surface irrigation.

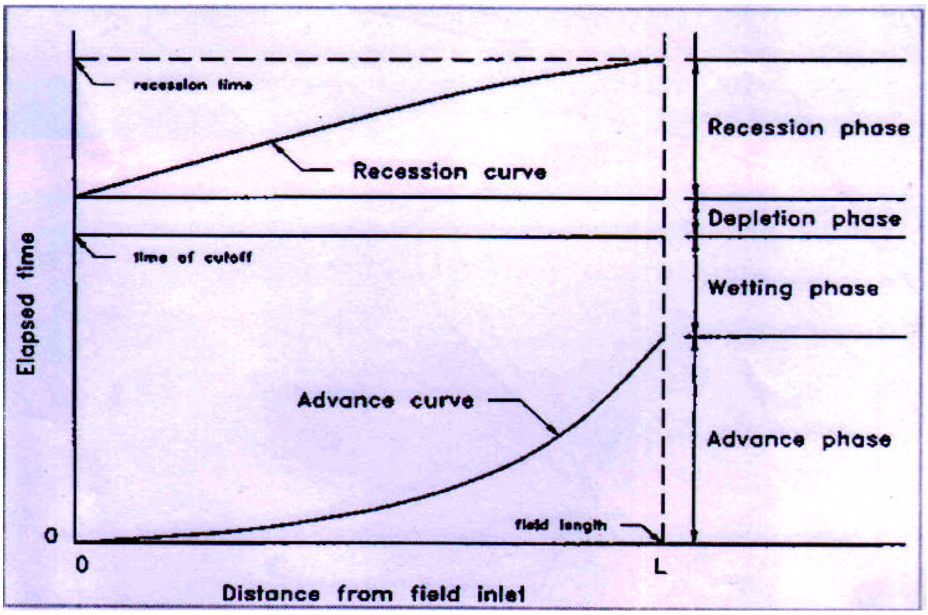
1. Surface slope of the field
2. Roughness of the field surface
3. Depth of water to be applied
4. Length of run and time required
5. Size and shape of water-course
6. Discharge of the water-course
7. Field resistance to erosion

If the surface irrigation method is perfectly selected, it fulfils following requirements :

1. It assists in storing required amount of water in the root-zone-depth.
2. It reduces the wastage of irrigation water from the field in the form of run-off water.
3. It reduces the soil erosion to minimum.
4. It helps applying uniform application of water to the fields.
5. Amount of manual labour required is less.
6. It is suitable to the size of the field and at the same time it uses minimum land for making ditches, furrows, strips, etc.
7. It does not avert use of machinery for land preparation, cultivation, harvesting.

Surface irrigation technique is broadly classified as basin irrigation, border irrigation, furrow irrigation and uncontrolled flooding.

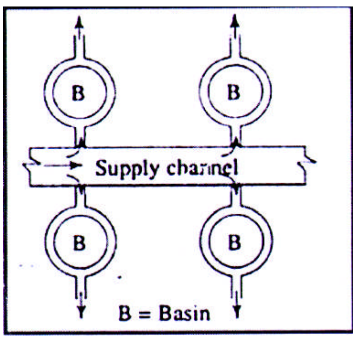
Phases of surface irrigation:



This divided into the four component systems: (1) water supply, (2) water conveyance or delivery, (3) water use and (4) drainage.

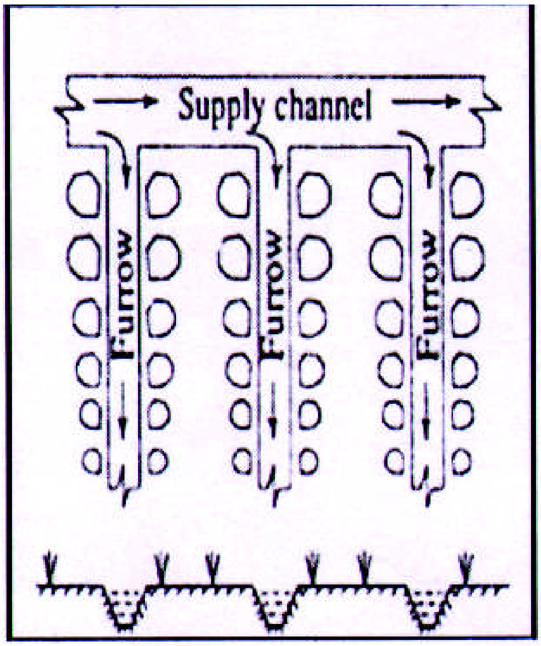
2) Basin irrigation: Basin irrigation is common practice of surface irrigation. This method is employed for watering orchards (Basak, 1999). It is useful especially in regions with layouts of small fields (Shah et al. 2002). If a field is level in all directions, is encompassed by a dyke to prevent runoff, and provides an undirected flow of water onto the field, it is herein called a basin. A basin is typically square in shape but exists in all sorts of irregular and rectangular configurations. It may be furrowed or ridged, have raised beds for the benefit of certain crops, but as long as the inflow is undirected and uncontrolled into these field modifications it remains a basin.

Basin Method (Source: Basak, 1999)



3) Furrow Irrigation: In furrow irrigation technique, trenches or 'furrows' are dug between crop rows in a field. Farmers flow water down the furrows (often using only gravity) and it seeps vertically and horizontally to refill the soil reservoir. Flow to each furrow is individually controlled. Furrow irrigation is suitable for row crops, tree crops and, because water does not directly contact the plants, crops that would be damaged by direct inundation by water such as tomatoes, vegetables, potatoes and beans. It is one of the oldest system of irrigation. It is economical and low-tech making it particularly attractive in the developing world or places where mechanized spray irrigation is unavailable or impractical.

Furrow technique :



In different situations, different furrow methods are used. They are mainly of five types:

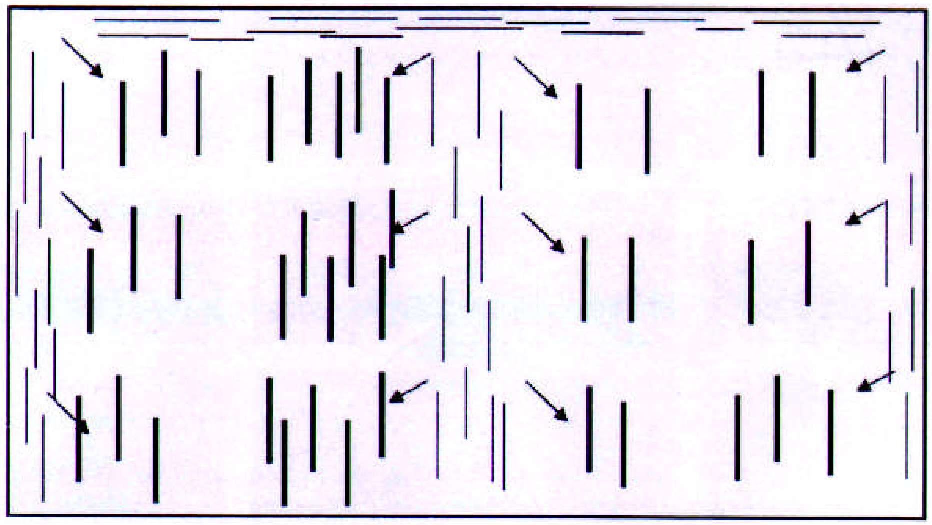
1. Sloppy Furrow
2. Levelled Furrow
3. Contour Furrow
4. Serial Furrow
5. Corrugated Furrow

There are numerous advantages of furrow technique of irrigation.

1. Large areas can be irrigated at a time.
2. It saves labour since once the furrow is filled, it is not necessary to give water a second time.
3. It is a reasonably cheaper method.
4. Plants get proper quantity of water by this system.

Furrow irrigation is also beneficial for growing of tree crops. In the early stages of tree planting, one furrow alongside the tree row may be sufficient, but as the trees develop then two or more furrows can be constructed to provide sufficient water. Sometimes a special zig-zag system is used to improve the spread of water.

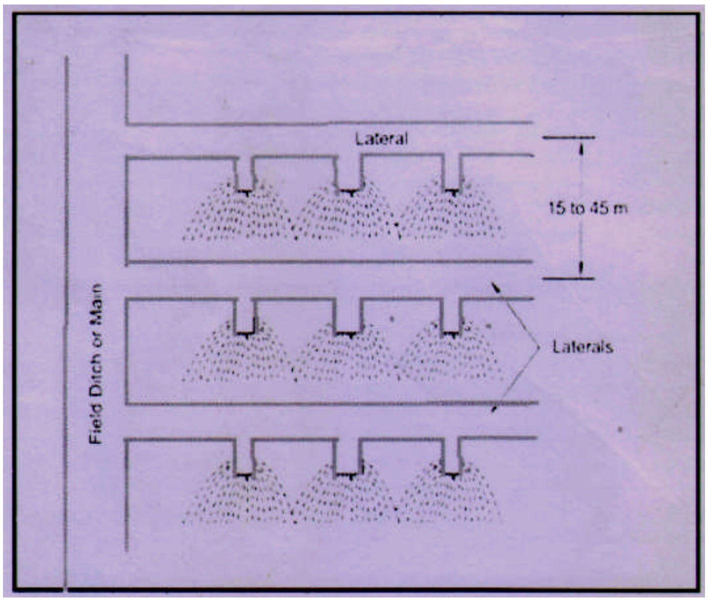
Major drawback of furrow system of irrigation is ensuring uniform dispersal of water over a given field. To tackle this problem, some farmers engage in field levelling to remove any small hills that would have been bypassed by the gravity flow of the water. Other problem with furrow irrigation is the increased potential for water loss due to run-off. Building retention ponds along the edges of fields can help capture this run-off, allowing it to be pumped back to the upslope side of the field for use in further irrigation cycles.



4) Uncontrolled flooding: There are many cases where croplands are irrigated without regard to efficiency or consistency. These are usually situations where the value of the crop is very small or the field is used for grazing or recreation purposes. Small land holdings are generally not subject to the range of surface irrigation practices of the large industrial farming systems. The assessment methods can be applied if desired, but the design techniques are not generally applicable nor need they be since the irrigation practices tend to be minimally managed.

5) Free Flooding: This flooding system of irrigation is used from ancient times. Flooding method consists in applying the water by flooding the land of rather smooth and flat topography. In current irrigation practice, several flooding methods have been developed. In free flooding method, water is applied to the land from field ditches without any check or guidance to the flow. The land is divided into plots of suitable size depending on porosity of soil. Water is spread over the field from watercourse. The irrigation operation begins at the higher area and proceeds towards the lower levels. The flow is stopped when the lower end of the field has received the desired depth of water. The field watercourse is properly spaced, the spacing depends on the topography, oil texture, depth of soil and size of stream.

Free Flooding for erodible soil:



This technique is beneficial for newly established farms where making furrows is very expensive. This method is economical and can be effectively used where water supply is in plenty. This method is suitable for the fields with irregular surface in which other techniques are difficult to apply. Major drawback of this method is that there is no perfect control over the flow of water to attain high efficiency. Sometimes the flow of water over the soil is too rapid to fulfil soil moisture deficiency. On the other hand, sometimes water is retained on the field for a very long time and consequently the water is lost in infiltration or deep percolation.

6) Border Strip Method:

In this technique of irrigation, a field is divided into number of strips. The width of strip varies from 10 to 15 metres and length varies from 90 m to 400 m. Strips are separated by low embankments or levees. The water is diverted from the field channel into the strips. The water flows gradually towards lower end, wetting the soil as it advances. The surface between two embankments should essentially be level. It assists in covering the entire width of the strip. There is a general surface slope from opening to the lower end. The surface slope from 2 to 4 m/1000 m is best suited. When the slope is steeper, special arrangement is made to prevent erosion of soil.

7) Drip irrigation:

In the area of irrigation process, drip irrigation is modern technique. It is also called trickle irrigation, which was originally developed in Israel in the early 1960s and became popular in areas of water scarcity. The drip irrigation is the most competent and it can be practised in array of crops, especially in vegetables, orchard crops, flowers and plantation crops (Mamata Swain, 1999),

Drip irrigation was used to the ancient custom in certain parts of India of irrigating a tulsi plant kept in the courtyard. During the summer months, the plant was irrigated by a hanging pitcher containing water and a minute hole at its bottom to allow the trickling of water on to the plant. The tribal farmers of Arunachal Pradesh practised a primitive form of drip irrigation system using a slender bamboo as the conduit for water flow. The use of drippers in sub-surface irrigation network was first experimented in Germany in 1869. The noticeable growth of the petrochemical industry during and after the 1950s aided manufacturing of plastic pipes at a cost much cheaper than the cost of metallic or cement concrete pipes. Plastic pipes are convenient for water conveyance under pressure and the plastic material are easily formed into the desired configuration. These features of plastic made the field-scale use of drip irrigation practicable. The drip system was developed for field crops in Israel in the early 1960s and in Australia and North America in the late 1960s. The area under drip irrigation system in the USA is about 1 M ha, followed by India, Spain and Israel. In India, there has been a tremendous growth in the area under drip irrigation during the last 15 years. At present, around 3.5 Lakh ha area is under drip irrigation with the efforts of the Government of India, while it was only 40 ha in 1960. Maharashtra (94,000 ha), Karnataka (66,000 ha) and Tamil Nadu (55,000 ha) are some of the States where large areas have been brought under drip irrigation. Many crops are irrigated by the drip method in India with the tree crops occupying the maximum percentage of the total area under drip irrigation, followed by vine crops, vegetables, field crops, flowers and other crops.

In drip irrigation, water is applied near the plant root through emitters or drippers, on or below the soil surface. The soil moisture is kept at an optimum level with frequent irrigations. In this method irrigation water is conveyed on the surface in 12 to 16 mm diameter tubing's fed from large feeder pipes. The water is allowed to drip or trickle slowly through the nozzle or orifices at practically zero pressure. In this way the soil in the root-zone of crops is constantly kept wet. Drip irrigation results in a very high water application efficiency of about 90-95 per cent.

7.1 Major component of drip irrigation:

1. Pump station
2. By pass assembly
3. Control valves
4. Filtration system
5. Fertilizer tank/venturi
6. Pressure gauge
7. Mains/Sub mains
8. Laterals
9. Emitting devices
10. Micro tubes.

Pump station takes water from the source and provides the right pressure for delivery into the pipe system.

Control valves control the discharge and pressure in the entire system.

Filtration system cleans the water. Common types of filter include screen filters and graded sand filters which remove fine material suspended in the water.

Fertilizer tank / venturi slowly add a measured dose of fertilizer into the water during irrigation. This is one of the major advantages of drip irrigation over other methods.

Mainlines, submains and laterals supply water from the control head into the fields. They are usually made from PVC or polyethylene hose and should be buried below ground because they easily degrade when exposed to direct solar radiation. Lateral pipes are usually 13-32 mm diameter.

Emitters or drippers are devices used to control the discharge of water from the lateral to the plants. They are typically spaced more than 1 metre apart with one or more emitters used for a single plant such as a tree. For row crops more closely spaced emitters may be used to wet a strip of soil. Many different emitter designs have been produced in recent years. The basis of design is to produce an emitter which will provide a specified constant discharge which does not vary much with pressure changes and does not block easily.

In India, there has been a fabulous growth in the area under drip irrigation during the last many years. At present, major area is under drip irrigation with the help of the Government of India. Reports indicated that Maharashtra (94,000 ha), Karnataka (66,000 ha) and Tamil Nadu (55,000 ha) are some of the States where large areas have been brought under drip irrigation. Many crops are irrigated by the drip method in India with the tree crops occupying the maximum percentage of the total area under drip irrigation, followed by vine crops, vegetables, field crops, flowers and other crops.

7.2 The advantages of drip irrigation are under:

1. Possibility of using soluble fertilizers and chemicals.
2. Fertilizer and nutrient loss is minimized due to localized application and reduced leaching.
3. Water application efficiency is high.
4. Field levelling is not necessary. Fields with irregular shapes are easily accommodated.
5. Recycled non-potable water can be safely used.
6. Role in frequency of irrigation.
7. Soil erosion is lessened.
8. Weed growth is lessened.
9. Water distribution is highly uniform, controlled by output of each nozzle.
10. Labour cost is less than other irrigation methods.
11. Variation in supply can be regulated by regulating the valves and drippers.
12. Plants remains dry, reducing the risk of disease.
13. Usually operated at lower pressure than other types of pressurised irrigation, reducing energy costs.

7.3 The shortcomings of drip irrigation are:

1. Initial cost can be more in this technique.
2. The sunrays can affect the tubes used for drip irrigation, shortening their usable life.
3. If the water is not properly filtered and the equipment not suitably maintained, it can result in blockage.
4. For subsurface drip the irrigator cannot see the water that is applied. This may lead to the farmer either applying too much water (low efficiency) or an insufficient amount of water, this is particularly common for those with less experience with drip irrigation.
5. Drip irrigation might be inadequate if herbicides or top dressed fertilizers need sprinkler irrigation for activation.

6. Drip tape causes extra clean-up costs after harvest. Users need to plan for drip tape winding, disposal, recycling or reuse.

7. Waste of water, time and harvest, if not installed properly. These systems require careful study of all the relevant factors like land topography, soil, water, crop and agro-climatic conditions and suitability of drip irrigation system and its components.

8. In lighter soils subsurface, drip may be unable to wet the soil surface for germination. Requires careful consideration of the installation depth.

One of the main purposes of drip irrigation is to decrease the water consumption by reducing the leaching factor. However, when the available water is of high salinity or alkalinity, the field soil becomes gradually unsuitable for cultivation due to high salinity or poor infiltration of the soil. Consequently, drip irrigation converts fields into fallow lands when natural leaching by rain water is not adequate in semi-arid and arid regions.

Most drip systems are designed for high efficiency and have little or no leakage. Without sufficient leaching, salts applied with the irrigation water may build up in the root zone. On the other hand, drip irrigation avoids the high capillary potential of traditional surface-applied irrigation, which can draw salt deposits up from deposits below. Drip irrigation systems cannot be used for damage control by night frosts.

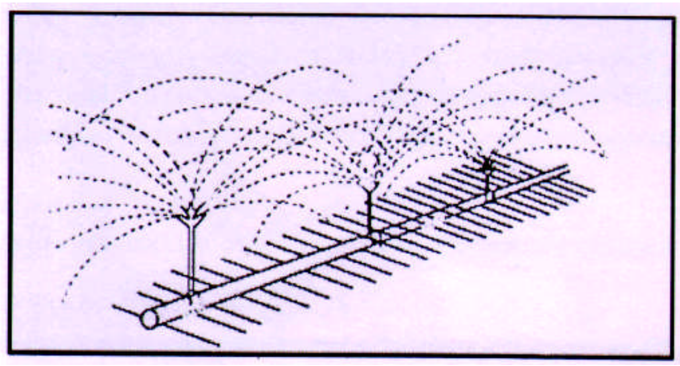
8) Sprinkler Irrigation:

In the sprinkler technique of irrigation, water is sprinkled into the air and allowed to fall on the ground surface just like rainfall. The spray is done by the flow of water under pressure through small orifices or nozzles. The pressure is generally obtained by pumping. Through proper selection of nozzle sizes, operating pressure and sprinkler spacing the amount of irrigation water required to refill the crop root zone can be applied almost uniform at the rate to suit the infiltration rate of soil. In agriculture, almost all crops are suitable for sprinkler irrigation system except crops such as paddy and jute. The dry crops, vegetables, flowering crops, orchards, plantation crops like tea, coffee are all suitable and can be irrigated through sprinklers techniques of irrigation.

The sprinkler irrigation is categorized according to the functions which are mentioned as under:

1. The main irrigation system
2. The supplementary irrigation system
3. The protective irrigation system

The sprinkler irrigation system is effective for irrigation on uneven lands and on shallow soils. It is also suitable to coarse sandy terrain where the percolation loss is more and where as a consequence, the frequency of irrigation required is more. The sprinkler irrigation system is appropriate in rising and falling land where land shaping is expensive or technically not practicable. The elimination of fertile soil cover by land shaping is not advisable. Sprinkler irrigation system can also be espoused in hilly regions where plantation crops are grown.



Historical facts signified that though sprinkler irrigation system is known since 1946, yet the farmers started adopting it in huge scale only since 1980s. It began in the hilly areas of Western Ghats in States of Kerala, Tamil Nadu and Karnataka and in the North eastern States mainly for plantation crops like coffee, tea, cardamom, rubber. Gradually it spreads to the water scarcity and light soil States of Rajasthan and Haryana in addition to the black soil area of Madhya Pradesh.

8.1 Advantages of Sprinkler irrigation

1) Elimination of the channels for conveyance, therefore no conveyance loss.
2) It is suitable to all types of soil apart from heavy clay.
3) It is appropriate technique for irrigating crops where the plant population per unit area is very high. It is most suitable for oil seeds and other cereal and vegetable crops.
4) It saves water.
5) With this technique of irrigation, there is control of water application convenient for giving light and frequent irrigation and higher water application efficiency.
6) Sprinkle irrigation increases in yield.
7) There is a mobility of system.
8) It may also be used for undulating area.

9) It saves land as no bunds are required.

10) This technique influences greater conducive micro-climate.

11) Areas located at a higher elevation than the source can be irrigated.

12) In this technique there is a possibility of using soluble fertilizers and chemicals.

13) In this method of irrigation there is less problem of clogging of sprinkler nozzles due to sediment laden water.

14) The overall cost of labour is generally reduced in this method of irrigation.

15) Erosion of soil cover which is common in surface irrigation can be reduced.

8.2 Disadvantages of Sprinkler system:

1. In this technique, initial cost of implementation is high.

2. High and constant energy requirement for operation.

3. Under high wind condition and high temperature distribution and application efficiency is poor.

4. Highly saline water causes leaf burning when temperature is higher than 95 F.

5. When lands have been already levelled and developed for surface or other irrigation methods sprinkler irrigation is not so economical.

6. There is loss of water due to evaporation from the area during irrigation.

9.5 EXERCISE

1) Explain the importance of irrigation in agricultural development.
2) Explain the various sources of irrigation and discuss various types of irrigation.
3) Explain briefly about methods of irrigation and state its advantages and disadvantages.
4) Explain the traditional methods of irrigation.
5) Write short note on -
    1) Disadvantages of sprinkler irrigation.

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10

REVIEW OF AGRICULTURAL POLICIES (PART-I & II)

Unit structure :

10.0 OBJECTIVES

1) To study the Indian Agricultural policy and its objective.
2) To understand the effects of agricultural policy on rural area.
3) To understand the concept of Green Revolution and its effect on weaker section.
4) To study the inter-relationship between Green Revolution and Rural Development.
5) To examine the problems in the spread of Green Revolution.

10.1 INTRODUCTION

Agriculture is a way of life, a tradition, which, for centuries, has shaped the thought, the outlook, the culture and the economic life of the people of India. Agriculture, therefore, is and will continue to be central to all strategies for planned socio-economic development of the country. Rapid growth of agriculture is essential not only to achieve self-reliance at national level but also for household food security and to bring about equity in distribution of income and wealth resulting in rapid reduction in poverty levels.

Indian agriculture has, since Independence, made rapid strides. In taking the annual foodgrains production from 51 million tonnes in early fifties to 206 million tonnes at the turn of the century, it has contributed significantly in achieving self-sufficiency in food and in avoiding food shortages.

Over 200 million Indian farmers and farm workers have been the backbone of India's agriculture. Despite having achieved national food security, the well-being of the farming community continues to be a matter of grave concern for planners and policy-makers. The establishment of an agrarian economy, which ensures food and nutrition to India's billion people, raw materials for its expanding industrial base and surpluses for exports and *a* fair and equitable reward system for the farming community for the services they provide to the society, will be the mainstay of reforms in the agriculture sector.

The National Policy on Agriculture seeks to actualise the vast untapped growth potential of Indian agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro business, create employment in rural areas, secure a fair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalisation.

10.2 INDIAN AGRICULTURAL POLICY

INDIAN AGRICULTURAL POLICY:

Indian agricultural policy has had the following main elements so far:

10.2.1 Technological measures : Initiation of measures to increase agricultural production substantially to meet growing needs of the population and also to provide a base for industrial development included steps to increase both extensive cultivation and intensive cultivation. For the former, irrigation facilities were provided to a large area on an increasing basis and area hitherto unfit for cultivation was made fit for cultivation. For the latter, new agricultural strategy was introduced in the form of a package programme in selected regions of the country in 1966. To sustain and extend this programme to larger and larger areas of the country, steps were initiated to increase the production of high-yielding varieties of seeds, fertilizers and pesticides within the economy and supplement domestic production by imports whenever necessary. As a result of these measures, agricultural production and productivity increased substantially. Foodgrains production which was merely 50.8 million tonnes in 1950-51 rose to 199.7 million tonnes in 1996-97 and stood at 192.4 million tonnes in 1997-98. Largest contribution came from wheat. Its production rose from 6.4 million tonnes in 1950-51 to 69.3 million tonnes in 1996-97. In 1997-98, the production of wheat stood at 65.9 million tonnes.

10.2.2 Land reforms : Land reform measures to abolish intermediary interests in land (viz., zamindars, jagirdars, etc.) and transfer of land to actual tiller of the soil were expected to be taken up on a priority basis. Measures taken under this head include 1: (7) Abolition of intermediaries; (n) Tenancy reforms to *(a)* regulate rents paid by tenants to landlords, *(b)* provide security of tenure to tenants, and (c) confer ownership rights on tenants; and *(Hi)* Imposition of ceilings on holdings in a bid to procure land for distribution among landless labourers and marginal farmers. These land reform measures were designed to eliminate the parasitic class of zamindars and absentee landlords and abolish all types of exploitation of the tenants at the hands of these people. Thus, the attempt was aimed at changing the entire agrarian structure of the rural areas.

