CHAPTER - III

AGRICULTURAL TECHNOLOGY & ITS IMPLICATIONS

3.1 AGRICULTURAL TECHNOLOGY
3.2 DISTINCTION BETWEEN FARM - TECHNOLOGY, FARM MECHANIZATION AND FARM - TECHNICAL KNOWLEDGE.
3.3 ROLE OF TECHNOLOGY IN AGRICULTURE.
3.4 INDIAN SCENARIO
3.5 GLOBAL SCENARIO
3.6 ADAPTABILITY OF NEW TECHNOLOGY
3.7 STAGES IN DEVELOPMENT OF FARM-TECHNOLOGY
3.8 EMERGING PROBLEMS IN INDIA
3.9 ACHIEVEMENTS IN AGRICULTURAL TECHNOLOGY.
3.10 COMPONENTS OF NEW AGRICULTURAL TECHNOLOGY.
CHAPTER - III

AGRICULTURAL TECHNOLOGY AND ITS IMPLICATIONS

3.1 - AGRICULTURAL TECHNOLOGY -

Since the time mankind learned to grow crops from the land, they had been using some crude form of technology. They might have been using some wooden implements to dig the land and prepared it for sowing. With accumulated experience they might have developed agriculture. Till last century the agriculture was very primitive. Animal power had been commonly used by the farmers for cultivation work. Primitive type and age old models of implements like wooden ploughs, spades, leather sacks etc. had been used by the farmers. This was the only crude technology the farmers had.

In 20th century the things changed fast. Inventions of mechanical power, electricity and its use as power etc. have revolutionized the agriculture. Not only this but invention in botany and biology gave a new direction in production of agriculture. Various methods and techniques have been developed for cultivation, irrigation plant protection etc.

Technology means the knowledge used in production to improve productivity. Agricultural technology therefore refers to the knowledge used in improving agricultural productivity. Infact, it is a combination of inputs and changes in it from time to time for maximizing productivity. As a result of this the per unit cost may be reduced. It could be a mix of human labour, seeds,
fertilizers and manure, animal labour, and management. The degree of variation in this mix is the dynamics of farm technology.

Speed of such change was really very slow in the past. But the pace at which today's agricultural technology changes is wonderful. The results of such rapid changes are well known today.

Science and technology, along with financial power and marketing strategies, enlarge cultivability of the land in many ways. Proper use of technology is now performing miracles in some developing countries. The need and demand based cultivation with proper marketing facilities also increase the scope of cultivation.

3.2 DISTINCTION BETWEEN FARM-TECHNOLOGY, FARM MECHANIZATION AND FARM-TECHNICAL KNOWLEDGE:

There is a difference between farm-technology and farm mechanization. Farm mechanization means the use of mechanical power in farm operations. Mechanization in agriculture may be of a competing nature or of a complimentary nature to human labour. Places where labour is not available or scarce, mechanization may complete, this means labour has been replaced by machines.
In the regions or countries where labour is available in abundance, mechanization would be complimentary in nature. Machines are designed to suit different situations.

On the other hand ‘Technical knowledge’ refers to the knowledge of using a technology. One can not use technology without having knowledge to use it. Any new technology will remain idle if users do not know how to use it. It becomes necessary, therefore to spread and impart knowledge of technology to the users. Extension services are required to educate the farmers who desire to use it.

Technical knowledge is classified as technological knowledge and managerial knowledge. Technological knowledge refers to the development of new technology in farming and the managerial knowledge deals with the techniques of management of farm business.

“Agriculture is not only a business but also a way of life; and cumulative in character”[1]. Farm technology therefore became hereditary process, in which the knowledge passed on from one generation to other. Further changes and developments take place with past and present experience and knowledge. Further, such new knowledge spreads fast due to facilities of communication and transportation. But only spread of knowledge is not enough, its implementation is necessary. Generally, people from less developed regions are less willing to accept new things so easily. May be due to their ignorance.

---

[1] “Fundamental of Agricultural Economics” by Sadhu & Singh Pg. 352
Many factors like culture, social attitude, and psychology of the people are responsible for easy acceptance.

Many often people are reluctant to accept such things which they do not understand; or because some one else have invented and brought it up they do not accept it. This is called social rigidity. A good example of Indian farmers can be given. During first few decades Indian farmers were not eager at all to receive and accept new technology and new ideas from the western developed world. Therefore unless cultural, social and psychological factors change, new technology would not work.