10.2.3 Co-operation and consolidation of holdings : In a bid to reorganize agriculture and prevent subdivision and fragmentation holdings, the Indian agricultural policy introduced the programmes of co-operation and consolidation of holdings. The latter programme aimed at consolidating all plots of land owned by a particular farmer in different places of the village by sanctioning him land at one place equal in area (or value) to his plots of land. Consolidation avoids wastage of time, land and energy employed in cultivation and also enables fanners to practice scientific techniques of production. Co-operation aims at bringing small and marginal farmers together to reap the benefits of large-scale farming. Under co-operative farming small and marginal farmers pool their land and resources (or only resources) and practice joint cultivation.

10.2.4 Institutions involving people's participation in planning: Bringing small and marginal farmers together to cultivate jointly is only half of the story. No planning in any country can be successful unless the masses are encouraged to join hands with the planning authorities in a bid to carry out the plans and programmes framed for their uplift and betterment. It was precisely with this end in view that the programme of Community Development was initiated in 1952 in this country. It was aimed to be a project of the people, by the people and for the people, wherein the role of the government and administrative authorities was defined as 'to help the people to help themselves.' The experience of the Community Development programme reads a sad story. It could never become the people's programme and remained tied to the umbilical cord of government assistance. Another programme designed to encourage the participation of masses in the planning process (and political decision-making) was the programme of democratic decentralization, often known as Panchayati Raj. Its experience was no different from Community Development. In fact, it proved to be worse. It conferred power (howsoever limited) on local dadas and influential political elements to exploit masses to their advantage and indulge in all sorts of political bickering and corrupt practices.

10.2.5 Institutional credit : Another important measure was the expansion of institutional credit to farmers, especially through co-operatives and commercial banks. After nationalization of banks in 1969, nationalized banks have paid increasing attention to the needs of agriculture. Regional Rural Banks have been set up to deal specially with the needs of agricultural credit. A National Bank for Agriculture and Rural Development (NABARD) has also been set up. As a result of the expansion of institutional credit facilities to farmers, the importance of moneylenders has declined steeply and so has the exploitation of farmers at the hands of moneylenders.

10.2.6 Procurement and support prices : Another policy measure of significant importance is the announcement of procurement and support prices to ensure fair returns to the farmers so that even in years of surplus the prices do not tumble down and farmers do not suffer losses. This is necessary to ensure that farmers are not 'penalized' for producing more. In fact, the policy of the Commission for Agricultural Costs and Prices in recent years has been to announce fairly high prices in a bid to provide incentive to the farmers to expand production.

10.2.7 Input subsidies to agriculture : The government has provided massive subsidies to farmers on agricultural inputs like irrigation, fertilisers, electricity and credit. The objective of input subsidisation is to increase agricultural production and productivity by encouraging the use of modern inputs in agriculture. However, over a period of time, the subsidies have continued to increase continuously and many economists now feel that agricultural subsidies have reached 'fiscally unsustainable' levels.

10.2.8 Food security system : In a bid to provide foodgrains and other essential goods to consumers at cheap and subsidised rates, the Government of India has built up an elaborate food security system in the form of Public Distribution System (PDS) during the planning period. PDS not only ensures availability of foodgrains at cheap prices to the consumers but also operates as a 'safety net' by maintaining large stocks of foodgrains in order to combat any shortages and shortfalls that might occur in some years and/or in certain areas of the country.

10.3 OBJECTIVES OF AGRICULTURAL POLICY

In addition to the measures mentioned above, the Indian agricultural policy contained a number of other elements, some of which are outlined below :

1) Provision and extension of irrigation facilities through major and medium irrigation projects and of power for minor irrigation through the programme of rural electrification.

2) Improving the system of agricultural marketing through the establishment of regulated markets and introducing a variety of measures like standardization of weights and measures, grading and standardization of farm output, providing information regarding market prices to fanners, etc. Efforts have also been made to strengthen the co-operative marketing structure.

3) Provision and expansion of storage and warehousing facilities to enable the government to build up adequate buffer stocks to cope with the food problem in years of shortage of foodgrains and save the farmers from indulging in 'distress' sales during surplus years.

4) Initiation of steps to improve the economic condition of agricultural workers. In this category come measures to enforce minimum wages, abolition of bonded labour, grant of agricultural land to landless labourers, schemes for expanding rural employment, etc.

5) Promotion of agricultural research and training to discover new high-yielding varieties of seeds, avoid wastage of grains in storage, successfully counter the attacks of pests, insects and rodents, develop techniques for increasing productivity of soil and ensure optimum utilisation of soil, water and sunlight resources. The triple function of agricultural research, education and extension is being implemented through the various research institutes, agricultural universities, project directorates, etc. At the apex stands the Indian Council of Agricultural Research (ICAR).

6) In an effort to extend green revolution to the Eastern Region of the country and develop dryland areas, the Seventh Five Year Plan introduced two specific programmes: *(a)* Special Rice Production Programme, and *(b)* National Watershed Development Programme for Rainfed Agriculture. The former was initiated by the government in the Eastern Region (comprising of Assam, Bihar, Orissa and West Bengal, eastern Uttar Pradesh and eastern Madhya Pradesh). The latter, introduced in 1986-87, lays emphasis on land and water management through introduction of optimal cropping system, dry land horticulture, farm forestry, fodder production, etc. The aim is to develop areas under dry land agriculture since these areas are characterised by low productivity, high risk arid low income. The Ninth Plan also places special emphasis on agricultural development in the Eastern Region, "partly because of the presence of large untapped potential partly because this region accounts for a major proportion of the poor people in India and partly because this region is expected to contribute more than 50 per cent of the total incremental foodgrain production in the Ninth Plan."[6]

7) In order to increase the production of pulses, a centrally sponsored National Pulses Development Programme was launched in 1986-87. The basic objective of the programme is to increase the production of pulses by adopting location specific technology. A centrally sponsored programme was also launched in 1984-85 to increase the production of oilseeds. Known as National Oilseeds Development Project (NODP), this programme aims at providing to the fanners various services such as inputs, extension, credit, etc. so as to assist them in increasing the production of oilseeds. In addition to the above, an Oilseeds Production Thrust Project (OPTP) was launched in 1987. During 1990-91, the above two projects were merged under one programme, i.e., Oilseeds Production Programme (OPP).

8) A country-wide Comprehensive Crop Insurance Scheme was introduced from 1985 Kharif season. The objectives of the scheme are: *(a)* to provide a measure of financial support to the farmers in the event of crop failure as a result of drought, floods, etc.; *(b)* to restore the credit eligibility of farmers after a crop failure for the next crop season; and (c) to support and stimulate production of cereals, pulses and oilseeds. The scheme covers crop loans issued by all the agencies, *viz.,* co-operative credit institutions, commercial banks and regional rural banks. Paddy, wheat, millets, pulses and oilseed crops are covered under the scheme.

9) A Rural Infrastructure Development Fund (RIDF) was set up within NABARD in 1996-97 to provide credit for medium and minor irrigation and soil conservation projects. A scheme of Accelerated Irrigation Benefit Programme (AIBP) was initiated during 1996-97 for providing assistance to States by way of loans for timely completion of selected large and multi-purpose irrigation projects. An amount of Rs. 500 crore and Rs. 952.2 crore was released under AIBP as Central Loan Assistance to the States during 1996-97 and 1997-98.

10.4 EFFECTS OF AGRICULTURAL POLICY

1) Increase in Foodgrains Production and Productivity : We can say that the HYV programme has had a distinct impact on food production and what is even more significant, it has inspired confidence in regard to its promise for the future. The production of foodgrains reached 99.5 million tonnes in 1969-70 and the still higher figure of 108.4 million tonnes in 1970-71, a record till then. Only five years earlier, in 1965-66, it was 72 million tonnes. In 1978-79 it attained the then all-time record of 130.5 million tonnes. In 1985-86, it scaled up what was till then the peak of 150.4 million tonnes. Still another much higher peak of 170 million tonnes was attained in 1988-89.

The increase in the production of wheat has been the most remarkable : from the annual average of 11 million tonnes for five years previous to 1965-66, it rose to 18.7 million tonnes in 1968-69, to 20 million tonnes in 1969-70 and further to 23.8 million tonnes in 1970-71 to 36.3 million tonnes in 1980-81 and 47.05 million tonnes in 1985-86. In 1988-89, it attained the all-time record production of 54 million tonnes. The production of rice rose from 30.4 million tonnes in 1973-74 to 52.7 million tonnes in 1977-78 to 53.8 million tonnes in 1978-79 and further to 63.8 million tonnes in 1985-86. In 1988-89, the production of rice was at the peak, touching up the level of 70.67 million tonnes. Thus, it may not be unjustified to call this a revolution.

2) Increase in Regional Imbalance : So far the response to the new technology has been unevenly spread in respect of the different regions of this country. Punjab, Haryana, Western U.P., Gujarat and Tamil Nadu have been in the van. There appear to be two main reasons for the inter-regional disparities. Much more is known about the response of alluvial soils to large use of fertilisers than is known about the response of the upland soils. The sub-soil water supplies for exploitation by tubewells are predominantly in the Ganges-Jamuna plains, in the river estuaries of Gujarat, in the plains to the east of the Ghats in Southern India. According to a recent study, rapid agricultural growth in India has been confined to 17 per cent of the districts.

The regional imbalance in respect of the extension of the HYV programmes is far more pronounced when we consider that our agricultural scientists have yet to develop anew technology that should be suitable for the extensive 'dry farming' areas. There are about 84 districts in the various parts of the country which receive only 40 cm to 100 cm of rainfall annually and where only one-fourth of the area is irrigated. They constitute nearly 36 per cent of the sown area in the country. On such areas the new technology has yet to make a significant impact. Dr. M.L. Dantwala has rightly pointed out that the technology evolved during mid-sixties was suited only to some specific regions, but not to other regions. No alternate technology which would have been applicable to all regions was available at that time.

3) Emergence of Unbalanced Cropping Pattern : The progress of the new technology, its 'spread has been *uneven in respect of the different crops too.* Wheat has been benefited the most, while jowar, bajra, maize and rice are the other four crops in which some progress has been registered, but unlike wheat, that cannot be described as a real 'breakthrough'. Pulses, oilseeds, sugarcane, cotton, jute and plantation crops have yet to be launched on the HYV path and much research has yet to be accomplished before the new technology begins to bear fruit in respect of them. Thus, in its coverage over crops, the 'green revolution' has been partial and lopsided. In fact, the enhanced profitability of growing foodgrains due to the application of the package of modern agricultural inputs has diverted acreage from commercial crops to foodgrains. The area devoted to the cultivation of foodgrains rose from 74 per cent of total area sown in 1950-51 to 80 per cent in 1980-81. On the other hand, over the same period, the acreage under cash crops declined from 26 per cent to 20 per cent of total sown area. However, over 1980-81 to 1988-89, the acreage under cash crops has slightly increased from 20 per cent to 24 per cent of total area sown. Among foodgrains, the coarse cereals have recorded only a marginal increase in acreage. The acreage under pulses have recorded a minimum increase. In short, the green revolution has been experienced more perceptibly in the case of wheat only.

4) Increase in Social Imbalance : In its first phase, the 'green revolution' has favoured the larger and richer farmer. The principal beneficiaries have by and large been the large landowners who have secured handsome dividends from farm inputs, bum per crops and attractive prices. They alone have had sizable surpluses to sell. The rich and middle farmers, who have enjoyed subsidised supplies of farm inputs, have earned profits. The majority of the peasants and farm labourers have remained outside the orbit of the new technology. Most of them continue passively to lead a precarious existence, though many among them may be quite conscious of the brighter prospects. The small size of their holdings and their limited resources do not permit them to share the prosperity.

It has thus been aptly observed, "with 47 per cent of farm families owning only one acre of land and 22 per cent owning no land at all, with only 3 to 4 per cent of big cultivators enjoying all power, wielding all influence, making all decisions in collaboration with governmental machinery and appropriating to themselves all the skill, the resources, the expertise governmental agencies offer, the poor half of the village have little to think anybody for."[2]

In some areas, tenants are being reduced to farm labourers as landowners discover the profitability of the new technology in the current economic setting. Even though income to the landless may rise, the socio-economic gap between the landowner and the landless is tending to widen.

Economic inequalities in the rural society have thus been getting accentuated. It has been estimated that the percentage of rural population below the bare minimum level of living (i.e. consuming below Rs. 15 per month at constant 1960-61 prices) for different States as well as for India as a whole went up by 40 per cent between 1960-61 and 1967-68.[3] The Green Revolution is said to be 'capitalist revolution' in 'Socialist India' where the rich landlords are getting richer and richer, and a serious social imbalance or ‘social polarisation’ is developing which may not only erode the traditional relationship in the countryside but may in due course create a politically explosive situation which would attract extreme leftist parties. A confrontation between the minority of prosperous landowners and the mass of share-croppers, tenants and landless labour could then become a distinct possibility.

However, according to a shrewd observer, “It is not… the new technology which is the primary cause of the accentuated imbalance in the countryside. It is not the fault of the new technology that the credit service does not serve those for whom it was originally intended; that the extension services are not living up to expectations; that the panchayats are political rather than development bodies; that the security of tenure is a luxury of the few; that rents are exorbitant; that ceilings on agricultural land are notional that for the greater part tenurial legislation is deliberately miscarried; or that wage-scales are hardly sufficient to keep soul and body together. These are man-made institutional inequities. Correcting all of these within the foreseeable future is out of the question. On the other hand, even if only some of them are dealt with security of tenure, reasonable rent and credit to sustain production needs a measure of economic and social justice could be fused with economic necessity, thereby adding another essential dimension to the green revolution."

5) Impact on Rural Employment : The more intensive farming methods associated with the new technology require more farm labour. The new varieties will not respond to traditional practice of planting the crop and then virtually forgetting it until harvest time. Substantial amounts of additional labour must be invested in applying fertiliser, weeding and the like.

Expansion of the area that can be multi-cropped is also resulting in a more effective use of the rural labour supply. This is a major economic gain. For the first time, significant local labour scarcities have been emerging. For example, the Punjab farmer is already experiencing a serious shortage of labour in peak periods, which is paving the way for further mechanisation of agriculture in the Punjab. A study of the working of the Intensive Agricultural Development Programme in Raipur district from 1964-65 to 1968-69 showed that the amount of labour employed went up three times in terms of labour days. This is in addition to the increased time the small cultivators devoted to their own land. The labour wage rates during the periods of peak demand in the crop season went up by 150 per cent and by about 100 per cent during the rest of the season. Dr. G.S. Bhalla's study on labour absorption in Indian agriculture has revealed that the elasticity of employment per hectare with respect to yield was as high as 0.87 in high growth districts. But the over all situation of employment generation in rural areas has deteriorated. The growth rate of employment generation in the agricultural sector has declined from 2.32 per cent in 1972-73—1977-78 period to 1.22 per cent in 1983-88 periods.

6) Effect on Agricultural Labour : Sometimes a view is put forward that the only feasible and the surest way of improving the economic condition of the weaker sections of the rural population is to promote faster agricultural growth through chemical-biological breakthrough or by making 'green revolution' greener still. But the Green Revolution does not seem to have benefited agricultural labour. There is no doubt that their wages have risen but since prices of commodities have risen much more, the real wages have gone down. An inquiry into wages in 15 districts in Punjab and Haryana has revealed that the weighted average daily wage rate for casual male agricultural labour went up by about 89 per cent between 1960-61 and 1967-68. But the consumer retail price index (general) in the same period (for agricultural labourers) went up by 93 per cent. Again, in the I.A.D.P. (Intensive Agricultural Development Programme) districts scattered throughout India, in which much of the efforts towards agricultural modernisation and development was concentrated, the real wage rate fell between 1962-63 and 1967-68. The real income (real wage) per agricultural labourer has declined from Rs. 445.6 in 1970-71 to Rs. 420.5 in 1988-89, whereas the real income of non-agricultural labourer has risen from Rs. 971.8 in 1970-71 to Rs. 1783.8 in 1988-89.[8]

7) Increase in Investment through Plough-back of Farm Income : A gratifying trend associated with the new farm technology is that the farmers benefiting from it are investing more and more of their increased farm income for the improvement of their farm organisation. A recent study on farm family investment conducted in the Punjab Agricultural University showed that the fixed farm capital investments accounted for 18.47 per cent of the total farm family income, of which purchase and development of land constituted about 7.02 per cent. Again, a short-term investment in the use of modern inputs such as improved seeds, fertilisers, insecticides and irrigation charges and hired labour (cash costs) formed 36.23 per cent of the total farm family income. In other words, the farmers are ploughing back about 55 per cent of their total family income for farm improvement.

10.5 GREEN REVOLUTION

10.5.1 Genesis of Green Revolution :

Adoption of innovating techniques lo usher in a technological revolution for the transformation of traditional agriculture into modern farming is designated by the happy phrase ‘Green Revolution.’ It was William S. Gaud, former Director of A.I.D., who was the first to use the term ‘Green Revolution’ in a speech in March 1968 addressed to the Society of International

Development[1] to describe significant changes in the agricultural sector in certain regions due to adoption of new farm technology. This new trend of agriculture is called more explicitly ‘the Seed-Fertilizer Revolution’[2] as high-yielding variety of seed is highly fertilizer-responsive and capable of achieving a higher rate of yield. M.L. Dantwala says, "The key factor behind the Green Revolution was a new technology with high-yielding varieties at its core."[3] The spectacular breakthrough in foodgrain production which occurred between 1966-1971 in India marks the beginning of the Green Revolution. The new strategy includes a package of techniques, but the most important is the spread of high-yielding variety cereals over fairly wide areas.

In one sense, the origin of the Green Revolution could be traced back to the year 1960-61 when the Intensive Agricultural District Programme (IADP) was launched in seven districts in India, including West Godavari in Andhra Pradesh. Initially, pioneered by the Ford Foundation, the IADP stressed the need for providing the cultivator a complete package of practices consisting of new inputs, technical advice and credit. However, the improved variety of seed used could not achieve spectacular yield. It is generally believed that the Green Revolution in India began in 1965-66 with the introduction of a new variety of Mexican wheat.

The term 'revolution' implies a sudden change. But the change in agriculture in terms of application of crucial input like irrigation is not so sudden. Introduction of high-yielding variety requires irrigation. Since a long time, huge public investments have been made on major and medium irrigation projects besides investments of individual farmers on minor irrigation works. Further, the HYV seed is confined mainly to food crops like wheat, paddy, jowar, etc. In 1980-81, only 28.6 per cent of cropped area enjoyed irrigation in all-India[4] and in this limited area only, modern inputs could be used gainfully. The scope of the Green Revolution thus being confined to a limited area, the usage of the term 'revolution' is questioned.

However, the introduction of HYV seed led to many changes with several linkages. Irrigation becomes a pre-requisite for the introduction of HYV and associated modern inputs. Therefore, the problem of water management now becomes important. Further, HYV seed is highly responsive to fertilizer and hence, there is a remarkable rise in the demand for fertilizers. The HYV crop attracts pests and diseases, leading to demand for pesticides, sprayers, etc. There is now need for enlarged credit facilities to meet the growing credit requirements of different categories of farm producers. The new farm technology necessitates additional investment on the production of chemical fertilizer, pesticides, water pumpsets, etc. Adoption of new farm technology results in higher levels of yield per unit of land. With higher levels of productivity, farm producers are able to achieve marketable surplus. In the process of marketing of farm products, the farm producers come into contact with the urban merchants and urban life and they would like to imitate urban life because of the ‘demonstration effect’. Now the inclination for better living like that of the urban rich urges the farm producers to adopt new farm technology at a higher rate and achieve still higher levels of yield. These different changes in the agricultural sector due to the adoption of new farm technology, with HYV seed at its core, are described as the Green Revolution.

10.5.2 Need for Green Revolution :

By 1960-61, a stage has been almost reached where we could no longer think of producing more of farm products through extensive cultivation in order to meet the growing requirements of fast-increasing population. It has been well recognised that higher productivity is the only answer to meet the future requirements of food and other farm products. The improved variety of seed, no doubt, proved better in terms of yield. Yet, the improved variety of seed was not capable of achieving significant increase in the yield levels. It was recognised that the introduction of HYV seed associated with other modern inputs could only help to increase productivity and thereby meet the growing requirements of food and other farm products.

10.6 EFFECTS OF GREEN REVOLUTION ON WEAKER SECTIONS

The small and marginal farmer, tenant cultivators and agricultural labour come under the category of weaker sections.

10.6.1 Small Farmer and Green Revolution :

Such of those who own two hectares of land and below are described as small farmers and those with one hectare and below are known as marginal farmers. As discussed earlier, a higher proportion of small-size holdings enjoys irrigation facility than that of large-size farms. Basing on a study pertaining to West Bengal, B. Sen concludes that by using high-yielding variety seeds a small farmer is able to earn additional income. It is stated that the proportion of additional income due to HYV in the total income of a small farmer is higher than that of the large-size farmer.[16] According to different farm management studies, the productivity of small-size holdings is higher.

In monetary terms also, per acre income from the small farms may appear to be high. But in an analysis of this type, we have to note one important factor. Generally, small farms are cultivated with family labour and other on-farm inputs like seed, farmyard manure, etc. If the retained or imputed costs are also taken into account, the net profits (after deducting from the gross farm income both paid-out costs and retained costs) may be negligible. In securing modern inputs like chemical fertilizers, pesticides, tractors, etc., the small farmers have their own problems. Also, in getting institutional credit and in marketing of products, the small and marginal farmers, tenant and mixed cultivators face many difficulties. The small farmer is always in pressing need for cash and is often forced to borrow from the local money-lender or merchant. Further, most of the small farmers do not have proper storage facilities. Under these circumstances, they are forced to sell away the produce immediately after harvest that too, to the local money-lending merchant and are denied a remunerative price. A study of the effect of the Green Revolution on small farmers and other weaker sections in Tamil Nadu reveals that large-size farmers have gained more than the small ones as a result of the Green Revolution.[17] Wolf Ladejensky who made certain field trips in Punjab and Bihar in 1969 came to the conclusion that in the areas visited, there was significant agricultural development due to the Green Revolution. At the same time, it was stated that the weaker sections were not benefited by the new farm technology. But a difference was noticed in the conditions of agricultural labour in Bihar and Punjab. In Punjab, due to the development of agro-industries, the small-size farm owners are able to get supplementary occupations unlike in Bihar. Hence, it is concluded that the problems of weaker sections are not of a serious nature in Punjab. But, it was stated, the Green Revolution was not responsible for income inequalities in the rural areas; the social, religious, economic and political factors prevailing there were responsible for the state of affairs of the weaker sections.[18]

Francine R. Frankel, who visited Ludhiana (Punjab), West Godavari (Andhra Pradesh), Tanjore (Tamil Nadu), Palghat (Kerala), Burdwan (West Bengal) districts where there was the IAD programme, came to the conclusion that as a result of the introduction of HYV and other modern inputs, the yield per hectare had gone up and consequently, almost all categories of farm producers were benefited. In Ludhiana district, where HYV wheat was grown widely, the different farmers were able to gain substantially. But it is stated that the additional gains from new farm technology were not properly distributed. Farmers with 5 to 10 acres of land were able to increase their net income to some extent. But those with 15 to 20 acres of land growing wheat were able to make adequate investment on the new inputs and achieved substantial gains. It was also noticed that in rice-growing regions, even though small farmers were able to gain to some extent, their real income did not improve because of considerable increase in the production costs. In the matter of yield per hectare of land, the large-size farmers did not make any headway as compared to small farmers. It was also noted that in the rice-growing regions, the economic conditions of about 75 to 80 per cent of the farmers had deteriorated.[19]

10.6.2 Tenants and Green Revolution :

We do not have full records to show the extent of different categories of tenants in different parts of India. However, based on certain studies pertaining to some regions, we have to analyse this problem and draw certain conclusions. The study of G. Parthasarathy during 1965-66 and 1971-72 pertaining to West Godavari district in Andhra Pradesh throws some light on certain important aspects.[20] It was observed that in the areas surveyed, certain tenant cultivators became agricultural labourers and in some cases agricultural labourers became tenant cultivators. Before the Green Revolution period, a certain proportion of the total produce was given to the landowner as rent. It was observed that rent was raised after the introduction of HYV seed. When traditional seed was used, only certain tenants used to give two-thirds of the produce as rent and after HYV seed came into practice the landlords are found to be insisting on two-thirds share from the produce. Even though landowners shared two-thirds of expenses on chemical fertilizer, pesticides, etc., in view of two-thirds rent the gains of new farm technology were not reaching the tenant cultivators. From the study, it is also found that three-fourths of the additional production due to new farm technology went to the landowners and only one-fourth to the tenant cultivators. This study reveals certain other things also. In view of the inability of the tenant cultivators to offer any asset as security, they were not able to get credit from the institutional sources. It was only the large-size farmers of dominating communities that were able to secure credit from the Primary Agricultural Credit Societies. The tenant cultivators were found to be borrowing from the landlords or the local moneylenders paying nearly two times the interest rate charged by the institutions. Due to payment of higher rate of interest, the gains accrued to tenant cultivators from the adoption of new farm technology were found to be negligible. As a result of this situation, the already existing income inequalities have further widened. From this study, it appears that inequalities in the distribution of output rather than inequalities in the distribution of land assets are mainly responsible for income inequalities. The study of Mencher[21] reveals that for many tenant cultivators, there was no security. Only those tenants cultivating the lands of widows and aged persons were found to be cultivating the same lands continuously for about four to five years. In other cases, tenants are changed almost every year and from one piece of land to another. Further, a survey conducted in Chingleput district of Tamil Nadu reveals that there was always conflict between landlords and tenant cultivators. Even though tenant cultivators had the support of some political parties, their conditions did not improve because of the dominating role of landlords and lack of security to the tenant cultivators. Francine R. Frankel, during his field trips, noticed the eviction of tenant cultivators and landowners taking up personal cultivation lured by the potential gains of the new farm technology.

Whether the tenant cultivator is making adequate investment and using modern inputs or not is being debated. In the absence of security of tenure and institutional credit the tenant cultivator may not have the necessary incentive to invest on new farm technology. There are some cases where new farm technology has changed the character of tenancy. For example, in Punjab some small farmers who are not able to make adequate investment on modern inputs in and cultivate the land profitably are found to be entrusting their land to tenant cultivators. Such tenant cultivators are functioning like large-size farmers and carrying on the farm operations by adopting new farm technology. Even in this type of tenancy, the extent of adoption of new farm technology is being debated. Lack of security of tenure and high rate of rent that the tenant cultivator has to pay are the disincentives in the adoption of new farm technology. While the Programme Evaluation Organisation Studies state that there is no difference between the landlords and tenant cultivators in the application of modern inputs, G. Parthasarathy argues that such a conclusion is based on limited sample data. Further, in the areas chosen for PEO study, the tenant cultivators must be cultivating large-size holdings than the landowning class. If only a study is conducted with reference to pure tenants and tenants in subsistence cultivation, the real problems of tenant cultivators could be better understood.

10.6.3 Agricultural Labour and Green Revolution :

According to the 1991 Census, of the total number of workers in rural areas, 32.2 per cent are agricultural labourers. With HYV seed, if only there is assured irrigation, more than two crops can be raised in a year. In such cases, agricultural operations have to be carried on very quickly. Ploughing of land, sowing of seed, transplantation, weeding, spray of pesticides, harvesting, threshing operations, etc., have to be carried on quickly and the field must be made ready for the next crop. Therefore, the demand for labour increases and employment can be for a greater period during a year. There is a general impression that due to the Green Revolution, the degree of seasonal unemployment is reduced and during the peak seasons when there is great demand for labour, the agricultural wages would go up. There are no adequate research studies relating to the impact of the Green Revolution on agricultural labour. From a study of G. Parthasarathy[22] in West Godavari district of Andhra Pradesh, it can be seen that due to the use of IRS along with other inputs, the gross income has gone up. The additional income made possible by the new farm technology was pocketed mostly by landowners and those who supplied modern inputs. The share of agricultural labour in the additional income was found to be just 7 per cent. As in the case of different categories of workers, money wages of agricultural labour also have gone up in recent years. In view of the growing cost of living, it may be concluded that there is no improvement in the real wages of agricultural labourers.

The share of agricultural and allied activities in the net domestic product declined from 60.5 per cent in 1950-51 to 31.2 per cent in 1994-95. This implies fall in the income per agricultural worker and uneven distribution of incomes between rural and urban sectors. In view of the slow labour absorption capacity of the non-agricultural sector, increased population results in a large number of new entrants to the labour force seeking livelihood, though meagre, in agriculture. This development is bound to depress the level of agricultural wages in spite of the new farm technology bettering the agricultural incomes and the Minimum Wages Act in force.

10.7 GREEN REVOLUTION AND RURAL DEVELOPMENT

The Green Revolution has the potentialities of contributing to rural development in terms of generation of higher production, employment and incomes in the agricultural sector. However, *as* discussed earlier, the Green Revolution is confined only to the irrigated areas. The scope of the Green Revolution, thus, being limited, high expectations concerning reductions in unemployment and poverty are perhaps unwarranted. In areas with satisfactory irrigation, there is demand for labour and employment and wages have risen and in areas with lack of irrigation understandably, such increases are not perceptible. B. Sen rightly stated: "Without the high-yielding varieties, the problem of poverty and unemployment would have been more acute; without them, there may have been a deceleration in the growth rate of the output of some foodgrains... if the Green Revolution has not turned out to be a Cornucopia, neither has it been a Pandora's Box." It is sometimes argued that the new farm technology necessitated tractorization and it led to the displacement of hired labour. Tractorization of farm operations has been confined to a limited labour. As such, the criticism that tractorization has led to large-scale eviction of tenants or displacement of hired labour is unwarranted. The Green Revolution cannot be blamed for inequalities in the regional development and among individual incomes. Such inequalities are already there. New openings made available by new farm technology for the development of one region should not be a matter of frustration and envy for a neighboring region. On the other hand, what is relevant is how best the knowledge of new farm technology can be diffused and applied in all regions under different agro-climatic conditions. Under the given natural endowment, necessary steps have to be taken in less favourable areas to provide infrastructural facilities, institutional arrangement and to form economic organisations. G. Parthasarthy analysing the relationship between agricultural production and reduction in rural poverty observes: "Even though no firm relationship has been established between the rate of growth of agricultural production and reduction in poverty, the higher overall rates of growth with perceptible margins above the rates of growth of rural population should be expected to set the pace for sustained reduction in poverty. High rates of growth also help through their favourable effect on prices paid by the poor for food and also through employment linkage effects between agriculture and non-agriculture." [24] The Green Revolution must spread to all regions, including the dry tracts and along with this step, rural industrialisation should receive adequate attention of the government. An increased emphasis on agricultural development and on dry land development has the potential to contribute to growth and equity simultaneously and also towards resolving the imbalances in crop productions. The HYV seed varieties suitable for dry crops have to be evolved and popularised. The small and marginal farmers in all regions need to be assisted to raise the levels of intensity of cropping and high-value crops. The problem of landless labour needs to be tackled more effectively. Employment guarantee must be provided to them and there must be a statutory permanent machinery at district level to arrange for regular employment to labour within the district. Through the provision of proper working conditions and remunerative wages, the landless labour must be encouraged to seek employment in the rural sector. This step is necessary to ensure regular supply of labour to agricultural sector and prevent exodus of rural labour to urban areas.

10.8 PROBLEMS IN THE SPREAD OF GREEN REVOLUTION

For the spread of the Green Revolution, certain inputs become very crucial :

10.8.1 Irrigation :

An important requirement for the Green Revolution is irrigation. Only in the irrigated lands, HYV seed, chemical fertilizer, pesticides and other modern inputs can be used profitably.

Since irrigation facility is available to a limited area, the Green Revolution is also confined to some extent to this limited irrigated area. For the spread of the Green Revolution to different regions, creation of irrigation facility on a wider scale becomes necessary. B. Sen argues that a higher proportion of small-size holding enjoys irrigation facility. He, therefore, concludes that small and marginal farmers are not at a disadvantage in adopting the new farm technology, although they have several other problems.

10.8.2 Capital :

Another problem in the spread of the new farm technology is in respect of investment capacity. The different categories of farmers must have investment capacity and only then they can use new farm technology leading to the Green Revolution. The small and the marginal farmers do not have their own funds to make adequate investment on modern inputs. Under these circumstances, timely and adequate supply of credit through institutions becomes necessary. Out of the total agricultural credit, only about 45 per cent comes from the institutional sources and still private agencies dominate the rural credit scene. The small and marginal farmers, the tenant cultivators, mixed cultivators and agricultural labourers are not able to secure adequate institutional credit. Lack of credit facilities, particularly to the needy persons, is a problem in spreading the Green Revolution.

10.8.3 Inadequate Extension Services :

For the spread of new farm technology, the farmers must have a clear knowledge about the soils, fertilizer requirements, crop choice, etc. In a situation where a majority of farmers are illiterate, technical know-how is very much lacking. The extension services available are inadequate. The village development officers who are in charge of extension are not fully equipped to provide the extension services needed. As stated elsewhere in this book, in advanced countries like Japan and America, for every 200 farmers, there is one qualified extension official. In India, each extension officer has to serve nearly 10,000 farmers requiring varied technical advice which he himself is not certain about. This, again, is a major problem in spreading the new farm technology, leading to the Green Revolution in India.

The different problems that crop up with the spread of the Green Revolution are analysed under three generation problems.[6]

10.8.4 First Generation Problems :

In the first stage, high-yielding varieties of seed for food and non-food crops for wet as well as dry cultivation have to be evolved. A much more important factor is the evolving of a new variety that suits the different agro climatic conditions and meets the consumer tastes. The grain of HYV like IR 8 is of a coarse type which is not acceptable to consumers. These problems of a technical nature demand realistic and practical solutions. Further, provision of irrigation water with efficient water management is of crucial importance. Also other inputs like chemical fertilizers and pesticides must be made available in adequate quantity and at right time to all categories of farm producers. The extension services become equally more important in the early stages of spread of the new farm technology. There must be institutional credit support, particularly to small and marginal farmers so as to enable them to invest on modern inputs and secure extension services. Thus, the first generation problems relate mainly to the technical matters of increasing the supply of new inputs and diffusion of knowledge for efficient use. In order to tackle the first generation problems there is need for- (a) increased public as well as private investment on expansion of irrigation facilities, (b) evolving of anew variety of seed in pulses, oilseeds, etc., along with the HYV seed of wheat and paddy, and (c) equally important is evolving of HYV that suits the different agro-climatic conditions. The consumers' acceptance should also be taken into account while evolving the HYV seed. Foodgrains grown with bio-fertilizer application are now gaining popularity particularly in International markets and hence this technology need to be popularised.

10.8.5 Generation Problems :

With the adoption of a new farm technology, the yield per unit of land is bound to increase significantly resulting in more marketable surplus. Therefore, the second generation problems are concerned with marketing and matters associated with it. For an efficient marketing system, there is need for storage, transport, processing and grading facilities. Also, there is need for efficient market news system, which helps the large number of farmers spread over the entire country to have timely and correct information about the prices prevalent in different market centres for different commodities and the quality and standards expected in the foreign markets. Effective steps to ensure good quality of different agricultural commodities are necessary in a situation of globalisation of trade in agriculture.

In case the price prevalent in the market is less than the 'minimum price', adequate facilities must be made available to sell at minimum prices. In case the prices of commercial crops are higher than the price of foodgrains, the farmers would naturally prefer to grow commercial crops. This would result in fall in the supply of foodgrains with all its adverse effects on the society. Therefore, price parity in between different crops must be maintained. In order to tackle the second generation problems, the government must take certain steps:

1. Appropriate policy measures are required to provide milling, grading, storage, transport, etc. facilities to the farmers in adequate measure.
2. Co-operative marketing societies including co-operative processing societies have to be strengthened on the lines of 'Amul' in Gujarat.
3. Keeping in view the low per capita rural incomes, role of middle men in credit and marketing need to be eliminated through adequate institutional credit. Integrating credit with marketing is a measure that needs serious consideration.

The small and marginal farmers are at a disadvantageous position in securing remunerative prices for their products. Therefore, necessary steps have to be taken to create such favourable conditions to the less privileged farmers so as to enable them to sell at remunerative prices.

10.8.6 Generation Problems :

Large-size farmers with assured irrigation facilities are mostly benefited by the new farm technology. The Green revolution is confined to regions with assured irrigation facilities and it is found that rich farmers have become richer by adopting the new farm technology.

Therefore, the Green Revolution resulted in imbalances in the regional development and inequalities of income. The third generation problems, therefore, are those relating to equity or redistribution of wealth. From the study of G. Parthasarathy, it appears that 75 per cent of the additional income derived from the Green Revolution is enjoyed by the landlords only. The share of the agricultural labourer is found to be just 7 per cent only. Further, due to the Green Revolution, in many places, it is reported that the tenant cultivators are evicted from the land and in some cases rents are raised. Thus, the Green Revolution has not helped the weaker sections of the rural society. It is, therefore, argued that the Green Revolution may lead to a Red Revolution if corrective steps are not taken immediately.

In the opinion of Falcon,[7] the third generation problems arise mainly through four sources:

1. Higher rate of population growth in those regions where there is already a high density of population;
2. Further widening of already existing inequalities in the individual incomes, wealth and political influence;
3. Limited employment opportunities in the non-agricultural sector in spite of its growth; and
4. Introduction of certain agricultural inputs like tractors which lead to the creation of unemployment.

In a developing country like India, population growth rate is higher than the rate of increase of employment opportunities in the non-agricultural sector. With the HYV seed of short maturity period, it is possible to raise more than two crops a year and hence, there is possibility of providing employment to labour almost throughout the year. But, if instead of raising labour-intensive crops like cotton, wheat is grown, the demand for labour would fall. The influence of HYV on employment potential depends upon different factors peculiar to different regions. Yet, the expert opinion is that HYV seed is capable of increasing employment opportunities. Due to the Green Revolution, the supply of foodgrains would increase. This may result in a fall in the prices of foodgrains and such situation may facilitate more savings and increased investment. If such favourable development results in higher levels of investment, the Green Revolution certainly is helpful for the progress of the country. On the other hand, if the Green Revolution leads to unemployment and social unrest, this would result in agitations and chaos in society. In the regions of assured irrigation, the impact of the Green Revolution is more significant and incomes for landowners in such regions would increase substantially. The agricultural price policy is also likely to benefit the landowning class. But such development would only further widen the existing inequalities of income and inequalities in the development of different regions. The large-size farmer is always in a better position in securing different modern inputs and in marketing of his products. Such farmer is in a position to own a tractor and use it profitably. The tractor may cause unemployment among agricultural labour. Also, with a tractor, the landowner himself may cultivate his entire land resulting, in some cases, in eviction of tenant cultivators. In the wheat growing regions, as a result of use of tractors in large-size farming, large-scale eviction of tenants and unemployment of labour can easily be noticed.

In the light of the third generation problems, the following steps become necessary:

1. The benefits of the Green Revolution must be spread to all regions. Therefore, *HYV* seeds suitable for dry areas must be evolved and popularised;
2. Labour-intensive type of farm practices must be adopted;
3. Through the development of cottage and small-scale industries, employment opportunities must be created in the rural areas;
4. In developing countries like India, the economic development and distributive justice cannot be achieved through the spread of the Green Revolution alone. Along with agricultural development, there is need for achieving progress in other sectors of the economy; and
5. The benefits of the Green Revolution must reach all those who are associated with it.

The small and marginal farmers and tenant cultivators must be helped to use the new farm technology and derive benefits from it. Necessary steps must be taken to ensure security of tenure and proper reward for the efforts of the tenant cultivators. The agricultural labour must be assured of decent wages. Progressive land tax or agricultural income tax becomes necessary to reduce the growing inequalities in individual farm incomes.

10.8.7 Adoption Pattern :

It is important to examine more closely the adoption pattern of new farm technology. As stated earlier, irrigation is a pre-requisite for determining the applicability of high-yielding varieties (HYV) on a given farm. Therefore, the adoption pattern would be determined mainly by the distribution of irrigated farms in different size groups. Furthermore, the scope for a rapid extension of irrigation being limited, annual additions to the existing extent of irrigated farms are unlikely to change significantly the existing distribution of irrigated farms. Therefore, B. Sen rightly states that "There is no escape from the fact that the adopters of the high-yielding varieties would be the farms that are already irrigated and for a long time to come, these farms would also constitute the bulk, if not the entire set, of adopter farms."[8] However, irrigation is not the only factor determining the adoption of high-yielding varieties. Besides irrigation, the farmer must have the ability to purchase critical inputs like fertilizer, pesticides, etc. The adoption of HYV in India has been taking place under the influence of a government-initiated mass action programme called the High-Yielding Varieties Programme (HYVP). In HYVP, credit is channelled through the co-operatives, duly certified seeds are supplied by the State Governments and the National Seed Corporation and fertilizer supply is arranged by the Central Government. The goal of the HYVP is to cover the entire irrigated land under foodgrains. Therefore, the adoption pattern is based on distribution of irrigated farms in favour or against a specific size-class of farms.

The study of B. Sen reveals that out of total 22.7 million irrigated farms in the country, about 14 million or 61.67 per cent are under small size group of 0.00 to 4.99 acres, while 7.73 million or 34.02 per cent are within 5.00 to 24.99 acres, and 0.97 million or 4.35 per cent are within 25.00 to 50.00 acres and above. A look into the percentage distribution of irrigated farms against different size groups clearly reveals that small-size farms enjoy relatively higher proportion of irrigation than the large-size farms.

Irrigated large farms constitute 42.6 per cent of all large farms in the country, while the irrigated small farms form 45 per cent of all small farms. Irrigated medium-size farms constitute 46.5 per cent of the total medium-size farms. Therefore, the proportion of existing small-size and medium-size farms adopting the new varieties is likely to be greater than the large-size farms. B. Sen after examining the proportion of irrigated land out of the total holding of different size groups concludes that "The proportion of irrigated land per farm is greater for small farms and that this proportion is inversely related to farm size. It is, therefore, reasonable to expect that the smaller farms would have a greater proportion of land per farm under high-yielding varieties than any other farm group."[10]

10.8.8 SIZE OF FARM AND NEW FARM TECHNOLOGY :

The size of the farm figures prominently in the discussion of adoption of the new farm technology. The concepts of 'indivisibility of factors of production' and 'economies of scale' are imported into the agricultural sector from the industrial sector, which has led a little controversy and confusion. But, "the theory of the firm is always difficult to apply to agriculture, as far as underdeveloped countries are concerned; it seems to have limited application."[11] To quote another expert, "Since land as a factor of production is perfectly divisible and since many inputs, e.g. labour, water, seeds, manures and pesticides, etc., are equally divisible, the improved methods can be applied to land, quite irrespective of its size."* Even equipment like a tractor "capable of being hired out (by hours) and livestock though indivisible, optimum utilisation of them is possible by employing them on different farms on hire or exchange basis. Japanese agriculture reveals that small-size farm is no serious impediment to technological progress in agriculture. The reports of the Farm Management Studies in India show that productivity per acre is higher in smaller holdings." On this issue, A.K. Sen's remarks fortify the above conclusions: "In an economy with structural unemployment, non-wage family-based farming has several advantages that capitalistic farming does not have."[14] The small-size holdings in Japan or in India in States like Kerala, have not stood in the way of higher productivity. This discussion may well be closed with the weighty remark of an eminent authority which clinches the issue: "It has often been suggested that the productivity of small-scale holdings is inherently low. But that is simply not true. Not only do we have the overwhelming evidence of Japan to disprove that proposition, but a number of recent studies on developing countries also demonstrate that given the proper conditions, small farms can be as productive as large farms."[15] All this clearly shows that new farm technology is neutral to scale or size of holding. In recent years, institutional credit is available fairly well to different categories of farmers. The regional rural banks are mainly intended for meeting the credit requirements of the weaker sections of the rural community. The supply position of different modern inputs is also encouraging. Further, there is pressing cash requirements for small farmers too. Therefore, the small-size farmers also, by taking advantage of institutional credit facilities, are quite encouraged to secure modern inputs and use them to their advantage.

10.9 EXERCISE

1) Explain the concept of Green Revolution and discuss the effect of green revolution on weaker section.
2) Discuss the various objectives of agricultural policy?
3) Explain the various problems in the spread of green revolution.
4) Explain the relation between Green Revolution and Rural Development.

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11

INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)

Unit Structure :

11.1 OBJECTIVES

1) To study the objectives and milestones of ICAR.
2) To study the organizational structure of ICAR.
3) To study the various salient achievements of ICAR.

11.1 INTRODUCTION

The Indian Council of Agricultural Research (ICAR) is an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. Formerly known as Imperial Council of Agricultural Research, it was established on 16 July 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture. The ICAR has its headquarters at New Delhi.

The Council is the apex body for co-ordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 101 ICAR institutes and 71 agricultural universities spread across the country this is one of the largest national agricultural systems in the world.

The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development that has enabled the country to increase the production of foodgrains by 5 times, horticultural crops by 9.5 times, fish by 12.5 times, milk 7.8 times and eggs 39 times since 1951 to 2014, thus making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields.

11.2 OBJECTIVE OF ICAR

To plan, undertake, aid, promote and co-ordinate education, research and its application in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

To act as a clearing house of research and general information relating to agriculture, animal husbandry, home science and allied sciences, and fisheries through its publications and information system; and instituting and promoting transfer of technology programmes.

To provide, undertake and promote consultancy services in the fields of education, research, training and dissemination of information in agriculture, agroforestry, animal husbandry, fisheries, home science and allied sciences.

To look into the problems relating to broader areas of rural development concerning agriculture, including post-harvest technology by developing co-operative programmes with other organizations such as the Indian Council of Social Science Research, Council of Scientific and Industrial Research, Bhabha Atomic Research Centre and the universities.

To do other things considered necessary to attain the objectives of the Society.

11.3 MILESTONE OF ICAR

Initiation of the first All-India Co-ordinated Research Project on Maize in 1957.

Status of Deemed University accorded to IARI in 1958.

Establishment of the first State Agricultural University on land grant pattern at Pantnagar in 1960.

Placement of different agricultural research institutes under the purview of ICAR in 1966.

Creation of Department of Agricultural Research and Education (DARE) in the Ministry of Agriculture in 1973.

Opening of first Krishi Vigyan Kendra (KVK) at Puducherry (Pondicherry) in 1974.

Establishment of Agricultural Research Service and Agricultural Scientists' Recruitment Board in 1975.
Launching of Lab-to-Land Programme and the National Agricultural Research Project (NARP) in 1979.

Initiation of Institution-Village Linkage Programme (IVLP) in 1995
Establishment of National Gene Bank at New Delhi in 1996.

The ICAR was bestowed with the King Baudouin Award in 1989 for its valuable contribution in ushering in the Green Revolution. Again awarded King Baudouin Award in 2004 for research and development efforts made under partnership in Rice Wheat Consortium.

Launching of National Agricultural Technology Project (NATP) in 1998 and National Agricultural Innovation Project (NAIP) in 2005.

11.4 ORGANISATION OF ICAR

Union Minister of Agriculture is the ex-officio President of the ICAR Society.
Secretary, Department of Agricultural Research and Education, Ministry of Agriculture, Government of India and Director General, ICAR is the Principal Executive Officer of the Council.
Governing Body is the policy-making authority
Agricultural Scientists' Recruitment Board
Deputy Directors-General (8)
Additional Secretary (DARE) and Secretary (ICAR)
Additional Secretary and Financial Advisor
Assistant Directors-General (24)
National Director, National Agricultural Innovation Project
Directorate of Knowledge Management in Agriculture

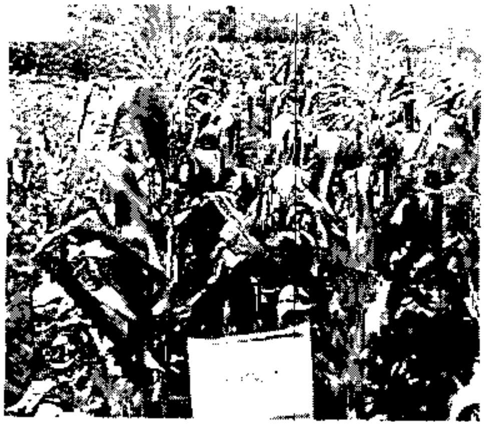
11.5 SALIENT ACHIEVEMENTS OF ICAR

A) Crop Sciences :

1) The division has played a pivotal role in ushering the era of green and yellow revolutions in the country. The national average productivity raised by 2-4 folds in foodgrains, rapeseed-mustard and cotton since 1950-51.

2) Spectacular success has been achieved in introduction and improvement of new crops, such as soybean and sunflower; India is now the fifth largest producer of soybean in the world.

3) The division has supported the development of improved crop cultivars and appropriate crop production-protection technologies, along with promoting the basic/ strategic/ applied research in cereals, millets, pulses, oilseeds, commercial crops and fodder crops.



4) Developed and released over 3,300 high-yielding varieties / hybrids of field crops for different agro-ecologies.

5) Facilitated development, evaluation and identification of technologies through the All-India Co-ordinated Projects.

6) First in the world to develop hybrids in grain pearl millet, castor, pigeonpea and cotton in the 1970s; developed hybrids in other crops like rice, safflower and rapeseed-mustard.

7) Developed single cross hybrids of QPM (quality protein maize) having high nutritional value and yield, and high yielding baby corn.

8) Developed and introduced early and suitable plant types in rice, sorghum, cotton, pigeonpea, chickpea, greengram, blackgram etc.; these have opened up avenues for multiple cropping systems and helped in enhancing cropping intensity, early pulse varieties have helped in claiming the new niche areas such as early chickpea varieties in Andhra Pradesh that led to high productivity in the crop.

9) Some of the improved Indian varieties have acclaimed global spread in case of sugarcane, wheat, rice, pigeonpea, sorghum and mustard.

10) For the first time, successfully employed molecular marker assisted selection/pyramiding of xa 13 and × a 21 genes from the source variety IRBB 55 in the genetic background of Pusa Basmati I: thus developed bacterial blast resistant variety. Improved Pusa Basmati I.

B) Horticulture :

1) Developed 721 high yielding varieties and production technologies in horticultural crops leading to the 'Golden revolution'. Through adoption of these technologies, India has emerged as the second largest producer of fruits and vegetables in the world. It has substantially improved the food and nutritional security.