Present situation in India is quite satisfactory. After green revolution and as a result of continuous efforts of union government in this direction; farmers in India have now become aware and receptive for all new technology in farming; which now give better results.

3.3 ROLE OF TECHNOLOGY IN AGRICULTURE -

Role of technology is extremely important in agriculture also. Higher output or yield would depend upon the nature of technology. Main factor in agricultural production is land which is limited in supply; therefore technology plays a crucial role in agriculture.
"The efficiency of a given technology shall therefore determine in
general the efficiency of farm enterprises. Use of new technology makes it
possible to raise the output without increasing the unit cost. If a technology
succeeds in it; it results in increased economic progress".2

It is ultimately an increase in ends relative to means that leads to
economic progress. It is only through technology that a society can aim at
increasing economic progress.

Thus technology plays a basic and vital role in making more production
possible. Selection of appropriate technology is most important. It should be
suitable to requirements and stage of development. With development of new
social order the agricultural technology too have changed from traditional to
modern stages.

Technology plays a double role, it benefits the farmer in terms of
increased production and the consumer in terms of reduced prices. This is
because improvements in input-output relationships, the cost of production is
reduced by use of new technology, this affects the agricultural prices. Increased
quantity and reduced cost causes fall in prices of agricultural products. This
benefits the consumers. It does not mean that technology alone is responsible
for fall in prices.

2 "Fundamentals of Agricultural Economics" Sadhu & Singh Pg. 352
Farm technology plays an important role in affecting farm income. This happens as in initial stage rise in cost of production results in a substantial gains in farm income, when new technology is adopted. Therefore more and more farmers start adopting new technology.

Generally, new technology is quickly adopted by farmers with large holdings, because they can afford to invest and bear the risks. Large size is favourable for using mechanical power for various operations on farms.

Small size farmers cannot invest much more money and therefore even they adopt new technology, their comparative gain is very small. This is the reason why new technology tends to widen the income inequality.

New technology if used, saves the time and efforts. All heavy works done with machinery increases the time of leisure of the farmers. It may also displace some of the family labour units to allow them to take up alternative employment elsewhere and enhance the family income. In fact the adoption of new technology helps in promoting economic welfare in several ways. Technology as such plays a crucial role in the economic life of a nation.
3.4 - **INDIAN SCENARIO** -

Important role played by agricultural technology is obvious in case of our country. The population of India in 1951 was 36.10 crores which increased with galloping speed (rate) to 102.7 crores in 2001 (census). Thus the growth was more than double. Now if food production viewed vis-à-vis population, in 1950-51 total food grain production was 50.82 million tonnes, which increased to 203 million tonnes in 1999-2000. It is beyond imagination what would happen in absence of new agricultural technology. Today India has become a self sufficient nation in food supplies, which could feed such a huge population. Not only this but India is one of the exporter of many agro products.

3.5 - **GLOBAL SCENARIO** -

In recent years, farm technology has played a more significant role in enhancing global food production and to cater to the growing food requirements - owing to demographic explosion. In absence of rapid technology advances in agriculture, the world would face a gloomy future prophesised by Rev. T.R. Malthus, in his theory of population\(^3\). Fortunately and with invention of new technology his theory has not yet been proved true.

\(^3\) (a) "An Essay on the principles of population" 1798 by Rev. T.R. Malthus
New farm technology in isolation cannot do anything unless it is adopted by the farm population. Adoption also depends upon the rate of technical progress. Technical knowledge varies with economic and social development of a country. Tradition ridden societies are less receptive to new ideas and innovations compared to advanced societies. Therefore technological progress takes place in developed countries. Naturally such developed countries reach to the heights of economic progress. Acceptability and implementation of new farm technology generally depend upon the following factors¹.

(1) Responsiveness of the society to new ideas.
(2) Extent and type of education.
(3) Financial soundness of the adopters and availability of credit.
(4) Present position of existing technology.

Responsiveness of the society is multifaceted concept. This means socially dynamic, politically conscious, educationally enlightened and economically developed society, which always respond positively to new ideas.

Education and extension services play crucial role in making society receptive to new ideas.