2) Through the adoption of improved technologies, production increased up to 2.4 fold in banana and tomato, 1.6 fold in potato and 1.3 fold in cassava from 1991-92 to 2005-06.

3) Released export quality red-peeled and regular bearing mango varieties Pusa Arunima and Pusa Surya with long shelf life; developed a regular bearing, anthracnose disease resistant, red colour fruit and high quality mango hybrid H 39.

4) Developed early maturing and prolific bearer aonla cultivar Coma Aishwarya and high input-efficient potato cultivar Kufri Pukhraj.

5) Developed technology for seed multiplication in potato through seed plot technique and micro- and mini-tubers.

6) Standardized micro-propagation technology for seed and planting material in potato and banana.

7) Developed technologies for producing disease free planting material in citrus through shoot tip grafting.

8) Standardized high density planting and suitable canopy architecture in apple, pear, pineapple, mango, citrus and guava for improving productivity.

9) Developed a micronutrient mixture. Banana Shakthi, for banana crop.

10) Developed high productive coconut and areca nut based multispecies cropping systems involving spice crops for enhancing productivity and profitability

C) Natural Resources Management :

1) For sustainable land use, soil resource, degradation and fertility maps of different agro-ecological regions developed.

2) Assessed soil carbon stocks using the benchmark sites under different land use systems of the country.

3) Prepared integrated nutrient management packages for major cropping systems.

4) Resource Conservation Technologies (RCTs) such as zero tillage, furrow irrigated raised bed planting system and laser land levelling developed.

5) Mitigation and adaptation technologies to meet the challenges of climate change were promoted through a network.

6) Developed consortia of biofertilizers for major crops.

7) Standardized technologies for enriched composts/ vermicornpost.

8) Developed cost effective amelioration technologies for waterlogged, salt affected and acid soils.

9) Developed a network of 47 model watersheds that provided a basis for developing the National Watershed Development Programme for Rainfed Areas (NWDPRA).

10) Evolved rainwater harvesting techniques for enhanced water and crop productivity.

D) Animal Science :

1) A unique National facility. High Security Animal Disease Laboratory with P-4 measures established that played a pivotal role in providing diagnostics services for avian influenza in the country besides developing vaccine using indigenous strains.

2) 80% of 140 indigenous breeds of livestock and poultry characterized phenotypically and genetically.

3) Five breeds of indigenous livestock and poultry were conserved and characterized both phenotypically and using molecular markers.

4) Vrindavani breed of cattle developed with production potential of 3,500 kg milk par lactation.

5) Graded Murrah buffaloes with 2.200 kg milk yield per lactation evolved.

6) Improved strains of sheep for fine wool (Bharat Merino), carpet wool (Chokla, Marwari, Magra) and meat (Malpura, Nellore, Mandya, Madras Red) developed.

7) Artificial insemination method standardized in mithun, yak, camel, goats, pig and equines; first mithun calf born through artificial insemination in India; crystoscope device developed to detect accurate time for insemination in cattle and buffaloes.

8) For promoting backyard poultry an early-maturing poultry strain, CARI-Nirbhik, producing 223 eggs by 72 weeks, developed.

9) Hormonal-modulation protocols developed to increase egg production in poultry.

10) A new fungus genus Cyllamyces icons with better fibre degrading ability identified for the first time in Indian cattle and buffaloes.

E) Agricultural Engineering and Technology :

1) Developed over 150 agricultural tools, implements and machines for timeliness of farm operations, drudgery reduction and efficient input use for various field and horticultural crops; of which 75 machines commercialized.

2) Conducted ergonomic and safety studies leading to reduced drudgery and improved safety of farm machines, particularly, to suit farm women.

3) Developed renewable energy source-based devices and gadgets such as solar refrigerator, low cost solar cookers and water heaters, solar concentrators for solar photovoltaic (SPY) panels, solar cocoon stiffler, high efficiency cook stoves, pyrolysed briquetted fuels, gasifiers. improved biogas plants, dewatering system for biogas slurry. Utilization of animals in rotary mode for operating different agricultural machines & equipment.

4) Developed structures, environmental control techniques and packages of production practices for raising nurseries, production of flowers, medicinal plants and off-season vegetables.

5) Developed plastic-lining for rainwater harvesting ponds and pond based micro-irrigation systems, plastic mulching of crops, carp hatcheries and transportation system for live fish.

6) Developed low cost improved storage structures for foodgrains, evaporatively cooled structures for fruits and vegetables, machinery and pilot plants for value addition to agricultural produces.

7) Developed equipment for soybean processing and utilization - soybean dehullers, extrusion expelling pilot plant, soy flaking machine, soy snack extruder, cottage level soypaner plant, okara fortified soy-cereal snacks.

F) Fisheries :

- Developed database of 2,200 fin fishes and shellfishes in Indian waters.
- Database of marine fishery resources of commercially important fish species developed.
- Identified 31 new species of fishes from Western Ghats and northeastern region.
- DNA bar coding of 75 species of Indian marine fishes completed.
- PCR-based gender identification of marine mammals developed.
- Micro satellite enriched genomic library developed for Pangasius.
- Milt cryopreservation and breeding protocols developed for the conservation of yellow catfish. Horabagrus nigricollaris, an endangered fish of western ghats.
- Early maturation and breeding of Indian major carp, rohu (Labeo rohita) achieved through photo thermal manipulation.
- Cloning and sequencing of genes, viz, gonadotropin GTH I and its releasing hormone (GnRH) encoding cDNAs accomplished in rohu.
- Developed genetically improved rohu. CIFA IR I, with enhanced growth.
- Achieved mass seed production of freshwater food fishes, viz. medium carps. Labeo gonius, Labeo imbriatus,, Puntius sarana; catfishes, Ompok pabda, Mystus vittatus; chocolate mahseer, Puntius hexagonolepis; and Chitala chitala, enabling diversification of culture practices.

- Portable FRP carp hatchery designed and developed.
- Hatchery breeding techniques developed for marine and freshwater ornamental fishes.
- Giant freshwater prawn, Macro brachium rosenberg bred using inland ground saline water.
- Captive breeding of kuruma shrimp, Metapenaeus japonicus carried out.
- Breeding and larval rearing of sand lobster, Thenus orientalis achieved, for the first time in the country.

Agriculture Education :

- Financial and professional support provided to Agricultural Universities (AUs) for modernization and strengthening of academic facilities, infrastructure and faculty improvement.
- Accreditation Board established for quality assurance in agricultural education and several AUs accredited.
- Norms, standards, academic regulations and under-graduate course curricula and syllabi revised and made utilitarian as recommended by the IV Deans' Committee and implemented by several AUs.
- Niche areas of excellence established to augment strategic strength of AUs in specific areas including those in new and emerging cutting-edge technologies.
- Over 180 units for experiential learning established in AUs for providing skill-oriented hands-on training to the students at undergraduate level.
- For quality upgradation, reduction of inbreeding and fostering national integration in higher agricultural education, admission of students up to 15% of total seats in undergraduate and 25% seats in post-graduate programmes being centrally undertaken.
- Faculty competence improved through 31 Centres of Advanced Studies.
- About 2,400 scientists trained in emerging areas including cutting-edge technologies through about 90 summer/winter schools organized every year.
- Awarded about 1,000 National Talent Scholarships for undergraduate studies, 475 Junior Research Fellowships for post-

graduate studies and about 200 Senior Research Fellowships for Ph.D. annually.

- Promoting excellence at national level through ICAR National Professor and National Fellow schemes.
- Need-based capacity building of NARS through Foundation courses, refresher courses, workshops, seminars and international programmes carried out by National Academy of Agricultural Research Management. The Academy also provides policy support, facilitates national dialogues and undertakes consultancies, for performance enhancement of NARS.
- Under the Indo-US Agricultural Knowledge Initiative, about 15 Borlaug fellows selected every year for training in USA; eight joint workshops organised; eight collaborative research projects undertaken, and visits of experts facilitated in the focus areas of (i) Education, learning resources, curriculum development and training; (ii) Food processing and use of byproducts and biofuels; (iii) Biotechnology; and (iv) Water management.
- ICAR facilitates admission of foreign students in Indian AUs by considering the applications received through the DARE, Educational Consultants India Ltd. (Ed. CIL), and Indian Council of Cultural Relations (ICCR). About 200 students are admitted annually in various degree programmes in agriculture, horticulture, forestry, veterinary, agricultural engineering etc.

G) National Agricultural Innovation Project (NAIP) :

- Earlier the NATP Project was implemented by ICAR during 1997-2005. The project has contributed to the development of about 300 new technologies and their adoption by farmers besides several new research tools, methodologies and intermediate products.
- The NAIP is being implemented in ICAR since July 2006 with the credit assistance of US$ 200 million from the World Bank and US$ 50 million Government of India share. Its main objective is to contribute to accelerated and inclusive growth through collaborative development and application of agricultural innovations by the public research organisations in partnership with private sector. NGOs and other stakeholders. By the end of December 2009, 187 subprojects have been approved at a total outlay of Rs 1,017 crores covering all the four components.

H) Knowledge Management :

- The agricultural research information system of the Council showcases and markets the developed technologies to various stakeholders.

- Disseminated information through flagship products such as research and popular periodicals, handbooks, monographs, technical and textbooks, popular books etc.
- About 200 publications brought out every year on topical issues related to agriculture.
- Scrolling news - another hallmark - launched at ICAR website.
- More than 1.5 lakh hits per month recorded for www.icar.org.in
- Accelerating ICT management in agricultural research through inter- and intra-net connectivity to narrow down the gap between technology developers and its users.
- Participated in Technological Exhibitions and Book Fairs of National level / international level to create awareness about agricultural research and education.

l) International Co-operation :

- Active collaboration with international agricultural research institutions including CG centres, CABI, FAO, NACA, APAARI, UN-CAPSA, APCAEM, ISTA, ISHS etc.
- MoU / Work Plans with over 30 countries for bilateral co-operation in agricultural research, training and study visits.
- ICAR offers quality and cost-effective agricultural education to international students at under-graduate and post-graduate levels. And need-based short-term training, programmes in specialized areas are also offered. Special concessions for SAARC students.
- Strong support to CGIAR institutes. Total funding support in 2007-08 of US$ 2.65 million.

11.6 EXERCISE

1) Explain the objectives and milestones of Indian Council of Agricultural Research.
2) Describe the various salient achievements of Indian Council of Agricultural Research.

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12

KRISHI VIGYAN KENDRA (KVK)

Unit Structure :

12.0 OBJECTIVES

1) To study the concept of Krishi Vigyan Kendra (KVK)
2) To study the various objectives of Krishi Vigyan Kendra for Rural Development
3) To understand the various functions of KVK in Rural area

12.1 INTRODUCTION

Krishi Vigyan Kendra (K.V.K.) is a noble concept developed by Indian Council of Agricultural Research (ICAR) which was rest upon a solid base of transfer of technology from laboratory to farmer's field with respect to Agriculture, Horticulture, Animal Husbandry, Floriculture Bee Keeping, Mushroom Cultivation, Broiler Farming and allied subjects. As per the recommendations of Mohan Singh Meheta Committee during 1974, K.V.K.s were established in different states. Gradually working guidelines are prepared to make the K.V.K. as the light house for the rural people.

Indian Council of Agricultural Research emphasized on the research on agriculture and allied subject during 1960’s to generate new technology for increasing crop production in different agro climatic zones of the country. A lot of technologies were generated through constant effort of the scientists to boost up the production. But the technologies so generated in the research field are not transferred through extension agencies of different State Government, it is observed that a lot of technologies could not reach the fanner due to high cost of adoption, lack of the interest of the extension agencies. Hence, the transfer of the technology was not complete and effective. Later on K.V.Ks were established for easy and active participation of fanners through Front Line Demonstration and on Farm Testing.

As per the mandate of Indian Council of Agricultural Research, K.V.K. will operate under the administrative control of State Agricultural University (SAU) or Central Institute situated in a particular area. Different scientists from different disciplines as per the specific requirement of that particular area are posted in the Krishi Vigyan Kendra as Training Associate. Generally there are six categories of scientists posted in the K.V.K. i.e. (i) Training Associate (Crop Production) to look after the experiment on field crops as well as provide training and advice on different field crops, (ii) Training Association (Horticulture) looks after the training and demonstration on horticultural crops such as vegetables, fruits and flowers. (iii) Training Associate (Plants Protection) Provides training and demonstration on control of different pests and diseases in different crops. He also imparts training and advice on different types of pesticides and insecticides, their methods and time of application, (iv) Training Association (Animal Science) looke after over all growth and management of animal resource of that particular area. He also imparts training and advices on broiler farming dog rearing as well as rabbit rearing etc. (v) Training Associate (Agricultural Engineering) looks after the use of different agricultural implements in the field for different agricultural operations through training, demonstrations and on farm testing, (vi) Training Associate (Home Science) involved in the improvement of skill and attitude of the fanners and farm women as well as provides advices and training on kitchen gardening preparation of nutritional food and different handicrafts. She also imparts training regarding the preservation and storage of fruits and vegetables for rural youths of the adopted village.

Training Organiser, head of the K. V. K. family co-ordinates the work of all scientists for smooth functioning of the K.V.K. as well as for the benefit of the rural people of that particular area. He is also liaisoning with other line departments for co-ordination and effective implementation of different programs of the K.V.K. in the adopted village. Every K.V.K. has adopted 4 to 6 economically, culturally and technologically backward villages situated within 10-20 Kms radius of the K.V.K. These villages are not too small or too large. Before adoption, a detailed survey of the village was conducted to study the socio-economic and cultural status of that village. Now-a-days Participatory Rural Appraisal (PRA) tool was used to conduct the survey in which the village people are actively participated in the process. The village map was drawn by the help of different colour by the villagers themselves and different prominent structures of the village such as school, temple, river, club etc. were depicted in that map. These structures will help the scientists to conduct the survey easily and smoothly. Basing upon the survey the field crop maps, animal resource map and other ancillary maps were prepared for future use. After the survey work, detailed plan of work was chalked out and depending upon the requirement different activities were undertaken in different areas by K.V.K. scientists.

12.2 THE OBJECTIVES OF KVK

a) To demonstrate the new improved technology to the farmers as well as to the extension agencies directly in the farmers field with their active participation.

b) To identify the important problems of that area as per the need of the farmers and prioritization of the identified problems as per their importance.

c) To collect feed back from the farmers and extension agencies and to communicate these message to research scientists for modification of technology.

d) To impart training on different topics to different groups of the villagers.

e) To provide new and important information to the extension agencies and NGOs for wider circulation in that locality to improve their economic condition.

f) To prepare different extension models and verify these models in the farmers field with their participation to create confidence among them.

To achieve the abovementioned objectives K.V.K. undertake following types of activities in the adopted villages :

1) Farm Advisory Service
2) Training programme for different categories of people.
3) Training programme for the extension functionaries.
4) Front Line Demonstration (Fill) (5) On Farm Testing (OFT).

Farm Advisory Services:

Krishi Vigyan Kendra otherwise known as Farm Science Center. It provides solution to any problems related to agriculture and allied subjects as and when faced by farmers of that particular locality. Interested farmers / persons can get proper advices regarding the establishment of new entrepreneurship on non-traditional sector. The main function of advisory service center is to provide continuous and constructive advice along with sound theory and practical knowledge to the contact villagers regarding agriculture and its allied subjects for their cultural and economical improvement. The objectives of the Farm Advisory Center are as follows :

a) To study the socio economic status of the villagers.
b) To keep close relationship between K.V.K. and villagers.
c) To prepare individual farm model for upliftment of rural people.
d) To provide training and advice to the rural people so as to enable them to take part in the agricultural planning of the villages, blocks as well as districts.
e) Formation of farm club, farm center or village committee for easy transfer of new information related to agriculture to the villagers in short time.

12.3 FUNCTIONS OF KVK

1) Training programme for different categories of people :

Training is one of the most important activities of Krishi Vigyan Kendra. Training is planned and systematic effort to increase the knowledge, improves the skill and change the attitude of a person towards a particular subject. Training need assessment is the first and foremost factor to be considered before conducting any training programme. Depending upon the need and categories of trainees. K.V.K. imparts mainly following three types of training:

2) Training to the practising farmers and farm women:

Training on different subjects were conducted by the scientists of the K.V.K. as per the need of the local farmers of a particular area as well as the types of trainees and different audio visual aids are used to increase the efficiency of the training. As the trainees are practising farmers and farmwomen, more emphasis was given on the practical than theory to improve their skill to change their attitude and increase their knowledge for that particular topic.

3) Training to the Rural Youth:

This type of training was imparted to the rural youth (Both male and female) mostly those are left their education in midway i.e. school dropouts. The main objective of this training is to provide sufficient knowledge and skill regarding a new entrepreneurship so that they can start their own business singly or collectively and generate some income for their livelihood. The main thrust areas of this type of training are mushroom cultivation, bee keeping, preservation of fruits and vegetables, broiler farming, goat rearing, tailoring, wool knitting, hand crafts and exotic vegetable cultivation etc. for more profit. In this training more emphasis was given on the practical aspects and trainees were do the practical themselves to get more confidence. The scientists of the K.V.K. provide knowledge regarding the availability of the raw materials as well as the marketing of different products in that particular locality for the interested participants.

4) Training programme for the extension functionaries :

In this group, mostly government employees of agriculture along with extension functionaries of line department and members of different NGOs operated in that locality are trained in different aspects. The main objective of this type of training is to refresh the memory and upgrade the knowledge and skill of the extension functionaries by providing recent and new information regarding new techniques as well as new approach of solving different problems faced by fanners of that locality. As the extension functionaries of different department act like a bridge between the scientists and villagers, the refinement of the knowledge is highly essential and quite helpful for effective and efficient transfer of the technology.

5) Front Line demonstration :

Front Line Demonstration (FLD) is the field demonstration conducted under the close supervision of the scientists because the technologies are demonstrated for the first time by the scientist themselves before being fed into the main extension system of the state department of Agriculture in that particular area. In this method newly released crop production and protection technologies and its management practices are adopted in a block of two to four hectares in the farmers field. Only critical inputs and training for this demonstration are provided by Krishi Vigyan Kendra. In FLD both farmers and extension functionaries are target audience. From the FLD, it is possible to generate some data related to factors contributing to higher yield and also constraints of production under various farming situations. Front Line Demonstration is conducted in a particular area after thorough discussion and consultation with the farmers of that locality. Depending upon the requirement of that area highly efficient new proven technology with higher potentialities is selected for this programme. Generally, a field day is observed in the demonstration field when the crop is at maturity stage and interaction between the scientists, fanners and extension functionaries takes place in the field. The crop is harvested in the presence of the interested group of fanners so that they can visualize the importance of new technology easily and effectively.

6) On Farm Testing (OFT) :

Testing of any improved technology along with the tanners practice in the fanners field with active participation of both the scientists and farmers is known as OFT. In this method two to three improved varieties or two to three improved technologies are tested in the same field so as to compare the results of these treatments. As per the suggestions of the fanners as well as local soil and climatic conditions the improved technology may slightly be modified by the scientists of K.V.K. to get maximum return.

All these activities of the K.V.K. are undertaken as per the suggestion and approval of the Scientific Advisory Committee. This committee consists of representative from the Vice-chancellor of State Agricultural University or Director of the Institute, representative from the Indian Council of Agricultural Research, representative of the District Collector, representatives from Department of Agriculture, Horticulture, Animal Husbandry, Sericulture, progressive male and female farmers, male and female social workers of that area and Training Organizer of the concern K.V.K. The Scientific Advisory Committee held once in a year to review the work of K.V.K. and provide suggestions for future plan of work. The future technical programme of the K.V.K. is prepared as per the suggestion of the farmers of that particular area.

Besides these activities each K.V.K. has got different demonstration units such as Mushroom unit. Biofertiliser unit, Vermicompost unit, Broiler fanning unit, Bee keeping unit, Fruit preservation unit etc. for the lagers. When a person will visit K.V.K., he will be able to see all the enterprise in the demonstration unit and he can interact with the scientists regarding the establishment of his own enterprise. These units will help the villager to increase his confidence on a particular enterprise.

From these discussions, it can be concluded that the scientists of K.V.K. provide required knowledge, impart training to improve the skill and attitude of the people towards a particular subject, provide proper guidance to solve any problem faced by the people related to agriculture and allied topics. Krishi Vigyan Kendra provides inspiration, constructive and constant advice to the people of that area to start new entrepreneurship for their livelihood and show them proper way when need actual help as the light house help the sailor in the sea. So we can rightly say that Krishi Vigyan Kendra is the light house for the rural people.

12.4 EXERCISE

1) Explain the concept of Krishi Vigyan Kendra and state the various objectives of K.V.K.
2) State the various functions of Krishi Vigyan Kendra for Rural Development.

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13

DEPARTMENT OF AGRICULTURE (GOVT. OF MAHARASHTRA) AND AGRICULTURAL UNIVERSITIES IN MAHARASHTRA

Unit Structure :

13.0 OBJECTIVES

1) To understand the structure of Department of Agriculture in Maharashtra
2) To study the role and functions of agricultural universities in rural development
3) To study approaches and various methods used for extension education
4) To study in detail about visions and goals of agricultural Universities in Maharashtra

13.1 INTRODUCTION

The need to grow more food was felt during the 19th Century because of the increasing pressure of population. According to the recommendation of Famine Commission (1881), Agriculture

Department was established in 1883. Work started with the aim of helping the rural community to achieve higher productivity in agriculture. Agriculture and Land Records Departments were functioning together till 1907. After getting encouraging results in an effort made during 1915-16 to stop soil loss, Mr. Kitting, the then Agriculture Director started soil conservation work from 1922.

Agriculture Department took up various land development activities with the enactment in 1942 and subsequent enforcement of Land Development Act in 1943. For the first time in 1943, the then Government prepared a comprehensive Agriculture Policy considering the problems in agriculture and allied sectors. According to this policy, emphasis was given on use of water as irrigation for agricultural crops.

The post independence period from 1950 to 1965 is recognized as pre Green Revolution period. During this period, several schemes were launched to boost growth of agriculture sector. Production of quality seeds through Taluka Seed Farms started during 1957. Emphasis was given on increase in irrigated area along with cultivated area during this period. A special campaign was launched in 1961-62 to encourage use of chemical fertilizers.

Development of hybrid varieties of different crops since 1965-66 laid down the foundation of Green Revolution. Five year plans following this period specially emphasized development of agriculture. Nala bunding work was taken up along with land development work by the department since 1974, which led to increase in well and groundwater level. Introduction of intensive agriculture, comprising of large-scale use of improved seed, fertilizers, pesticides and available water helped increase in agriculture production. Later on, considering the need for providing guidance to the farmers for proper and judicious use of these inputs, Training and Visit Scheme was launched in 1981-82. Valuable contribution of this scheme through effective implementation of programs like Crop Demonstrations, Field Visits, Corner meetings, Workshops, Fairs, Exhibitions etc. aimed at transfer of technology from Agriculture Universities to farmer's fields was evident from the increased agricultural production.

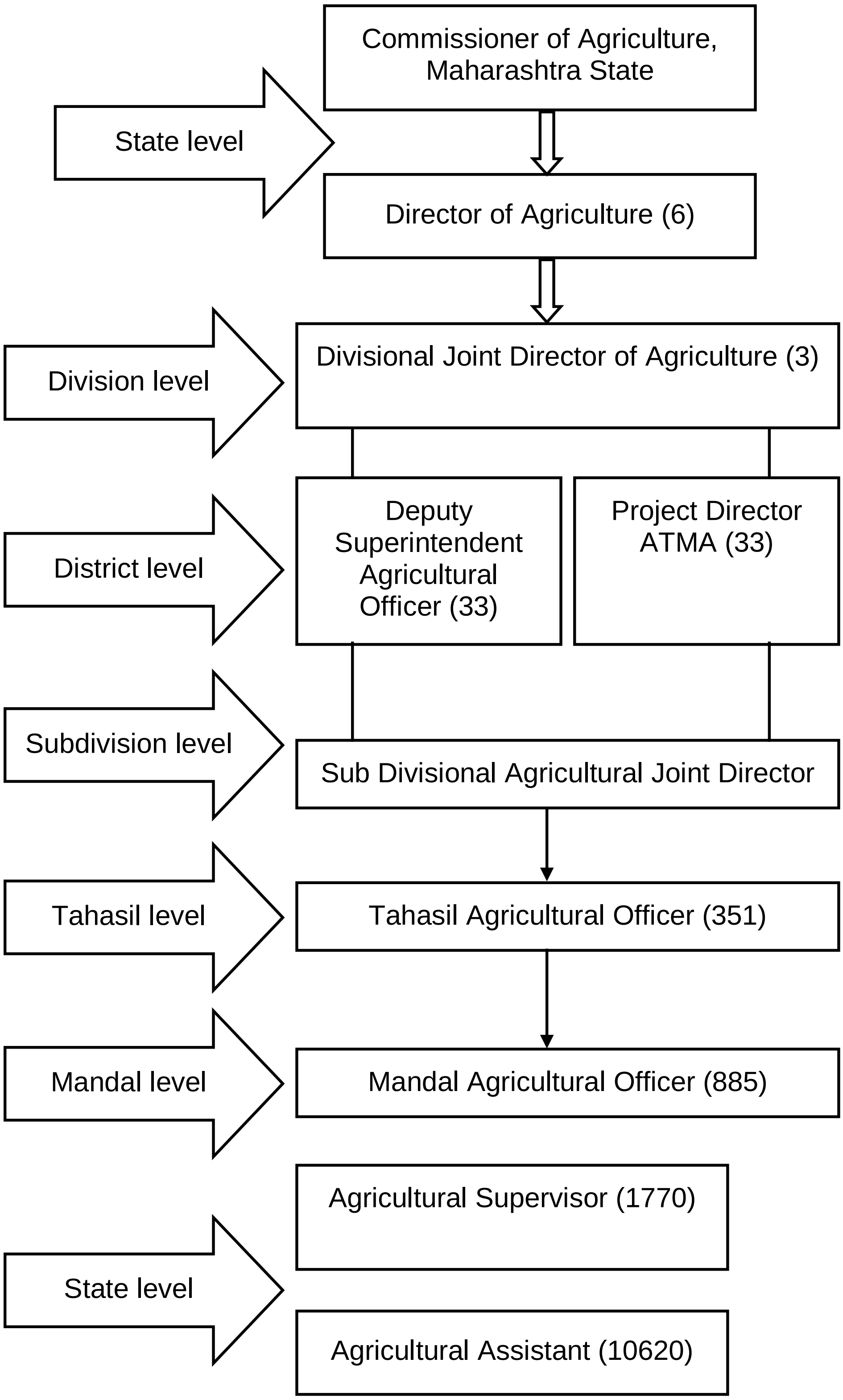
Though we have become self-sufficient in foodgrain production inspite of the tremendous increase in population, self-sufficiency in agriculture is not the only aim of the State but assurance of more and more net income to the farmers through the efficient and sustainable use of available resources is more important. To achieve this, commercial agriculture should be practiced. Different schemes are implemented to increase agricultural production, export promotion and to encourage the agro processing industry with a view to take advantage of liberalized economy and Global trade. Thus, agriculture department is firmly stepping towards economic progress along with self-sufficiency through agriculture and to achieve important position in the global agriculture produce market. The innovative horticulture plantation scheme under employment guarantee scheme implemented by the State is a part of this policy.

Agriculture department considers farmer as the focal point and the whole department is organized in such a fashion that a single mechanism is working to facilitate the farmer for adoption of advanced technology and sustainable use of available resources. Every agriculture assistant working at village level has a jurisdiction of three to four villages with number of farmers limited to 800 to 900, which facilitates more interaction for easier transfer of technology.

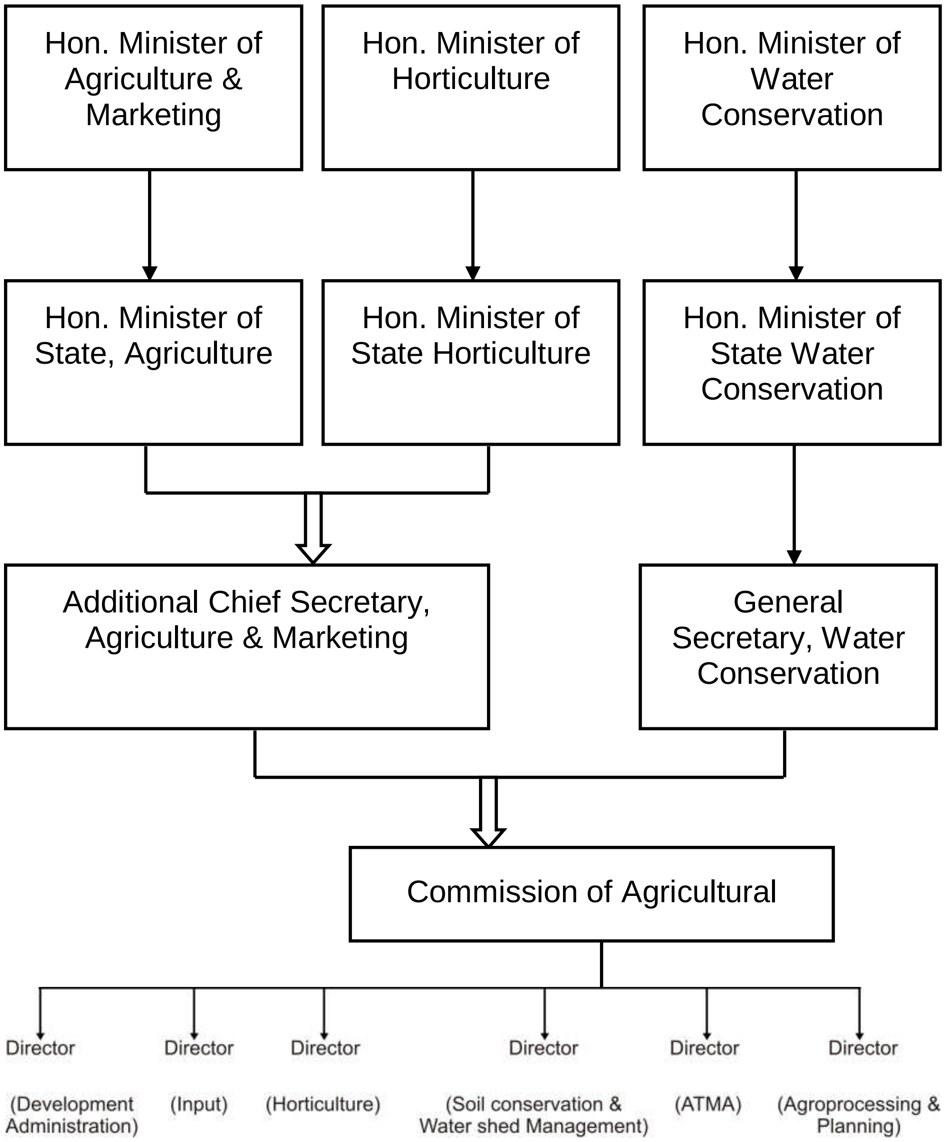
Agriculture Assistant at village level undertakes soil conservation work, horticulture plantation and various extension schemes. He is supervised by Circle Agriculture Officer at circle level. Administrative control, liason with other departments, monitoring and training programs etc. are facilitated by Taluka Agriculture Officer at taluka level, Sub Divisional Agriculture Officer at sub-division level, District Superintending Agriculture Officer at district level and Divisional Joint Director at division level. In addition, Agriculture Officer at Panchayat Samiti level, working under Agriculture Development Officer, Zilla Parishad at district level also implements various agro-inputs related schemes.

All the schemes implemented in the field are supervised technically and administratively by respective directorates of Soil Conservation, Horticulture, Extension and Training, Inputs and Quality Control, Statistics, Monitoring and Evaluation and Planning and Budget at State level in the Commissionerate of Agriculture. Also, separate sections are there for the Establishment and Accounts related matters.

13.2 REGIONAL LEVEL STRUCTURE OF AGRICULTURAL DEPARTMENT

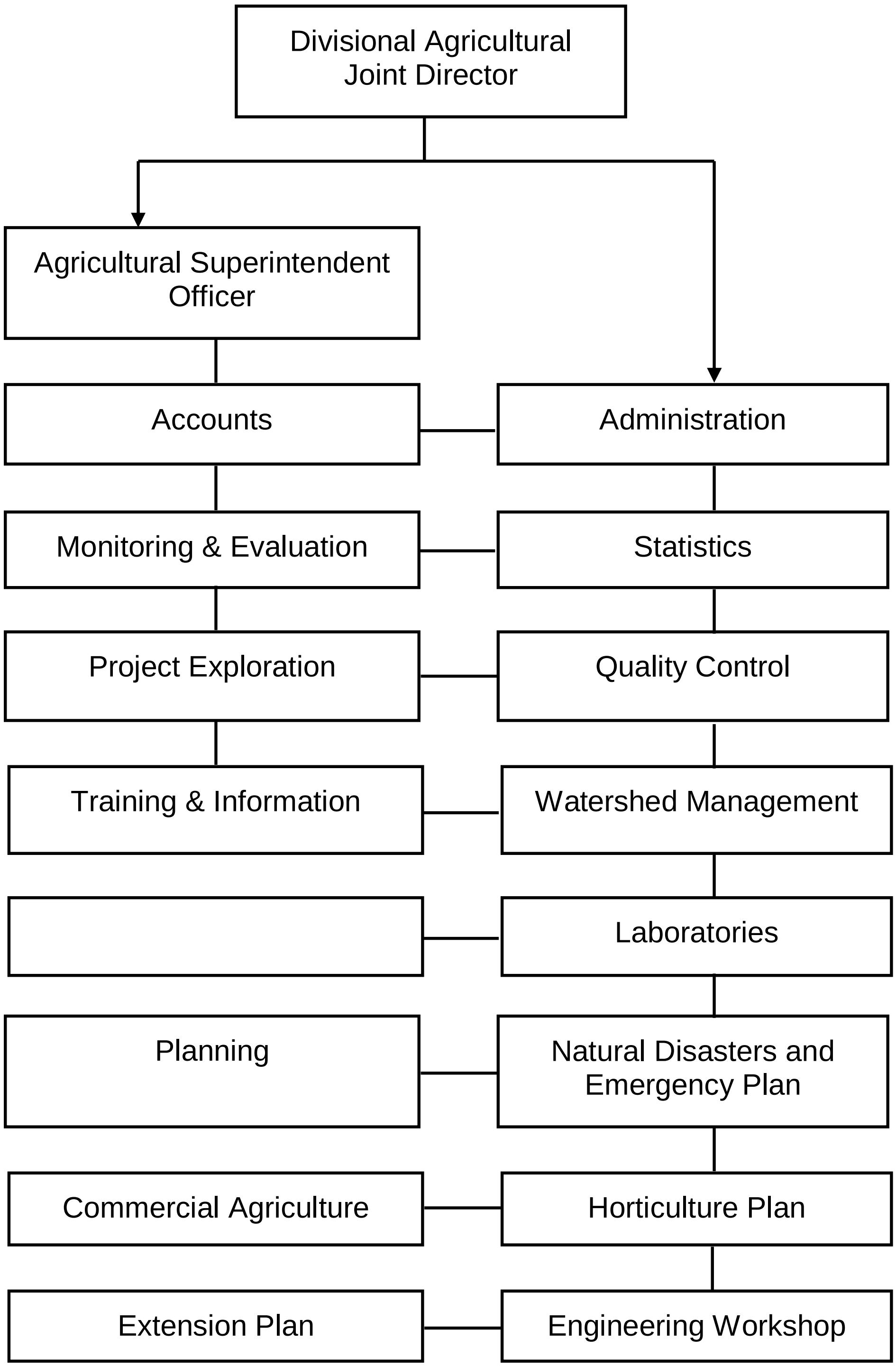


13.3 DEPARTMENT OF AGRICULTURE, GOVERNMENT OF MAHARASHTRA



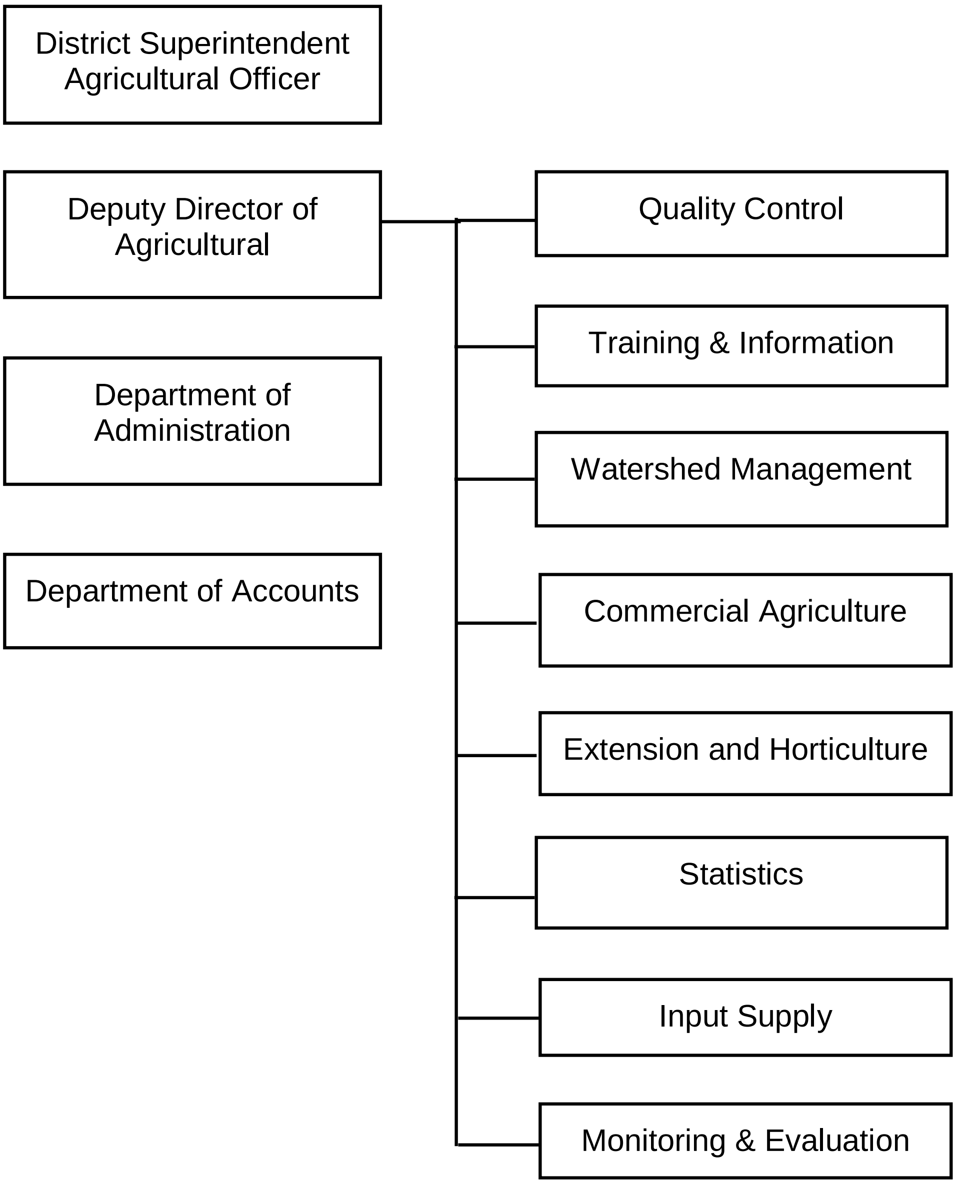
13.4 DIVISION LEVEL

Office of Divisional Agricultural Joint Director :



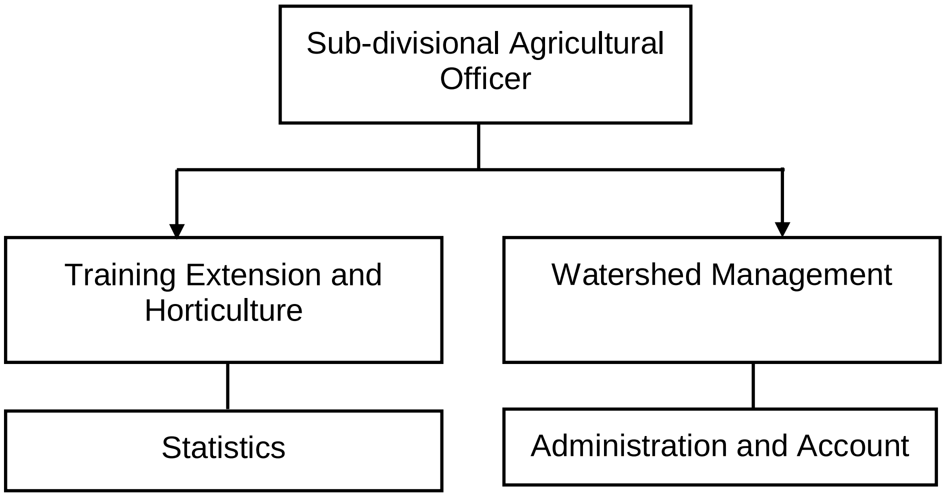
13.5 DISTRICT LEVEL

Office of District Superintendent Agricultural Officer :

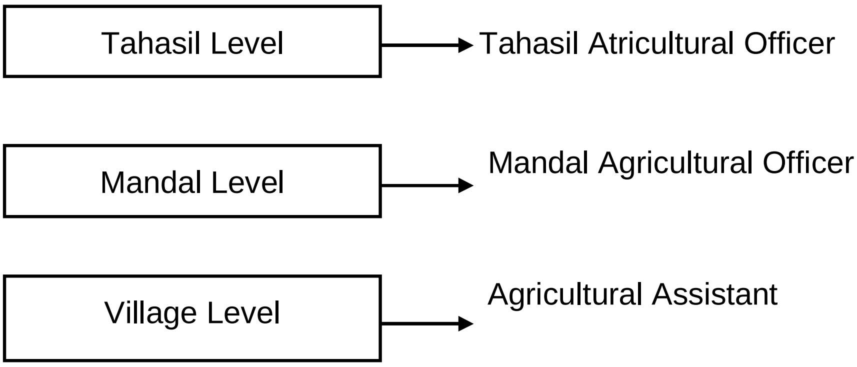


13.6 SUB-DIVISIONAL LEVEL

Office of Sub-divisional Agriculture Officer :



13.7 TAHASIL LEVEL



13.8 HISTORICAL DEVELOPMENT OF THE SAUs AND DOEE IN UNIVERSITIES WITH AGRICULTURAL FACULTIES IN INDIA

In its early phases, the Indian agriculture education system was in the domain of public-funded general universities. Agricultural research and education received major support in the first decade of the 20th century when Lord Curzon was the Viceroy of India. By 1905 only six agricultural colleges had been established in Pune (Maharashtra), Kanpur (Uttar Pradesh), Sabour (Bihar), Nagpur (Maharashtra), Faisalabad (Now in Pakistan) and Coimbatore (Tamil Nadu) with annual funding of Rs. 2 million by the Government of India. These staff and laboratories and mandated with research and teaching initiatives in 1926, the Royal Commission placed Emphasis on the importance of a strong research base for agricultural development in India.

The most significant milestone was the establishment of the imperial (new India) Agriculture Research Institute (IARI) at Pusa (Bihar) in 1905. Due to an earthquake in 1934, the Pusa Institute was shifted to New Delhi in 1936. The Royal Commission established the autonomous imperial (new Indian) Council of Agriculture Research (ICAR) in 1929. It was mandated to promote, guide and co-ordinate agriculture research with a non-lapsing fund of Rs. 5 million. The establishment of the ICAR empowered agricultural research in India. However, the ICAR had no administrative control on research institutions in the provinces.

At the time of independences in 1947, only 17 agricultural and veterinary colleges were established to focus on training of students in agriculture, whereas the State. Departments of Agriculture and Community Development focused on research and extension. There were no close linkages between agricultural colleges and research departments to ensure maximum utilization of proven technologies instead of costly agricultural education and limited resources, regional interests pressed for the establishment of a large number of new agricultural colleges during the early past-independence period. From 1953 to 1960, the number of agriculture / veterinary colleges almost doubled in spite of inadequate financial support, rapid spread of agricultural colleges affiliated with traditional universities led in the downward slide of standards in education, which became a serious problem. Accordingly, the pace of progress remained slow and production technology developed at these institutions did not keep pace with the fast changing requirements. Therefore, it was realized that both the system of education as well as the set-up of the agriculture / animal science institutions needed to be reorganized to serve as an effective vehicle for agricultural progress and developed. This necessitated a review of the existing system of agricultural education.

Reorganizing the weakness of the then existing educational system and need for linking programs of agricultural education with production programs, the University Education Commission (1948) headed by Dr. S. Radhakrishnan suggested the establishment of ‘Rural Universities’. This recommendation was strengthened by the proposals made by two joint Indo-American Teams (1955 and 1960), which endorsed the establishment of State Agriculture Universities (SAUs).

The United States Agency for International Development (USAID) and American land-grant universities helped with the development of SAUs in India in some developing countries, especially in Asia, agricultural research and education is organized under an autonomous agriculture, university based on the pattern of the land-grant universities in the United States of America. The SAUs of India, Pakistan and the Philippines are based on this model as well.

In India the first SAU was established in 1960 at Pantnagar in Uttar Pradesh. The SAUs were given autonomous status and direct funding from the State Government. They were autonomous organizations with Statewide responsibility for agricultural research, education and training or extension education. The establishment of the SAUs based on a pattern similar to that if the land-grant universities in the United States was a landmark in reorganizing and strengthening the agriculture education system in India. These universities become the branches of research under the ICAR and became the partners of the National Agricultural Research System (NARS). The green revolution, with its impressive social and economic impact, witnessed significant contributions from the SAU's both in terms of trained, scientific work force and the generation of new technologies.

The SAU's are headed by a vice-chancellor, governed by a board and advised by an advisory committee. The governing boards of the SAUs have representatives from government, farmers and agri-business. Being autonomous organizations, they are able to effectively integrate research and education and worry out their mandate. The SAUs receive core funds for research and education from the State Governments and substantial grants from the national institutes. The second National Education Commission (1964-66) at that time headed by the University Grant Commission Chairman, Dr. D.S. Kothari, recommended the establishment of at least one agricultural university in each Indian State. These universities imparted education on all aspects of agriculture on the same residential campus and integrated teaching with research and extension.

Subsequently, implementation of the recommendations of the Education Commission (1946-1966) and Review Committee of Agricultural Universities (1977-1978) streamlined their functioning and all matters related to agricultural research in the States were transferred to the Universities. According to Review Committee of Agricultural Universities (1978) an essential feature of the Agricultural University system is the acceptance of the philosophy of service to agriculture and to rural communities with the following mandates :

- ❖ State-wide responsibility for teaching, research and extension education.
- ❖ Integration of teaching research and extension at all levels of the university administration.
- ❖ Multi-disciplinary teamwork in the development programs of education, research and extension.
- ❖ Acceptance by all concerned in the university of a philosophy of service to agriculture and the rural community and emphasis on

programs that are directly and immediately related to solving social and economic problems of the countryside.

- ❖ Quick communication of new knowledge to students in classrooms, to extension personnel and to farmers.
- ❖ Programs giving specialized training to the rural youth and adult men and women when are not candidates for degrees through departments involved in responsibility for the subject matter being taught.

To accomplish these commitments, there is a need for adequate and efficient extension to be set up for the speedy and effective communication of new knowledge and technology to extension agents and to farmers. As agriculture plays a very important role in the Indian economy. Setting up an adequate number of agricultural universities was considered very important. However, the responsibility for extension rests with the Department of Agriculture and Co-operation (DAC) and the Department of Animal Husbandry, Dairying and Fisheries (DADF), which are under the Central Ministry of Agriculture.

13.9 THE DIRECTORATE OF EXTENSION EDUCATION

The Directorate of Extension Education (DOEE) is the nodal agency of SAUs for promoting agricultural development in the State through quick transfer of technology by providing training, consultancy and farm information to line departments' professional extension personnel and farmers. It also involves the assessment, refinement and adoption of technology through on-farm testing and front-line demonstrations. The directorate provides guidelines, monitors and evaluates the extension programs of Krishi Vigyan Kendras (KVKs) functioning under SAUs. The directorate also extends its support to the State departments through disseminating farm information by publishing literature on different agricultural disciplines and related subjects. Thus, the three principals, functional areas of the DoEE are training, consultancy and communication. The directorate has a team of multi-disciplinary scientists who work in participatory mode in close co-ordination with the Department of Agriculture, Animal Husbandry, Horticulture. Forestry, Co-operatives, Panchayat Samities and other agencies engaged in the betterment of rural people.

13.9.1 Mandate of the Directorate of Extension Education :

- To formulate and impart in-service training to different categories of officers and functionaries from line departments of State and non-government organizations.

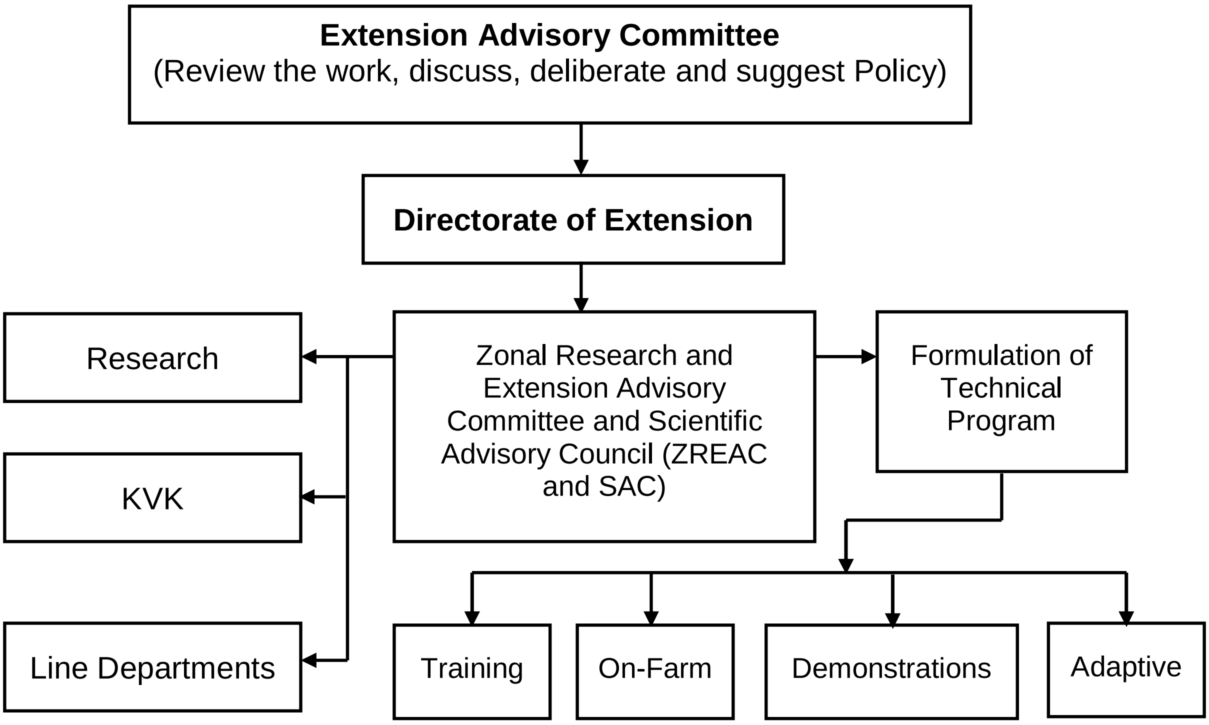
- To conduct short and long-term vocational trainings for farmers, farm women, youth and school dropouts.
- To assess and refine the latest agricultural technology through front-line demonstrations for their wider adoption.
- To provide farm information services through various extension activities, including literature, for the quick dissemination of technology.
- Through the DoEE, the university extension service maintains live and intimate links with the research departments' on one hand and with the field-level functionaries of different State departments, development agencies and farmers on the other hand.