¹ Fundamentals of Agricultural Economy by AN Sadhu & Amerjit Singh 3rd Edition
Page No. 355.
Purchasing of new technical equipments involve finance. Rich farmers can afford to purchase new equipment as they have a sound financial position. But countries where farming population is poor, problem of finances would come across adoption of new technology. Lastly if present position of existing technology is more advantageous than the new, then new farm technology would not be adopted. This may happen if gains from the use of new technology are only marginal.

3.7 - STAGES IN DEVELOPMENT OF FARM TECHNOLOGY -

The process of change in agricultural technology was not an abrupt event. It gradually and component-wise developed over several years period. It has undergone through following stages.

(1) Changes in farm machine technology
(2) Changes in animal production technology
(3) Changes in plant production technology
(4) Changes in land use technology
(5) Changes in food and fiber processing technology.

In fact agricultural technology have come through machines. The oldest reference in this regard is Whitney Cotton Gin in England in about 1820. This cotton ginning factory sparked off a revolution in farm machines technology⁵.

The reaper, mover, the seed drill, the steel plough and the threshing
cmachine appeared on the scene in rapid succession. American farmers adopted
new machines earlier than Europe and rest of the world. This took America on
the top of the world for agro production and paved further way for changes in
other components of technology. Asian countries and India as well started
using machines very late. However efforts continued in the developing
countries to invent and design such machines those will suit to their country’s
needs. Second stage is animal production. Animal husbandry was practiced
side by side by the farmers traditionally, for draught power and milk and wool,
and meat. Main aim remained to supply milk in particular. Therefore as
observed, in India green revolution was closely followed by white revolution
due to significant development in animal production. The research work still
continued.

The third stage is plant production. This has reference with invention of
various plants, with the help of experiments on plants to produce hybrid
varieties of seeds. Hybrid seeds have brought about a significant revolution in
agriculture. They have solved the food problem of the world.

The fourth stage is the optimal use of land. This included conservation
of land, preservation of forest wealth, controlling of soil erosion, preventing
depletion of soil fertility, are the parts of land technology.
The last stage is technological developments in food and fiber processing. Remarkable achievements have been made in the techniques of preserving, food, vegetable, meat, and other food items etc. It became possible to sell the products far from the production place. This technology includes packing and canning of fruits, and fruit juices etc. This gave advantage to some of the regions, which have a specialization in fruit production and not in food production.

Thus from stagnant agriculture to a revolutionary product technology, it has certainly been an impressive advance, though a long march had to be made. Such transformation of traditional agriculture shows man's competence. Food production, the mainstay of life on this earth, directly depends on the prosperity of agriculture. Though scientists are working in the laboratory for some alternative synthetic foods, but land is only the main source.

In the future times the population of the world would not be stagnant (or stationary), food habits of the people also would not undergo much changes, therefore, the process of research and developments in agriculture technology would continue, and it must. The present technology could not be said to be the most ideal, it would require further developments as per needs.
One of the greatest event of this century is advancement in biological engineering, which has entirely changed the face of world of agriculture, by development of high yielding varieties of seeds of some crops like wheat, rice, maize, bajra, jawar and other crops like vegetables etc.

3.8 - EMERGING PROBLEMS IN INDIA -

Despite the significant achievements made in agricultural technology in India, there are problems causing following concerns:

1. The growth rate of population in the country is as high as 1.8 percent, and inspite of a significant growth in production of food crops, she has over 200 million poor people to feed.

2. The Planning Commission had fixed a target of 4.5 percent annual growth rate of agriculture during 1997-2002. Expected food grain in 2002 was 220.5 million tonnes and actual production was 212.0 million tonnes. To fill up such a gap more efforts would be needed.

3. To provide food to every one is a problem confronting the country today.

4. Declining per capita availability of cultivable land.
5. There occurs wide spread mismatch between production and post-harvest technologies. Minimization of losses is possible through improved post-harvest technologies.

6. Inadequacy of infrastructure facilities in rural areas.

7. Emerging problem of declining capital investment in agriculture.

8. The existing institutions are in a state of reorientation, particularly following the W.T.O. regime of liberalization and globalization. The role of state, cooperative sector, private sector, N.G.Os etc. would have to be redefined, to face the new challenges relating to input use and input and output markets.