13.9.2 Organizational Structure of the Directorate of Extension Education :

The Directorate of Extension Education (DoEE) conducts its extension activities through its headquarters. KVKs, Krishi Gyan Kendras (KGKs) etc. The directorate disseminates the latest technological innovations through farm advisory, training, information and communication services by involving scientists from different departments of the university and research institutions. It aims to serve as a link between research, extension and farmers and provide critical feedback for university research as well as to the main extension system. A well-defined mechanism is followed involving the Directorate of Research, the line departments and extension education units while formulating technical programs for different units of the DoEE.

As per mandate, a Scientific Advisory Committee is constituted at each KVK for assessing, reviewing and guiding their programs and progress. The members of this committee comprise a cross-section of scientific and fanning communities' representatives of both government and non-government organizations who are directly or indirectly involved in the process of agricultural training, production and development. The AT1C is a constituent unit of the directorate, which serves as a single-window delivery system to help farmers and other stakeholders by providing solutions to location-specific problems and making all technological information, along with technology inputs, available. The organizational set up and extension mechanism of the DoEE is presented in Figures 4. 1 and 4.2 (on the next page)

A Typical Organizational Set-Up of the Directorate of Extension Education at the State Agricultural University Level

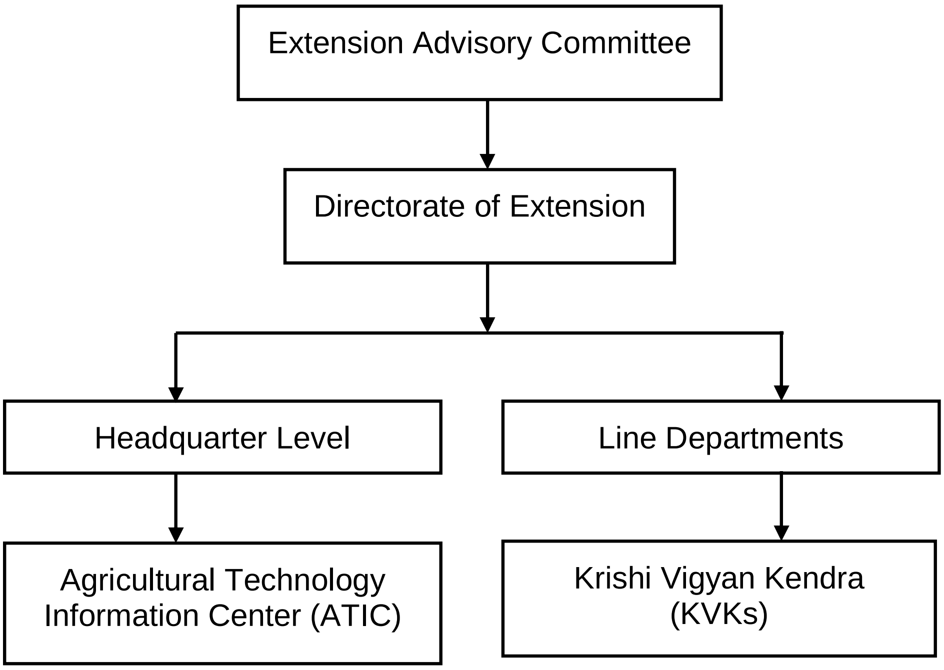


13.10 APPROACHES AND METHODS USED BY THE DIRECTORATE OF EXTENSION EDUCATION

1) ELECTRONIC MEDIA INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

ICT has a major role to play in all facets of Indian agriculture. The extensive use of ICT and its infrastructure would therefore be a critical component of the strategy to revitalize the national extension system. The directorate usually arranges radio talk discussion by university experts on All India Radio. The scientists from headquarters, KVK and KGK also deliver radio and TV talks regularly for the benefit of the farming community. Integrated use of both the conventional as well as upcoming electronic media like Intra and Internet, information kiosks, cable TV, mobile telephones, vernacular press and other print media is the way forward by pooling and effective use of ICTs. The radio and Doordarshan (public television broadcaster of India) cover special activities carried out by the university such as kisan mela, agricultural officer workshops, training, field days, kisan goshti. etc.

A Typical Extension Activities Mechanism of the Directorate of Extension Education :



2) MASS MEDIA :

Among various extension methods, the use (if media is useful in creating awareness and stimulating interest, along with large coverage of the audience (Hussain, 1997; Okunade, 2007). New and improved agricultural technologies, developed in Agricultural Research Institutes, universities, the private sector and often by the farmers themselves, have to be disseminated among the masses in order to increase productivity and overcome hunger and poverty. In this context, farmers need adequate exposure to information on technologies that may be available. Research has shown that by-and-large farmers' exposure to information is an important factor influencing their technology adoption behavior. In South Asian countries, including India, it is primarily the public extension services that are mandated to disseminate new agricultural technologies.

3) Organizing Farmer's Fairs and Field Days :

The directorate is engaged in refining and disseminating agricultural knowledge to farming communities through a network of KVKs in various agro-climatic zones. The directorate orgazines farmer's fairs and field days for the active participation of farmers and farm women. These activities give farmers and the public the opportunity to witness the latest. Proven technologies Exhibitions on the laest technologies are organized for face-to-face interactions between farmers and scientists. The sale of the lastest varieties of plants and vegetable saplings creates a large amount of publicity on the spot technical solutions are demonstrated at visits of experimental sites.

4) Capacity Building of Extension Staff and Farmers :

Human resources development is an important mandatory activity of the university's extension education system. The DOEE is organizing various national level, state-level and in-house personnel trainings, model training courses, faculty development courses, winter and summer schools, etc. The directorate is also organizing vocational trainings for economic empowerment and livelihood security for farm families short-term trainings for farmers, farm women and rural youth on new production technologies are organized regularly at the directorate.

The DOEE organizes national level training programs, workshops and seminars for promoting the professional competency of the officials and extension personnel working in different time departments of government. Major training areas include oilseeds and pulse, cropping system approach, seed production technology post-harvest technology, integrated post management, arid horticulture, micro-irrigation systems etc.

The directorate organizes short-term training courses for subject matter specialists of line departments on subjects like integrated pest management, organic farming, vermicompost, women in agriculture, aromatic and medicinal plants, etc. In these courses, the officials are exposed to emerging problems and their possible solutions as well as recent technological advances.

To update scientist of SAUs on recent advances in science and technology the ICAR-sponsored winter / summer schools are being organized by the DOEE courses on communication technologies and extension methodology : innovates breeding methodology. For sustainable, higher production in course cereals; and advanced media communications, extension techniques and vocational entrepreneurship for sustainable livelihood by agriculture practitioners are being organized.

Scientists of the DOEE are provided trainings with the purpose of updating skills required for work effectiveness and efficiency. In recent years, scientists have been trained in the areas of on-farm testing, post-harvest management, tally accounting, impact studies, etc.

The DOEE is one of the recognized centres for agri-clinics and agri-business trainings in the country. These trainings are sponsored by the ministry of Agriculture and Co-operation. (Government of India, New Delhi) with these trainings, the DOEE is providing 60 day training these not yet employed in the agriculture sector. The purpose of such training is to teach entrepreneurial and managerial skills to agricultural graduates so as to enable them to establish their own enterprises and provide jobs to others as well. Major areas where participants establishes their own business are bio-fertilizers and bio-pesticide production, rural storage structures (‘godown’), agricultural input marketing, custom hiring fruit and ornamental plant nurseries, agri-clinics retail shops, etc.

5) Training Programs for Farmers :

The directorate is organizing inter-state and state-level short-term courses for practicing farmers and farm women on crop production, horticulture, plant protection, animal production, home science and other related disciplines. These training programs are sponsored by line departments of agriculture, horticulture soil water conservation and NGOs. These trainings not only provide the participants practical exposure but also give an opportunity for participants to raise their incomes by adopting new technologies. These trainings are organized on the principles of ‘Learning by Doing’ and ‘seeing is Believing’.

6) Education :

The changes in agricultural research investment by center and State Governments are substantiated by the compound growth water in each period in Table 4.3. It show that public expenditure on research and education in India grew at 5.54% from 1960-70. 54.02% from 1971-1980. 5.3% from 1981-1990 and 7.18% from 1991-2004. The phases of changes in the real investment correspond to organizational changes in the research and education system. State research and education pending stagnated all declined marginally in almost all the States during the but two decades. From 1971-1980 it grew rapidly because of the establishment of several SAUs during the period in many States.

13.11 AGRICULTURAL UNIVERSITIES IN MAHARASHTRA

	Name of the University	Place	Working Area	Year
1	Mahatma Phule Agricultural University	At Post Rahuri, Dist. Ahemednagar	Pune, Satara, Sangali, Kolhapur, Nagar, Solapur, Dhule, Nasik, Jalgaon, Nandurbar	1969
2	Punjabrao Deshmukh Agricultural	Dist. Akola	Akola, Amravati, Yavatmaal, Buldhana,	1969

	University		Vardha, Nagpur, Chandrapur, Bhandara, Gadchiroli, Vashim, Gondiya	
3	Kokan Agricultural University	Dapoli, Dist. Ratnagiri	Thane, Mumbai, Mumbai (Sub), Ratnagiri, Sindhudurga	1972
4	Marathwada Agricultural University	Parbhanee, Dist. Parbhanee	Beed, Jalna, Latur, Aurangabad, Parbhanee, Hingoli	1972

1) Mahatma Phule Agricultural University :

Introduction :

"The Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri is the premier Agricultural University in Maharashtra that renders services to the farmers through Education, Research and Extension Education. In pursuance of the Maharashtra Agricultural University (Krishi Vidyapeeth) Act 1967, initially, the Maharashtra Agricultural University (Krishi Vidyapeeth) was established for the entire Maharashtra State and started functioning in March 1968 with its office at Mumbai. The office was shifted to College of Agriculture, Pune in 1969. Later on in 1972, four agricultural universities were established in Maharashtra. Mahatma Phule Krishi Vidyapeeth, Rahuri is one of them established in 1969 for the western Maharashtra having jurisdiction spread over 10 districts viz. Jalgaon, Nandurbar, Dhule, Nashik, Ahmednagar, Pune, Solapur, Satara, Sangli and Kolhapur. The University is named after the great social reformer 'Mahatma Jyotiba Phule'.

Mandates :

- To provide education in agriculture and allied sciences.
- To have further advancement of learning and research in agriculture and allied sciences. To integrate and co-ordinate the teaching of the subjects in the different faculties of the university.
- To co-ordinate the education, research and extension education activities for augmentation of agricultural production.
- To provide integrated agricultural education activities at all levels for maximum effectiveness and at a minimum cost.
- To undertake and guide extension education programmes.

Goal :

Sustainable growth of agriculture by interfacing education, research and extension education initiatives complemented with efficient and effective institutional, infrastructure! Support that will create a proper fit between humanity and its habitat.

Visions of MPKV :

To harness science to ensure comprehensive and sustained physical, economic and environmental access to food and livelihood security through generation, assessment, refinement and adoption of appropriate technologies.

- MPKV-Recipient of 'Institution of Excellence Award (2008)' by Govt. of India - A Special grants of Rs. 100 crores.
- MPKV bestowed with the 'Sardar Patel Best Institution Award' by the ICAR, New Delhi for excellence in the field of Education, Research and Extension Education.
- Born as per the Maharashtra Agricultural University (Krishi Vidyapeeth) Act 1967, in the year 1968 with its headquarter at Rahuri, Dist. Ahmednagar (M.S.).
- The H. E. Governor of Maharashtra State is the Chancellor of the University, The Minister of Agriculture, Maharashtra State is the Pro-Chancellor, while, Vice-Chancellor is the Head of the University.
- The highest policy-making body is the Executive Council. The Hon. Vice-Chancellor, MPKV is the Chairman of this Council. The Council constitutes of nominated peoples representatives, eminent members from Agriculture and Development Departments, Scientists, representative of ICAR and progressive farmers.
- The University is assisted by Academic Council, Agricultural Research Council, Extension Education Council, Council for Co-ordination and Review of Seed Production and Agriculture Development Programme.
- The jurisdiction of MPKV consists of 10 districts of Western and North Maharashtra viz., Jalgaon, Dhule, Nandurbar, Nashik, Ahmednagar, Pune, Solapur, Sangli, Satara and Kolhapur comprising of 5 Agro-climatic Zones.
- The irrigated area under MPKV jurisdiction is 12 lakhs hectares which accounts to almost 50% area of the State. Nearly 80% of drought prone area in the State is under the jurisdiction of University.
- MPKV consists of 27 research stations in 5 agro-climatic zones including 4 State level Crop Specialists, 4 Zonal Agricultural Research Stations and 17 Strategic and Verification Research Centres to conduct research.

- Three constituent Agriculture Colleges at Pune, Dhule and Kolhapur; 1 Horticulture College at Pune and 1 Agricultural Engineering College at Rahuri. 40 affiliated Colleges in the jurisdiction of MPKV. A new constituent Agriculture College is sanctioned by the Govt. of Maharashtra for Nandurbar district.
- MPKV offers Post Graduate education at Central Campus, Rahuri and College of Agriculture. Pune, Kolhapur and Dhule; Ph.D. Programme at Rahuri; M. Tech. (Agril. Engg.) at Rahuri with high quality faculty and modern laboratories. Special infrastructure facilities for international students.
- Faculty of Lower Agricultural Education offers Diploma courses in Agriculture through 9 constituent and 85 affiliated Agricultural Schools under MPKV.
- Sixteen KVKs in the jurisdiction of MPKV. Four Krishi Vigyan Kendras (KVKs) under MPKV including 1 at College of Agriculture, Dhule and 3 additional sanctioned KVKs established at Mamurabad (Jalgaon), Borgaon (Satara) and Mohol (Solapur). 12 KVKs are under NGOs in the jurisdiction of MPKV for transfer of technology.

2) Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri :

1) About University :

The Kokan region, inspite of being a generous gift of natural resources, has by and large reminded under-developed. This lad to the peculiar social problem of migration of able bodies and talented men to nearby areas like Mumbai and Pune in search of employment leaving behind old men, women and children to look after agriculture in traditional way. Following are the most primitive methods of cultivation.

2) The University :

The Kokan region is distinguished from the rest of Maharashtra State by virtue of its distinct agro-climatic conditions - soil types, topography, its location between the Sahyadri ranges and the Arabian sea, crops and cropping pattern, land holdings and socio-economic conditions of the farmers. As such, the problems in agricultures and allied sectors are also entirely different from the other of Maharashtra. Due to this unique features the Government of Maharashtra established the Kokan Krishi Vidyapeeth on the 18^{th} May 1972 to import education conduct research on location specific problems and disseminate the improved crop-production technologies amongst the farming community. The university was renamed as Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli on 12^{th} February, 2001.

3) Jurisdictions :

In the Kokan region, there are in all 17 different constituent and private colleges which run UG and PG Programmes and every year 1550 students are admitted. Out of these 19 colleges, the Maximum number is in Ratnagiri distict (10) followed by Sindhudurg (4) Raigad (3) and Thane district (2)

4) Mandate and objectives :

- To provide education in agriculture and allied sciences by integrating and co-ordinating teaching in different facilities and examine the students, confer degrees diplomas, certificates and other academic distinctions.
- To provide research base to improve the productivity of agriculture, horticulture, livestock, fisheries and agri-allied activities in Konkan region through basic, applied, adoptive and need based resealed for attaining economic growth and self-sufficiently at the State.
- To develop appropriate plants for conservation of natural resources and their sustainable use.
- To undertake and guide, extension education programmes including first line transfer of technology extend technological services for training conduct demonstrations and developed appropriate communication network.
- To Standerised technologies for crop production, protection, harvesting, marketing, post harvest and also for livestock, poultry and fisheries for improving the standard of living of the farmers farm workers and women of Konkan ingenital and rural womens in particular.
- To provide necessary production support of nucleus breedess and foundation seed of important crops of the region and also generate revenue through large firms for sustainable growth of the university.

5) Vision :

To ensre comprehensive and sustained physical economic and environmental access to food and livelihood security, through generation, assessment and adoption of appropriate technologies.

6) Mission :

The mission statement as below to cater the need of the Konkan region with regards to education, research and extension education in agriculture.

3) Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola :

Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola was established on 20th October, 1969 with its headquarters at Akola. This Agricultural University was named after the illustrious son of Vidarbha Dr. Punjabrao (alias Bhausaheb) Deshmukh, who was the Minister for Agriculture, Govt. of India. The jurisdiction of this university is spread over the eleven districts of Vidarbha. According to the University Act 1983 (of the Government of Maharashtra), the University is entrusted with the responsibility of agricultural education, research and extension education along with breeder and foundation seed programme.

The University has its main campus at Akola. The instructional programmes at main campus are spread over in 5 Colleges namely, College of Agriculture, College of Agricultural Engineering & Technology, College of Forestry, College of Horticulture and Post Graduate Institute. At this campus 4 degree programmes namely B.Sc. (Agri.), B.Sc. (Hort.), B.Sc. (Forestry) and B.Tech. (Ag. Engg.), two Master's Degree Programme viz. M.Sc. (Agri.) and M.Tech. (Agri. Engg.) and Doctoral Degree Programmes in the faculties of Agriculture and Agril, Engineering are offered.

The University has its sub-campus at Nagpur with constituent College, College of Agriculture which offers B.Sc. (Agri.) and M.Sc. (Agri.) degree programmes. The Nagpur Campus is accomplished with a garden surrounded by its natural beauty and a well established Zoo which attract the general public and visitors to the city. A separate botanic Garden is being maintained on 22 hectares with a green house for the benefit of research workers.

In addition there are 2 affiliated grant-in-aid colleges and 14 private non-grant-in-aid colleges under the umbrella of this University.

A Central Research Station is situated at the main Campus which caters to the need of research projects undertaken by Crop Scientists of the principle crops of the region are Cotton Sorghum, Oilseeds and Pulses.

Agro-ecology of the region :

This region has been divided into four zones on the basis of precipitation, number of rainy days, soil group, physiology and cropping system. The zone receiving 700-950 mm. precipitation with less than 52 rain days having vertisols of varying depth has been identified as the Assured Kharif Crop Zone consisting of the district namely, Buldhana, Akola, Amravati and a part of Washim district while the districts Yavatmal and Wardha and a part of Nagpur are characterized by its precipitation in the range of 950-1250 mm., 52-62 rainy days having vertisol soils constituted the Moderate Rainfall Zone. The district, namely, Bhandara, Gondia, Chandrapur and Gadchiroli have been categorized as the High Rainfall (1250-1700 mm.) Zone. While hilly tracks of Amravati district receiving rainfall in the range of 950-1700 mm. have been categorized as Moderate to high Rainfall Zone. The Vidarbha region is endowed with rich forests. The region has an area of 27.5 lakhs hectares under forest which accounts for 52 per cent of the total forest area of the State and 28 per cent of the geographical area of the Vidarbha region.

4) Marathwada Krishi Vidyapeeth :

1) Introduction :

Established in 1972, on land grant pattern, Marathwada Agricultural University (MAU) Parbhani is one of the four Agril. Universities in the State of Maharashtra. Except some industrialization around Aurangabad and Nanded, the entire region has rural setting. The objectives of the University are : Education in agriculture & Allied Sci., Undertake Research based on regional needs and facilitate technology transfer etc.

2) History :

MAU is one of four Agril. Universities in the State of Maharashtra. Prior to original Maharashtra Agricultural University, it was established on May 18, 1972 to fulfil the regional aspirations of agrarian growth. It is entrusted with the responsibilities to provide education in agriculture and allied fields, undertake research and facilitate technology transfer in Marathwada region of Maharashtra. The first college of Agriculture was established in this region at Parbhani in 1956 by Hyderabad State Government just before State reorganization. During Nizam's rule, however, agricultural education was available only at Hyderabad but crop research centres viz., sorghum, cotton, fruits existed in the region. The foundation of research was laid by the erstwhile Nizam State with commencement of the Main Experimental Farm at Parbhani in 1918. The famous 'Gaorani' desi cotton is the result of the research on cotton and local sorghum cultivars were improved by selection by the then Economic Botanist. Since then Parbhani remain the hub of educational, research and extension activities in Marathwada.

3) Mandate :

Provide education in agriculture, allied sciences and humanities. Provide research base to improve the productivity of important agri-horticulture, livestock, fisheries and agri-allied activities of Marathwada region.

To develop appropriate plans for conservation of natural resources and sustainable use.

To undertake and guide extension education programmes, first line transfer of technology, extend services of training; conduct demonstrations and develop appropriate communication network.

Standardize technologies for crop production, protection, harvesting, marketing, post harvest utilization as also for livestock, fisheries and allied agro-communities for improving the living status of farmers, farm workers.

Provide research base to improve the productivity of important agri-horticulture, livestock, fisheries and agri-allied activities of Marathwada region.

To develop appropriate plans for conservation of natural resources and sustainable use.

To undertake and guide extension education programmes, first line transfer of technology, extend services of training, conduct demonstrations and develop appropriate communication network.

Standardize technologies for crop production, protection, harvesting, marketing, post-harvest utilization as also for livestock, fisheries and allied agro-communities for improving the living status of farmers, farm workers and Women of Marathwada.

Provide the necessary production support of nucleus, breeders and foundation seed of important crops of the region and also generate revenue through large farms for sustainable growth of the University.

13.12 EXERCISE

1) Explain the importance and structure of Agricultural Department in Maharashtra.
2) Discuss the role of agricultural universities in Rural Development.
3) State the various approaches and methods used by Agricultural Universities for extension education.
4) Write detail note on Agricultural Universities in Maharashtra.

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14

SUSTAINABLE AGRICULTURE AND ORGANIC FARMING

Unit Structure :

14.1 OBJECTIVES

1) To study the concept, philosophy and goals of sustainable agriculture.
2) To study the parameters and strategies of sustainable agriculture.
3) To understand the distinguish between sustainable and convential agriculture.
4) To understand the various problems of sustainable agriculture.
5) To understand the concept and principles of organic farming.
6) To study the various methods used for organic farming.

14.1 INTRODUCTION

The concept and philosophy of sustainable agriculture assumed global significance aftermath the adverse social and environmental impact of modern agriculture. Spearheaded with use of high yielding varieties/ external inputs and non-renewable energy; agricultural modernization was adopted as essential means for development and transformation of rural communities and nation's prosperity. However, the euphoria of its potential benefits began to wane on account of regional imbalances and social inequity in development and rapid environmental degradation. Massive and injudicious application of synthetic fertilizers and toxic pesticides besides large-scale irrigation led to colossal damage to ecosystem and more importantly the human and cattle health. Disquieting impacts include.

1. Contamination of water by pesticide, nitrates and wastes, causing harm to wildlife, disruption of ecosystem and possible health problem
2. Contamination of food and fodder by pesticide residues
3. Damage to farm and natural resources by pesticides
4. Contamination of atmosphere by ammonia, methane etc.
5. Formation of ozone depletion, global warming and atmospheric pollution
6. Overuse of natural resources causing depletion of ground-water
7. Displacement of traditional varieties and breeds by modern varieties / breeds
8. New health hazards due to agrochemicals - during field spray and working in manufacturing industries.

Injudicious and rampant use of chemical fertilizers has led to imbalance in soil nutrient status and thus foodgrains are devoid of essential nutrients leading to increasing levels of hidden hunger. Similarly, the injudicious and rampant use of pesticides has resulted in the problem of pesticidal residues in blood as well as mothers' milk. Such effects have put the human and cattle in trap of deadly diseases and have also threatened the existence of other living beings. Realizing the catastrophic impact of pesticides, the famous American writer Carl Rachel in her famous book ‘The Silent Spring’ has warned that human being is an integral part of nature and any war against nature is the war against self. She further advocates that often the technological advancements become so antagonistic with the nature's activities and system that it is wise to lay them off.

However, the proponents of modern and exploitative agriculture still argue in their favour and advocate their continuance for food security and prosperity.

The debate is mounting between modernists and environmentalists and conservationists over issue related to sustainability and food security.

While ensuring food security to burgeoning population is the prime concern, conservation of natural resources and protection of environment for deriving benefits in perpetuity are equally important. Consequently vision and action towards balanced and sustainable development were recognized and accepted by the global community of scientists, policy-makers and development agencies.

14.2 CONCEPTS AND PHILOSOPHY

The word sustain, which has been derived from Latin word root ‘sustinere’ (sus - meaning from below and tenere meaning to hold), means to keep existence or maintain implying long-term support or permanence.

Though the concept of ‘sustainability’ first came up during the energy crisis of 1970s in relation to supply of oil, when it was defined as ‘maintaining the present without compromising the future’ the term ‘sustainable development’ first appeared in the document 'The World Conservation Strategy" published in 1980 by the International Union for the Conservation of Nature and Natural Resources and the notion was been defined as an "integration of preservation (nature protection) and development to provide a planetary change which can ensure safe survival and welfare of all people." The principle of uniform distribution of resources, which was the cornerstone of Brundtland Commission Report and democratic participation, which was emphasized by the Second U.N. Conference on the Environment and Development in Rio de Janeiro are the important features for sustainability.

However, different societies have different conceptualization of sustainability as well as different requirements of sustainability based upon varying cultural expectations or environmental constraints. According to Bruntland, the core of the idea of sustainability is the concept that current decisions should not damage the prospects for maintaining or improving living standards in future.

With mounting criticism and growing recognition of problems with modernists' approach to agriculture as well as increased public awareness about environmental issues, search for conceptualization, description and operationalization of alternative forms of agriculture intensified. Sustainable agriculture emerged as the term to describe the varied field of agricultural practices that differ from conventional concepts of modern agricultural production (Hauptli, et.al. 1990).

Keller cites the observation of the highly renowned agricultural scientist and thinker, Dr. M. S. Swaminathan, that in a world where 30 million infants were born with mental impairment due to low birth weight and Third World countries like India had over 250 million people living below the poverty line, sustainability in agriculture was no longer a choice, which was a necessity. According to Swaminathan the success of sustainable agriculture results from a combination of science, technology, service and public policy. He further quotes ‘Varro’, a Roman landowner as the earliest proponent of sustainable agriculture, who said in the First Century B.C. : "Agriculture is a science which teaches us what crops should be planted in each kind of soil and what operations are to be carried on, in order that the land may produce the highest yields in perpetuity." Sustainable agricultural systems are those, which are capable of maintaining their productivity and usefulness to society indefinitely and such systems must be resource conserving, socially supportive, commercially competitive and environmentally sound.

Leopold Center in Lowa has defined sustainable agriculture as "farming systems that are environmentally sound, profitable, productive and maintain the social fabric of the rural community."

Many view sustainable agriculture as philosophy based on co-existence and communion with nature, where emphasis is upon understanding of long-term impact of our activities on the environment and on other species.

Brown defines sustainable agriculture as stewardship. It emphasizes stewardship of both natural and human resources. This includes concern over the living and working condition of farm laborers, consumer health and safety, and the needs of rural communities.

In attempt to describe the alternative forms of agriculture in contrast to modern agriculture many terms were used viz., sustainable agriculture, regenerative agriculture, eco-agriculture, low external input agriculture, low input sustainable agriculture, resource-conserving agriculture, organic agriculture, permaculture, etc., which led to confusion and misconception. The most common misconception about sustainable agriculture has been that it represents a return to some form of low technology or backward or traditional agricultural practices, which is untrue. It envisages utilization of economically and ecologically viable old as well as new innovations. Sustainable agriculture does not mandate a specific set of agricultural practices, rather a basket of options and approaches according to need could be tried. However, the basic challenge with sustainable agriculture remains how best to optimally utilize the internal resources.

14.3 GOALS FOR SUSTAINABLE AGRICULTURE

According to Pretty a sustainable agriculture is any system of food or fibre production that systematically pursues the following goals :

1. Thorough incorporation of natural processes such as nutrient cycling, nitrogen fixation and pest-predator relationship into agricultural production process.
2. A reduction in the use of off-farm, external and non-renewable inputs.
3. A more equitable access to productive resources and opportunities, and progress towards more socially-just forms of agriculture.
4. Productive use of the biological and genetic potential of plant and animal species.
5. An increase in self-reliance among farmers and rural people.
6. Long-term sustainability of current production levels.
7. Profitable and efficient production with an emphasis on integrated farm management, and the conservation of soil, water, energy and biological resources.

14.4 DIMENSIONS AND PARAMETERS OF SUSTAINABLE AGRICULTURE

In order to practice sustainability, it is imperative to have its holistic understanding. Swaminathan identified 14 major dimensions of sustainable agriculture covering the social, economical, technological, political and environmental facets of sustainability as technological appropriability, economic feasibility, economic viability, environmental soundness, temporal stability, resource-use-efficiency, local adaptability, social acceptability, political tacitness, administrative manageability, cultural desirability, equity and productivity. Lockeretz (1988) delineated following physical and biological parameters for sustainable agriculture.

1. Diversity of crop species.
2. Selection of crops and livestock that are adapted to particular environment.
3. Preference for farm generated resources rather than purchased materials.
4. Tightening of nutrient cycles to minimize nutrient losses.
5. Livestock housed and grazed at low stocking densities.
6. Enhancement of storage of nutrient in the soil.
7. Maintenance of protective cover on the soil.
8. Rotation that include deep rooted crops and control weeds.
9. Use of soluble inorganic fertilizer.
10. Use of pesticide for crops protection only as a last resort.

14.5 STRATEGIES OF SUSTAINABLE AGRICULTURAL DEVELOPMENT

Today's economic growth is impoverishing growth or unsustainable growth is a type of economic growth when the economy has grown in quantitative terms but the economy's reproductive capacity has declined because of environmental and natural resource degradation and other associated problems in the economy. Following strategies can be suggested to the long term sustainable development :

1) **Crop Rotations & Pest Management Techniques :**

It mitigate weeds, "disease, insect and other pest problems; provide alternative sources of soil nitrogen; reduce soil erosion; and reduce risk of water contamination by agricultural chemicals pest control strategies that are not harmful to natural systems, farmers, their neighbors or consumers. Which reduce the need for pesticides by practices such as scouting/ use of resistant cultivars, timing of planting and biological pest controls increased mechanical / biological weed control; more soil and water conservation practices; and strategic use of animal and green manures use of natural or synthetic inputs in a way that poses no significant hazard to man, animals or the environment.

2) Group-based Technologies :

More and more emphasis will need to be placed on the group-based technologies. The areas where group action is called for include :

a) Synchronization of sowing schedules of certain crop to avoid synchronization with pest reproduction cycle in certain crops where this is a major problem.
b) Watershed management of both arable and non-arable land belonging to individuals as well as villages, forest and revenue department.
c) Synchronized sprays compel with pest reducing crop rotations and mixtures to minimize use of chemicals in the short run and total elimination in the long run.
d) Biological pest control coupled with water management and drainage.

3) Agro-forestry and Rainwater Harvesting :

The shift from crop to trees (horticultural and/or timber) is taking place both for reducing the need for outside labour and also for reaping larger commercial gain by larger farmers. Agro-forestry for high and slow growth regions thus is an urgent priority. In many parts of the world, there is renewed interest in the traditional practice of rainwater harvesting as a method of combating increasing water scarcity. Water harvesting can be effective in arid, semi-arid and semi-humid areas where surface or ground-water supplies are not available or are uneconomical to develop. Run-off water can be collected over large areas (macro-catchments), from micro-catchments or in the form of floodwater, and is then stored in reservoirs, cisterns or in the soil. Adoption of this technology can allow crop production in areas where otherwise it would not be possible, reduce the risk of crop failure and generally increase yields in rain-fed agriculture.

4) Development of drought prone regions & Land Development :

The continued neglect of dry regions is really criminal. Hill areas or drought prone regions which are depend on domestic servant or a cheap labour. National Commission on Development of Backward Areas (1981, Planning Commission, New Delhi) went so far as to say that we should not try to create conditions by which supply of cheap labour for large irrigation projects is affected adversely. Need to maintain soil fertility and water purity, conservation and improvement the chemical, physical and biological qualities of the soil, recycling of natural resources and conserving energy. Sustainable agriculture produces diverse forms of high quality foods, fibers and medicines.

5) Integration of Human, Science & Environment :

Need to use locally available renewable resources, appropriate and affordable technologies and minimizes the use of external and purchased inputs, thereby increasing local independence and self-sufficiency and insuring a source of stable income for peasants, family and small farmers and rural communities. This allows more people to stay on the land, strengthens rural communities and integrates humans with their environment. Sustainable agriculture respects the ecological principles of diversity and interdependence and uses the insights of modern science to improve rather than displace the traditional wisdom accumulated over centuries by innumerable farmers around the world.

6) Equitable and Participatory vision of development :

Sustainable agriculture is a model of social and economic organization based on an equitable and participatory vision of development which recognizes the environment and natural resources as the foundation of economic activity. Agriculture is sustainable when it is ecologically sound, economically viable, socially just, culturally appropriate and based on a holistic scientific approach.

7) Forest Management :

The key point of forest management is to convert resource potential into economical values, without affecting sustainability. Present problems are: too much high quality timber is used as fuel and brushes in marginal areas are collected exhaustively (by pulling roots, rather than cutting stems). Therefore, suggestions are- a) Save good timber from fuel wood collecting and alternative sources of energy must be found first, b) Save brushes in marginal land and planted fuel forest is strongly recommended to improve the way of collecting firewood, c) Policy and regulation of forest laws to implement and enforce the law. The first priority is to set a forest price and keep all licensed logging under control.

8) Climate change activities :

For facing the challenge of climate change following steps can be adopted :

a) making climate information more relevant and usable;
b) developing appropriate tools for prioritising responses;
c) applying climate risk screening tools at the project level;
d) identifying and using appropriate entry points for climate information;
e) shifting emphasis to implementation, as opposed to developing new plants; and
f) encouraging meaningful co-ordination and the sharing of good practices.

The strategies suggested above require strong, social and economic capabilities to be implemented effectively.

14.6 COMPARISON OF CHARACTERISTICS OF SUSTAINABLE AGRICULTURE AND CONVENTIONAL AGRICULTURE

Sustainable Agriculture	**Conventional Agriculture**
General • Long term sustainability • Internal solution to internal problems • Emphasis on management solutions to problems • Responsive to feedback and participatory	• Short term benefits • External solutions to internal problems • Emphasis on technology solutions to problems • Detachment
Technical • Low internal input • To maintain soil fertility and productivity, rely upon crop rotation, recycling of residues, animal manure • To manage insects, weeds and other pests utilizes natural cultural and biological controls • R & D emphasis on farming system and system approach • Diversified enterprises within the farm, crops grown and cultivars used; biodiversity • Emphasis is on working with natural process • Recognizes location specificity of technologies, use of appropriate and indigenous technologies • Use of technologies that preserve and enrich the natural resource base.	• High external input • Use of synthetic compounded fertilizer • Use of pesticides, herbicide, growth regulators, Pharmaceuticals and livestock feed additives • Emphasis on individual crop • Intensive mono cropping genetic erosion • Emphasis is on controlling natural processes • Belief in universal technologies, e.g. pesticides, fertilizers, use of imported and packaged technologies • Use of technologies that exploits and destroys the natural resource base
Economic • Priority is food security • Relies on available indigenous farm resource self reliant	• Export and profit-oriented • Capital intensive, usually need credit • Emphasis on commodity exchange in the market

• Places high value on human fulfillment and the environment	
Socio-political • Belief in accountability and value laden	• Socio-politically detached and ignore consequences

14.7 PROBLEMS OF SUSTAINABLE AGRICULTURE DEVELOPMENT

Ecologically and environmentally, the continued use of chemical fertilizers has increased soil erosion and decline soil productivity. Increased resistance of weeds and insects to herbicides and insecticides, combined with the destruction of wildlife and beneficial insects by pesticides may trigger a new vicious cycle both economically and ecologically. As a result of the intensive use of chemicals in agriculture soil and water are more and more contaminated, human beings are faced with the dilemma of consuming unsafe food and drinking polluted water or spending extra money to restore the damaged environment. From the natural resources perspective, fossil fuel and other chemicals are non-renewable, thus, the depletion of finite reserves of concentrated plants nutrients is only a matter of time. At present and in foreseeable future, there are no substitutes that can replace these depleted resources. Therefore, it seems sensible to consider alternative approaches, like sustainable agriculture. However, many developing countries have attempted to produce sufficient food to fulfill the needs of their increasing populations. This forces them to apply more chemicals to their land because it is effective in the short term.

Most parts of India, rains are seasonal. As a consequence, ground or stored water has to be used for irrigation, industrial and domestic use. Pressure on water resources is bound to increase in the future due to population growth, urbanization, increased industrial requirement and higher living standards. To enhance the productivity of dryland agriculture, some protective irrigation will have to be provided in the areas which receive low rainfall. The water-table in many parts of India is receding and overexploitation of groundwater resources is a major threat to survival of future generations. Transgenic technologies have little to contribute towards alleviating the problems created by the overexploitation of water resources. However, if transgenic technologies can contribute towards enhancing productivity and yield stability of crops adapted to a low water requirement, the overall dependence on groundwater for irrigation will be reduced.

Replacement of traditional mixed cropping patterns with monocultures requiring unacceptable levels of pesticide use and negative impacts on bio-diversity, as well as irrigation induced problems of mineral contamination, increased salinity and the lowering of water tables. At the same time, the Green Revolution may have relieved pressure to expand agriculture into ecologically fragile areas and reduced the dependence of rural areas on unsustainable resource extraction activities.

The real problem will be the process of integration of the different technologies into the farming system. That is the process of sorting all the various legitimate factors that prevent or discourage farmers from accepting sustainable development and adjusting the socio-economic environment to overcome these. It will have to be largely a farm level diagnostic effort to make certain the required extra labour is in fact available. There is actually enough organic residues to justify the composting process and this could provide the desired nutrients for the entire intended area or, if not, the percentage of the area that can be provided. Likewise, the extra land for building leguminous hedgerows needs to be available and not already committed to subsistence cropping. In many intensive farming communities in Asia, villages are immediately adjacent to each other with all in-between land already allocated and in use. Thus, the extra land may just not be there.

The problems have increased dramatically in recent years. This includes contamination of water by pesticides and fertilizers, contamination of food and fodder by residues of pesticides, nitrates and antibiotic, workers and public, disruption of ecosystem and harm of wildlife, damage to farm and natural resources by pesticides, causing workers and public, disruption of ecosystem and harm of wildlife.

14.8 ORGANIC AGRICULTURE - INTRODUCTION

Introduction :

Organic agriculture has grown out of the conscious efforts by inspired people to create the best possible relationship between the earth and men. Since its beginning, the sphere surrounding organic agriculture has become considerably more complex. A major challenge today is certainly its entry into the policy-making arena, its entry into anonymous global market and the transformation of organic products: into commodities. During the last two decades, there has also been a significant sensitization of the global community towards environmental preservation and assuring of food quality. Ardent promoters of organic farming consider that it can meet both these demands and become the mean for complete development of rural areas. After almost a century of development organic agriculture is now being embraced by the mainstream and shows great promise commercially, socially and environmentally. While there is continuum of thought from earlier days to the present, the modern organic movement is radically different from its original form. It now has environmental sustainability at its core in addition to the founders concerns for healthy soil, healthy food and healthy people.

14.9 CONCEPT OF ORGANIC FARMING

Organic farming is very much native to this land. Whosoever tries to write a history of organic farming will have to refer India and China. The farmers of these two countries are farmers of 40 centuries and it is organic farming that sustained them. This concept of organic farming is based on following principles :

- Nature is the best role model for farming, since it does not use any inputs nor demand unreasonable quantities of water.
- The entire system is based on intimate understanding of nature's ways. The system does not believe in mining of the soil of its nutrients and do not degrade it in any way for today's needs.
- The soil in this system is a living entity
- The soil's living population of microbes and other organisms are significant contributors to its fertility on a sustained basis and must be protected and nurtured at all cost.
- The total environment of the soil, from soil structure to soil cover is more important.

14.10 THE PRINCIPLES OF ORGANIC AGRICULTURE

To understand the motivation for organic farming, the practices being used and what we want to achieve, it is important to understand the guiding principles of organic agriculture. These principles encompass the fundamental goals and caveats that are considered important for producing high quality food, fiber and other goods in an environmentally sustainable way. The principles of organic agriculture have changed with the evolution of the movement and are now codified. The principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations. The principles of organic agriculture serve to inspire the organic movement in its full diversity. They are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world and a vision to improve all agriculture in a global context. The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity.

The International Federation for Organic Agriculture Movement's (IFOAM) definition of Organic agriculture is based on :

The principle of health
The principle of ecology
The principle of fairness and
The principle of care

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

1) Principle of health :

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of eco-systems - healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of eco-systems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

2) Principle of ecology :

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm eco-system; for fish and marine organisms, the aquatic environment. Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific.

Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

3) Principle of fairness :

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs

4) Principle of care :

Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to; be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

In totality organic agriculture aims at a sustainable production system based on natural processes. Key characteristics are that organic agriculture :

- relies primarily on local, renewable resources;
- makes efficient use of solar energy and the production potential of biological systems;
- maintains the fertility of the soil;
- maximises recycling of plant nutrients and organic matter;
- does not use organisms or substances foreign to nature e.g. GMOs, chemical fertilisers or pesticides);
- maintains diversity in the production system as well as the agricultural landscape;
- Gives farm animals life conditions that correspond to their ecological role and allow them a natural behaviour.

Organic agriculture is also a sustainable and environmentally friendly production method, which has particular advantages for small-scale farmers. Available evidence indicates the appropriateness of organic agriculture for small farmers in developing countries like India. Organic agriculture contributes to poverty alleviation and food security by a combination of many features, such as :

- increasing yields in low-input areas;
- conserving bio-diversity and nature resources on the farm and in the surrounding area;
- increasing income and/or reducing costs;
- producing safe and varied food;
- being sustainable in the long term.

14.11 METHODS OF ORGANIC FARMING

Introduction :

Organic farming methods combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes. Organic farming methods are studied in the field of agro ecology. While conventional agriculture uses synthetic pesticides and water-soluble synthetically purified fertilizers, organic farmers are restricted by regulations to using natural pesticides and fertilizers. The principal methods of organic farming include crop rotation, green manures and compost, biological pest control and mechanical cultivation. These measures use the natural environment to enhance agricultural productivity: legumes are planted to fix nitrogen into the soil, natural insect predators are encouraged, crops are rotated to confuse pests and renew soil and natural materials such as potassium bicarbonate and mulches are used to control disease and weeds. Organic farmers are careful in their selection of plant breeds and organic researchers produce hardier plants through plant breeding rather than genetic engineering.

a) Crop Diversity :

Crop diversify is a distinctive characteristic of organic farming. Conventional farming focuses on mass production of one crop in one location, a practice called monoculture. This makes apparent economic sense: the larger /the growing area, the lower the per unit cost of fertilizer, pesticides and specialized machinery for a single plant species. The science of agro-ecology has revealed the benefits of polyculture multiple crops in the same space, which is often employed in organic farming. Planting a variety of vegetable crops supports a wider range of beneficial insects, soil micro-organisms and other factors that add up to overall farm health, but managing the balance requires expertise and close attention.

b) Farm Size :

Farm size in great measure determines the general approach and specific tools and methods. Today, major food corporations are involved in all aspects of organic production on a large scale. However, organic farming originated as a small-scale enterprise, with operations from under 1-acre (4,000m^2) to under 100 acres (0.40 km^2). The mixed vegetable organic market garden is often associated with fresh, locally-grown produce, farmers' markets and the like, and this type of farm is often under 10 acres (40,000 m^2). Farming at this scale is generally labour-intensive, involving more manual labor and less mechanization. The type of crop also determines size: organic grain farms often involve much larger area. Larger organic farms tend to use methods and equipment similar to conventional farms, centered around the tractor.

C) Plant Nutrition :

Soil Fertility -

The central farming activity of fertilization illustrates the differences. Organic farming relies heavily on the natural breakdown of organic matter, using techniques like green manure and composting, to replace nutrients taken from the soil by previous crops. This biological process, driven by micro-organisms such as mycorrhiza, allows the natural production of nutrients in the soil throughout the growing season and has been referred to as feeding the soil to feed the plant. In chemical farming, individual nutrients, like nitrogen, are synthesized in a more or less pure form that plants can use immediately, and applied on a man-made schedule. Each nutrient is defined and addressed separately. Problems that may arise from one action e.g. too much nitrogen left in the soil are usually addressed with additional, corrective products and procedures e.g. using water to wash excess nitrogen out of the soil. Organic farming uses a variety of methods to improve soil fertility, including crop rotation, cover cropping and application of compost.

d) Pest Control :

Biological Pest Control

Biological control of pests in agriculture is a method of controlling pests including insects, mites, weeds and plant diseases that relies on predation, parasitism, herbivory or other natural mechanisms. It can be an important component of Integrated Pest Management (IPM) programs. Biological Control is defined as the reduction of pest populations by natural enemies and typically involves an active human role. Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids and pathogens. Biological control agents of plant diseases are most often referred to as antagonists. Biological control agents of weeds include herbivores and plant pathogens.

Predators, such as lady beetles and lacewings, are mainly free-living species that consume a large number of prey during their lifetime. Parasitoids are species whose immature stage develops on or within a single insect host, ultimately killing the host. Most have a very narrow host range. Many species of wasps and some flies are parasitoids. Pathogens are disease-causing organisms including bacteria, fungi and viruses. They kill or debilitate their host and are relatively specific to certain insect groups. There are three basic types of biological control strategies conservation, classical biological control, and augmentation.

e) Conservation :

The conservation of natural enemies is probably the most important and readily available biological control practice available to homeowners and gardeners. Natural enemies occur in all areas, from the backyard garden to the commercial field. They are adapted to the local environment and to the target pest and their conservation is generally simple and cost-effective. Lacewings, lady beetles, hover fly larvae, and parasitized aphid mummies are almost always present in aphid colonies.

Fungus-infected adult flies are often common following periods of high humidity. These naturally occurring biological controls are often susceptible to the same pesticide used to target their hosts. Preventing the accidental eradication of natural enemies is termed simple conservation.

14.12 EXERCISE

1) Explain the concept and Philosophy of sustainable agriculture.
2) Describe the strategies of sustainable agriculture development.
3) Distinguish between characteristics of sustainable agriculture and conventional agriculture.
4) State the various problems of sustainable agriculture in rural area.
5) Explain the concept and principles of organic agriculture.
6) Explain the various methods of organic farming.

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15

GREENHOUSE AND TISSUE CULTURE

Unit Structure :

15.1 OBJECTIVES

1) To understand the concept and working of GreenHouses.
2) To study the various types and uses of GreenHouse.
3) To study the techniques use for plant tissue culture.
4) To study the various tools and equipments used for tissue culture in laboratory.

15.1 INTRODUCTION

A greenhouse (also called a glasshouse or, if with sufficient heating, a hothouse) is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial-sized buildings. A miniature greenhouse is known as a cold frame. The interior of greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather.

Many commercial glass greenhouses or hothouses are high-tech production facilities or vegetables or flowers. The glass greenhouse are filled with equipment including screening installations, heating, cooling, lighting and may be controlled by a computer to optimize conditions for plant growth.

15.2 WORKING OF GREENHOUSES

The explanation given in most sources for the warmer temperature in a greenhouse is that incident solar radiation (the visible and adjacent portions of the infrared and ultraviolet ranges of the spectrum) passes through the glass roof and walls and is absorbed by the floor, earth, and contents, which become warmer and re-emit the energy as longer-wavelength infrared radiation. Glass and other material used for greenhouse walls do not transmit infrared radiations, so the infrared cannot escape via radiative transfer. As the structure is not open to the atmosphere, heat also cannot escape via convection, so the temperature inside the greenhouse rises. This is known as 'green house effect.' The greenhouse effect due to the infrared - opaque 'greenhouse', including carbon dioxide (CO_2) and methane (CH_4) instead of glass, also affects the earth as whole; there is no convective cooling as air does not escape from the earth.

However, R. W. Wood in 1909 constructed two greenhouses, one with glass as the transparent material and the other with panes of rock salt, which is transparent to the infrared. The two greenhouses warmed to the similar temperatures, suggesting that an actual greenhouse is warmer not because of the 'greenhouse effect' as described in the previous paragraph, but by preventing connective cooling, not allowing warmed air to escape.

More recent quantitative studies suggest that the effect of infrared radiative cooling is not negligibly small and may have economic implications in a heated greenhouse. Analysis of issues of near - infrared radiations in a greenhouse with screens of high co-efficient of reflection concluded that installation of such screens reduced heat demand by about 8% and application of dyes to transparent surfaces was suggested. Composite less - reflective glass or less effective but cheaper anti-reflective coated simple glass, also saving.

15.3 TYPES OF GREENHOUSES

Greenhouses can be divided into glass greenhouses and plastic greenhouses.

In domestic greenhouses, the glass used is typically 3 mm (or 1/8”) horticultural glass grade, which is good quality glass that should not contain air bubbles (which can produce scorching on leaves by acting like lenses)

Plastic mostly used are polyethylene film and multi wall sheets of polycarbonate material or PMMA acrylic glass.

Commercial glass greenhouse are often high-tech production facilities for vegetables or flowers. The glass greenhouse are filled with equipment such as screening installations, heating, cooling and lighting, and may be automatically controlled by computer.

15.3.1 Dutch light: In the UK and other Northem European countries a pane of horticultural glass referred to as ‘Dutch light’ was historically used as standard unit of construction, having dimension of $28^{3/4}" \times 56"$ (approx. $730\,mm \times 142\,mm$). This size gives a larger glazed area when compared with using smaller panes such as the 600 mm width typically used in the modern domestic designs which then require more supporting framework for a given overall greenhouse size. A style of greenhouse having sloped sides (resulting in a wider base than at eaves height) and using these panes uncut is also often referred to as of ‘Dutch light design’, and a cold frame using a full - or half - pane as being of ‘Dutch’ or ‘half - Dutch’ size.

15.4 USE OF GREEN HOUSES

Greenhouses allow for greater control over the growing environment of plants. Depending upon the technical specification of a greenhouse, key factors which may be controlled include temperature, levels of light and shade, irrigation, fertilizer application and atmospheric humidity. Greenhouse may be used to overcome short-comings in the growing qualities of a piece of land, such as a short growing season of poor levels and they can thereby improve food production in marginal environments.

As they may enable certain crops to be grown throughout the year, greenhouses are increasingly important in the food supply of high - latitude countries. One of the largest complexes in the world is in Almeria, Andalucia, Spain, where greenhouses cover almost 200 sq.km (49,000 acres).

Greenhouses are often used for growing flowers, vegetables, fruits and transplants. Special greenhouse varieties of certain crops, such tomatoes, are generally used for commercial production. Many vegetables and flowers can be grown in greenhouses late winter and early spring and then transplanted outside as the weather warms.

Bumblebees are the pollinators of choice for most pollination, although other types of bees have been used, as well as artificial pollination. Hydroponics can be used to make the most use of the interior space.

The relatively closed environment of a greenhouse has its own unique management requirements, compared with outdoor production, pests and diseases, and extremes of heat and humidity, have to be controlled and irrigation is necessary to provide water. Most greenhouses use sprinklers or drip lines. Significant inputs of heat and light may be required, particularly with winter production of warm - weather vegetables.

Greenhouse also have applications outside of the agriculture industry. Glass point solar, located in Fremont, California, encloses solar fields in greenhouses to produce steam for solar-enhanced oil recovery.

15.5 HISTORY OF GREENHOUSES

The idea of growing plants in environmentally controlled areas has existed since Roman times. The Roman emperor Tiberius ate a cucumber-like vegetable daily. The Roman gardeners used artificial methods (similar to the greenhouse system) of growing to have it available for his table everyday of the year. Cucumbers were planted in wheeled carts which were put in the sun daily, then taken inside to keep them warm at night. The cucumbers were stored under frames or in cucumber houses glazed with either oiled cloth known as specularia or with sheets of selenite (a. k. a lapis specularis), according to the description by Pliny the Elder.

In the 13th century, greenhouses were built in Italy to house the exotic plants that explores brought back from the tropics. They were originally called giardini botanici (botanical gardens)

'Active' greenhouses in which it is possible for the temperature to be increased or decreased manually, appeared much later. Sanga yorok Written in the year 150 A.D. in Korea, contained description of a greenhouse which was designed to regulate the temperature and humidity requirements of plants and crops.

One of the earliest records of the annals of the Joseon Dynasty in 1438 confirms growing mandarin trees in a Korean traditional greenhouse during the winter and installing a heating system on ondol.

The concept of greenhouses also appeared in the Netherlands and then England in the 17th century, along with the plants. Some of these early attempts required enormous amounts of work to close up at night or to winterize. There were serious problems with providing adequate heat in these early greenhouses. Today, the Netherlands has many of the largest greenhouses in the world, some of them so vast that they are able to produce millions of vegetables every year.

The French botanist Charles Lucien Bonaparte is often credited with building the first practical modern greenhouse in Lieden, Holland during the 1800s to grow medicinal tropical plants. Originally only on the estates of the rich, the growth of the science of botany caused greenhouses to spread over the universities. The French called their first greenhouses orangeries, since they were used to protect orange trees from freezing. As pine apples became popular, pineries or pine apple pits, were experimentation with the design of greenhouses continued during the 17th century in Europe, as technology produced better glass and construction techniques improved. The greenhouse at the Palace of Versallies was an example of their size and elaborateness: it was more than 15 meters (490 ft) long, 13 meters (43 ft) wide, and 14 meters (46 ft) high.

The golden era of the greenhouse was in England during the Victoria era, where the largest greenhouses yet conceived were constructed as the wealthy upper class and aspiring botanists completed to build the most elaborate buildings. A good example of this trend is the pioneering kew gardens.

15.6 GREENHOUSE VENTILATION

Ventilation in one of the most important components in a successful greenhouse. If there is no proper ventilation in greenhouse and their growing plants can become prone to problem. The main purposes of ventilation are regulates the temperature and humidity of the optimal level and to ensure movement of air and thus prevent build up of plant pathogens (such as Botrytis cinerea) that prefer still air conditions ventilation also ensures a supply of fresh air for photosynthesis and plant respiration and many enable important pollinators to access the greenhouse crop.

Ventilation can be achieved via use of vents - often controlled automatically via a computer and recirculation fans.

15.7 GREENHOUSE HEATING

Heating or electricity in on the most considerable costs in the operation of greenhouses across the globe especially in colder climates. The main problem with heating a greenhouse as apposed to a buidings that has solid opaque walls in the amount of heats lost through the greenhouse coversing since the coverings need to allow light of filter into the structure they converaly cannol insulte very well with traditional plastic greenhouse coverings having an R - value of around 2 a great amount of money amount of money is therefore spent to continually replace the neat lost most greenhouses, when supplement as heat is need use natural gas or electric furnaces.

Passive heating methods inputs solar energy can be captured from periods or relative abundance (day time/ summer) and released to boot the temperature during cooler periods (night time / winter) waste neat from heat generated by the chickenes which would otherwise be wasted.

15.8 GREENHOUSE CARBON DIOXIDE ENRICHMENT

The possibility of using carbon dioxide enrichment in greenhouse cultivation to enhance plant growth has been known for nearly 100 years. After the development of equipment for the controlled serial enrichment of carbon dioxide the technique was established on a broad scale in the Netherlands secondary metabatiberies e.g. cardice glycoside in Digitalis lanata, are produced in higher amounts by greenhouse cultivation at enhanced temperature and at enhanced carbon dioxide concentration commercial greenhouse are now frequently located near appropriate industrial facilities of mutual benefit.

For example Conner Ways Nursery in the UK is strategically placed near a major sugar refinery.

Consuming both need CO_2 form the refinery which would otherwise be vented to atmosphere the refinery reduce its carbon emissions whistle the nursery enjoys boosted tomato yields and does not need to provide its own greenhouse heating.

Enrichment only becomes effectives whereby Liebig's law carbon dioxide has become the limiting factor in a controlled greenhouse irrigation may be trival and soils may be fertile by default in less controlled gardens and one fields rising CO_2 levels only increases primary production to the points of solid depletion (assuming on droughts, flooding or both as demonstrated prima facie by CO_2 levels continuing to rise in addition laboratory experiments free air carbon enrichment (face) test plots and field measurements provide replicability.

15.9 TECHNIQUES IN PLANT TISSUE CULTURE

Introduction :

Plant tissue culture is not a separate branch of plant science like taxonomy, cytology, plant physiology etc. Rather it is a collection of experimental methods of growing large number of isolated cells or tissues under sterile and controlled conditions. The cells or tissues are obtained from any part of the plant like stem, root, leaf etc. which are encouraged to produce more cells in culture and to express their totipotency (i.e. their genetic ability to produce more plants). Cells or tissues are grown in different types of glass vials containing a medium with mineral nutrients, vitamins and phytohormones. Therefore, to carry out the experiments using tissue culture techniques, a well equipped laboratory is first required.

In recent years there has been a large increase in the number of research laboratories using tissue culture techniques to investigate many fundamental and applied aspects of higher plants. However, the use of these techniques is not confined to research alone. Tissue culture techniques are being exploited by many commercial laboratories. Even many horticultural companies are setting up small to multiply plants which are difficult to propagate by conventional means.

In this chapter, the general organization of a tissue culture laboratory and the basic techniques will be discussed under different subheadings.

15.10 TISSUE CULTURE LABORATORY

An ideal tissue culture laboratory should have at least two big rooms and a small room. One big room is for generally laboratory work such as preparation of media, autoclaving, distillation of water etc. The other big room is for keeping cultures under controlled light, temperature and humidity. The small room is for aseptic work for keeping autoclaved articles.

General Laboratory :

The general laboratory for tissue culture should be provided with the following articles and arrangements.

A Washing Area:

This is very important for a tissue culture laboratory. It should be provided with a large sink, running hot and cold tap water, brushes of various sizes, detergent and a bucket of single distilled water for a final rinse of the washed glass goods. A number of plastic buckets are required for soaking the glass goods to be washed. Another separate bucket with lid is also required for disposing off the used or infected media before cleaning. Only this bucket should be kept outside the room or clearing area and should be cleaned twice in a week.

Hot Air Oven

It is necessary for drying the washed glass goods. For this purpose, a number of enamelled trays of different sizes are required for keeping wet glass goods inside the oven.

Refrigerator

It is essential for storing various thermolabile chemicals like vitamins, hormones, amino acids, casein hydrolysate, yeast extract, coconut milk, etc. Stock solutions of salts are also kept to prevent contamination.

Distillation Plant

A single distillation and a double distillation water plant are indispensable. Two big plastic containers are required for storing the distilled water.

Weighing Balance

Three types of weighing balances viz. pan balance, chemical balance and electric balance are required for weighing chemicals, sugars, agar-agar and others.

pH meter :

It is necessary for the measurement and adjustment of pH of the nutrient medium Fig. 15.1.

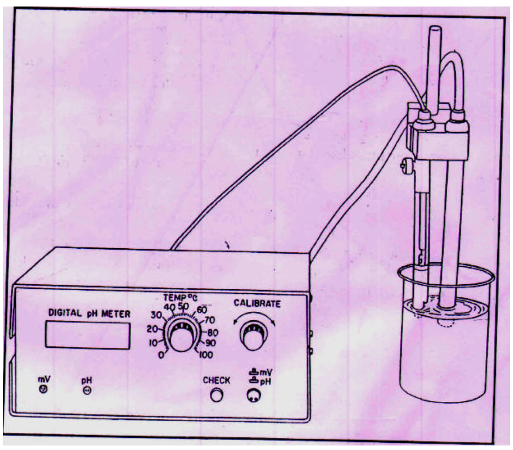


Fig. 15.1

Vacuum Pump :

It is required for filtering liquid media, sugar solution etc. through filter apparatus using air suction.

Autoclave :

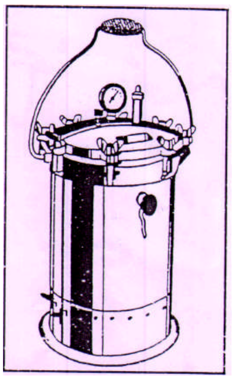
It is very important for sterilization of nutrient media, glass goods, instruments, etc.

Working Tables :

These are necessary for preparation of medium.

Heater :

It is needed for heating or warming the medium to dissolve agar to melt the agarifted medium.



Simple portable auto clave : Fig. 15.2

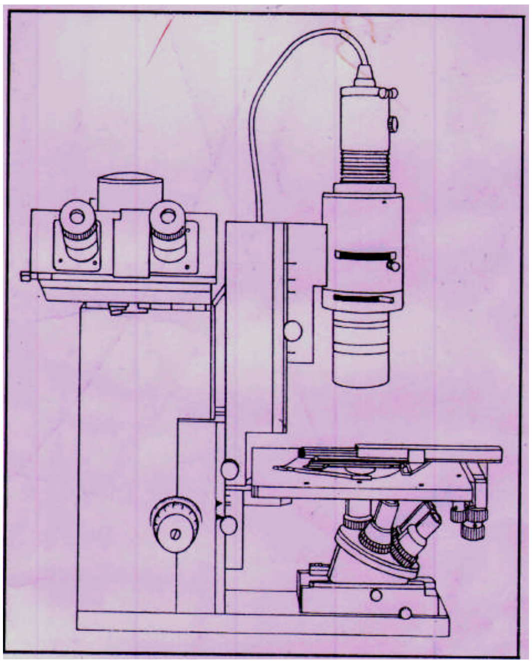


Fig. 15.3

An inverted microscope for the observation of living cell and tissue cultures during experiments

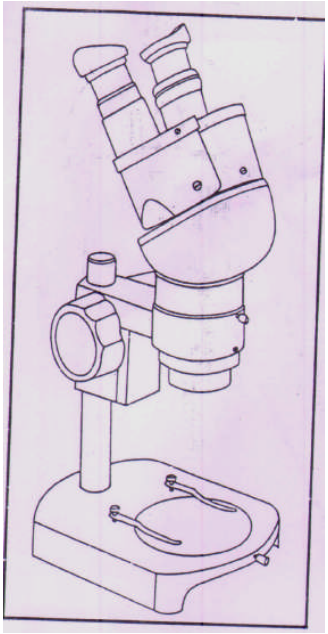


Fig. 15.4
A stereoscopic dissecting microscope

Microscope :

Simple, compound, inverted binocular dissection microscopes are essential for various purposes. Some of the microscopes (Fig. 15.4) should be fitted with a camera for taking photomicrograph.

Microtome :

It is needed for sectioning the cultured tissue.

Wooden Racks :

These are required for keeping the various chemicals.

LABORATORY FOR ASEPTIC INOCULATION :

This room should be without any window or ventilator in order to make it dust-free. The room should be provided with double doors. The doors should have a automatic door closer. Inside floor should be fitted with a rubber mat to facilitate cleaning. For entering into the room, shoes should be left outside. For aseptic work, a large wooden chamber *(Ca,4'×4'×7')* is made for short term work. Upper half of the sidewalls of the chamber is made of large glass sheets. The chamber should also have double doors provided with a door closer. The chamber is provided with two UV (one small, one big) sterilizing lamps and a fluorescent lamp. The switches to operate them are present outside the chamber so that the lamps can be safely switched on and off. Inside the chamber, the working table and shelves are made of thick glass sheets.

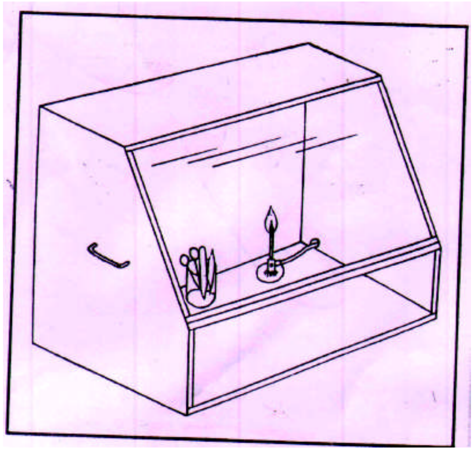


Fig. 15.5

For simple routine work such as aseptic seed germination, harvesting of cultured tissue from the aseptic stock for cytological work or for microtome preparations, a small inoculating hood may be used. This can be placed on a small table at the convenient corner of the room. The figure of an ideal chamber is given here 15.5.

Laminar airflow cabinet (Fig 15.6) is the most suitable, convenient and reliable instrument for aseptic work. It allows one to work for a longer period, which is not possible inside the inoculation chamber. Long hours of work inside the inoculation chamber may also cause suffocation and needs the interruption of work.

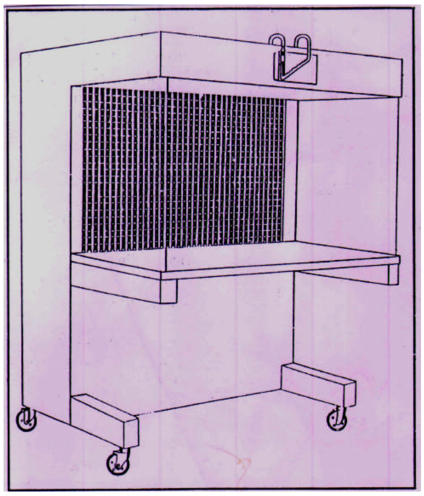


Fig. 15.6

One can work openly and easily for a longer period on the table of laminar airflow.

Laminar airflow has a number of small blower motors to blow air, which passes through a number of HEPA (high efficiency particulate air) filters. Such filters remove particles larger than $0.3\,\mu m$. The ultra clean air which is free from fungal and bacterial contaminants, flows at velocity of about $27 \pm 3m / minute$ through the working area. All contaminants are blown away by the ultra clean air and thereby an aseptic environment is maintained over the working area. Before starting work, laminar air flow is put on for 10-15 minutes. The flow of air does not put out the flame of a spirit lamp. Therefore, a spirit lamp can be used conveniently during the work.

CULTURE ROOM :

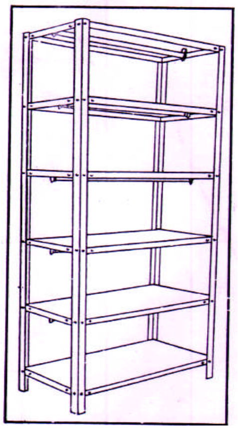


Fig. 15.7

Design for a skeleton rack for keeping culture vessels and Incubation of culture

The culture room means the room for keeping or incubating the culture under controlled temperature, light and humidity. The culture room is also fitted with double doors in order to make it dust-free and to maintain a constant room temperature. One should enter the culture room keeping the shoes outside the door. To maintain the temperature around $25 \pm 2^0 C$ inside the culture room, air coolers are used. This room is also provided with specially designed shelves (Fig. 15.7) to keep culture vessels. The shelves are made of glass or plywood. Flask, bottles, jars, petriplates can be placed directly on the shelves. Culture tubes can be kept on a support such as empty paper cover of fluorescent lamps. Cultures can be grown in light or in dark. For light arrangement, each culture rack is provided with fluorescent lamps which are photo-periodically controlled by an automatic timer. Racks covered with black curtains are suitable for dark incubation of culture. A thermometer and a hygrometer are fixed on the wall at the safety corner of the room to check temperature and relative humidity respectively. The relative humidity of the culture room is maintained above 50%. Some small shelves are placed in the culture room for temporarily keeping the autoclaved articles and the culture vials containing the medium.

The culture room should also have a shaker for suspension culture or single cell culture in moving liquid medium. The speed of revolution of the shaker can be controlled. The platform of the shaker is fitted with clips for holding conical flasks (150ml to 200ml).

GLASS GOODS AND INSTRUMENTS :
GLASS GOODS

Different types of glass goods are used to culture plant tissues. The conventional and some specific glass goods are required for culture work. Glass goods should be of Corning or Pyrex or similar boro-silicate glass. Measuring cylinder, conical flask, pipettes, beakers are required for preparation of media. Plant tissues are grown in wide-necked Erlenmeyer conical flask (100ml, 150ml, 250ml etc.), culture tubes (25mm in diameter and 150 mm in length), pretriplates (50, 90,140 mm in length), screw-capped universal bottle, milk bottle may also be used. Particular care must be taken to ensure that glass goods are properly cleaned before use. The traditional method of cleaning new or dirty glass goods is to soak these in soap water followed by brushing and washing well with tap water and finally rinsing with single distilled water. These are dried in the hot air oven and then the clean glass goods are stored in a dust-proof cupboard or drawer. In order to autoclave the culture medium and to culture the plant material, culture vessels particularly culture flasks and culture tubes must be fitted with cotton plugs which exclude microbial contaminants, yet allow free gas exchange. For this tightly rolled plugs of non- absorbent cotton wrapped in gauge cloth may be used. When in position the exposed part of each plug and the rim of the culture vessel should be covered by brown paper or a cap of aluminium foil. This will keep the plug and vessel rim free from dust and will protect the plug from wetting during autoclaving.

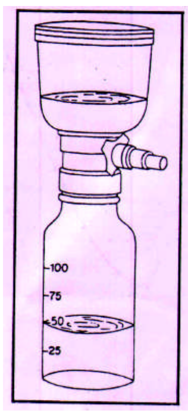


Fig. 15.8
A specially designed glass-made bacterial filtration system

In some laboratories, pre-sterilized, disposable plastic wares are used in order to culture plant tissues. Some of these plastic wares are autoclavable.

For the sterilization of medium containing thermolabile compounds or enzymes for proto-plast isolation a specially designed glass mad bacterial filter (Fig. 15.8) or an autoclavable plastic made bacterial filter is used.

A small spirit lamp made of glass will be required for the flame sterilization of instruments using methylated spirits.

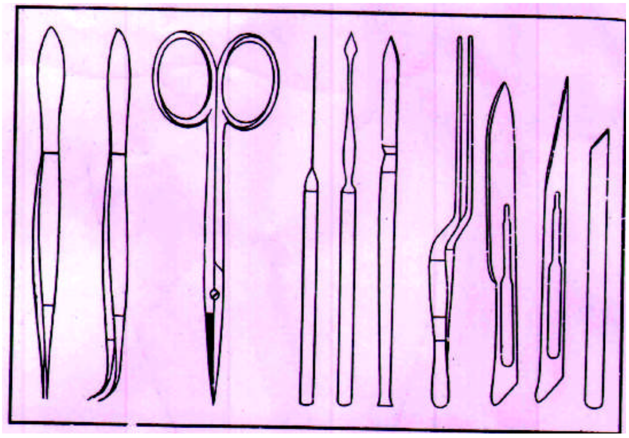


Fig. 15.9

A set of instruments used for tissue culture work

INSTRUMENTS :

Instruments routinely used for culture work include various sizes of scalpel and forceps, spatula, scissors, etc. (Fig 15.9). All instruments should be stainless steel.

Summary :

Plant tissue culture is a collection of experimental methods of growing large number of isolated cells or tissues under sterile and controlled condition. To carry out the experiments using tissue culture techniques, a well equipped laboratory is first required. An ideal tissue culture laboratory should have a big room for general laboratory and a small room for aseptic work and for keeping autoclaved articles. The general laboratory should be provided with a washing area, hot air oven, refrigerator, distillation plant, weighing balance, pH meter, vacuum pump, autoclave, working table, heater, microscope, microtome and wooden racks.

Laboratory for aseptic inoculation should be without any window or ventilator in order to make dust-free. The room should be provided with double door having automatic door closers. For aseptic work, a large wooden chamber is made for short term work. For simple aseptic routine work a small inoculating hood may be used. Laminar air flow is the most suitable, convenient and reliable instrument for aseptic work. It has a number of small blower motor to blow air which passes through a number of HEPA (high efficiency particulate air) filters. Such filters remove particles larger than $0.3\mu m$. The ultraclean air is free of fungal and bacterial contaminants.

The culture room means the room for keeping the culture under controlled temperature, light and humidity. To maintain the temperature around $25 \pm 2^0 C$ inside the culture room, air coolers are used in tropical countries. This room is also provided with specially designed racks to keep culture vessels. The relative humidity of the culture room is maintained above 50%. The culture room should also have a shaker for suspension culture in moving liquid medium.

Different types of Corning or Pyrex or similar borosilicate glass goods are used to culture plant tissues. Plant tissues are grown in wide necked Erlenmeyer conical flask, culture tube (25mm in diameter and 150 mm in length), screw-caped universal bottle. In order to autoclave the culture medium and to culture the plant tissue, culture vessels particularly culture tubes and flasks must be fitted with cotton plugs which exclude microbial contaminants. Yet allow free gas exchange. For the sterilization of medium containing thermolabile compounds and enzymes, a specially designed bacterial filter is used.

Instruments routinely used for culture work include various sizes of stainless steel made scalpel, forceps, spatula, scissors etc.

Excised plant tissues and organs will only grow in vitro on a suitable artificially prepared nutrient agarified or liquid medium, which is known as culture medium. The Murashige and Skoog (MS) based culture media are commonly used for plant tissue culture and have proven effective for growth promotion of both mono-cotyledons and dicotyledons. A culture medium is composed of inorganic salts, an iron source, vitamins, amino acids, plant hormones and a carbohydrate supply. Inorganic salts are supplied in two groups - as macrosalts and microsalts. The most commonly used phytohormones are synthetic auxins and cytokinins. The auxins are 2,4D, IAA, BOTA, NAA, IBA etc. and the cytokinins are Kinetin, 6 - BAP, Zeatin, 2 iPA etc. The concentration and ratio of hormones may vary from plant to plant and should be standardized for a particular plant tissue. Some plant tissues grow in the presence of complex natural additives such as coconut milk, casein hydrolysate, yeast extract, watermelon extract, maltextract, potatoextract, ripe tomato extract, orange juice extract etc. Diphenyurea, a growth factor found in coconut milk, exhibits cytokinin - like responses.

On the basis of constituents, culture media are of two types - i) Chemically defined in which the composition and concentration of all constituents are known. ii) Chemically under - fined in which the exact composition and the concentration of all constituents are not known due to addition of natural additives.

It is not possible to weigh and mix all the constituents just before the preparation of medium. So it is convenient to prepare the concentrated stock solutions of macro salts, vitamins, aminoacids, hormones etc. All stock solutions should be stored in a refrigerator for a limited period.

Several techniques have been adopted for in vitro plant tissue culture. Among them some are general techniques such as preparation of nutrient medium, sterilization, aseptic manipulation, maintenance of culture and some are specific techniques such as organ culture, callus culture, organogenesis, embryogenesis, suspension culture, anther and pollen culture, plant proto-plast culture, embryo culture etc.

15.13 EXERCISE

1) Explain the concept and working of greenhouses.
2) Describe the various types and uses of greenhouses.
3) Explain the concept of tissue culture and write detail note on tissue culture laboratory.
4) Write short notes on following -
   i) Greenhouse
   ii) History of greenhouse
   iii) Tissue culture
   iv) Instruments used for tissue culture

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