3.9 - NEW ACHIEVEMENTS IN AGRICULTURAL TECHNOLOGY -

The Department of Agricultural Research and Education (DARE) was set up in 1973 in the Ministry of Agriculture for coordinating research and educational activities in agriculture, animal husbandry and fisheries. The Indian Council of Agricultural Research (ICAR) is an apex institution which in fact implements the programmes of DARE in the country. ICAR is the parent body carrying out R&D work on all types of crops, animals, fisheries etc. through a network of research institutes. Research stations and state level agricultural universities in various parts of the country has done commendable work in evolving, testing and propagating new farm technologies.
ICAR has initiated research on almost all economically important corps, besides soil sciences, horticulture, animal husbandry, fisheries and agricultural extension. Today India is one of the 8 gene countries in the world having three Bordeaux dealing with plants, animals and fisheries.

Following are some of the significant achievements, in farm technology.

**BIO-TECHNOLOGY**

(1) **Bio-diversity in Agriculture:**

Scientists think that mapping and sequencing should be given top priority as they are the potential contributors of genetic improvement in crop plants and live stock.

(2) **Boll Guard Cotton:**

Boll worm attack is the single major threat to the cultivation of the cotton. Efforts in the direction of controlling the boll worm challenge through spraying bacterial extract gave only temporary relief. Attempts were therefore made to transfer the genes responsible for the bacterial toxin to the cotton plant. The efforts were successful in 1981 but it took almost 15 years to complete field trials. Inspite of this achievement, still cotton farmers are beset by the boll worm infections. Therefore it calls for studies on the suitability of boll guard cotton to our conditions, and recommendations by the experts in the field.
The International Rice Research Institution (IRRI) (Philippines) is in the forefront of the genetic engineering research in rice and had already transferred several genes targeted against stem borer insect, fungal sheath blight and bacterial blight. The new varieties have to be field tested before they are released for cultivation.

WATER MANAGEMENT -

Water is a scarce resource therefore various techniques have been developed for increasing water use efficiency. Watershed management is the approach in the irrigation development, particularly in rainfed agriculture. Watersheds are spatially laid from ridge (line of meeting two sloping surfaces) to valley, they most efficiently conserve land and water resources and facilitate availability of water throughout the crop period.

AGRICULTURAL ENGINEERING -

It deals with mechanization through efficient use of input to increase farm productivity, conserving natural resources, reduce crop losses, improve quality of agro-produce etc. Mechanization is one of the measures of modernization of agriculture.
BIO-INTENSIVE, INTEGRATED PEST MANAGEMENT -

Indiscriminate use of chemical pesticides have an ill-effect on corps, and consequently harmful for health. Therefore bio-intensive integrated pest management, a technically feasible and economically viable method of pest-management has become popular, particularly among small and marginal farmers. It relates to conservation and augmentation of natural enemies of corps pests and adoption of all compatible cultural, mechanical, physical, genetic, selective chemical pesticides, tolerant varieties and legal methods.

AGRO-BIODIVERSITY -

In September 2000 the National Bureau of Plant Genetic Resource was having 197839 seed samples with them. These samples were for 160 species of different agricultural and horticultural crops. Out of the above said 197839 samples, 90832 accessions pertained to cereals 31179 pulses, 25070 oilseeds, 13430 minor millets 10088 vegetables, 6755 fibers crops 1539 spices 709 medicinal and aromatic (perfume smell) plants and 778 narcotics.

Biodiversity has direct consumptive value in food, agriculture, medicine and industry. It also maintains ecological balance and helps in the continuation of the evolutionary process. The indirect eco-system services provided through biodiversity are photosynthesis pollination, transpiration, chemical cycling, nutrient cycling soil maintenance, climate regulation, waste treatment and pest control.
NUTRIENT MANAGEMENT -

High yielding variety of seeds are nutrient responsive. They need intensive nutrient application and improved farm management to obtain full benefits from such varieties. But it is now realised that uses of large doses of fertilizers, pesticides, fungicides, weedicides etc. leads to deterioration of soil health and pollution hazards. The consumption of nutrients which is about 16.5 million tonnes realised from 40 million tonnes of nitrogenous phosphatic and potassic fertilizers is also causing a serious strain on foreign exchange reserves of the country. Hence there is a need of supplementary and indigenous renewable form of nutrient resources.

INTEGRATED PLANT NUTRIENT SYSTEM -

Basic of this system is conservation of natural resources. Components of this system are :-

1. On-site resource generation (recycling of crop residues)
2. Mobilization of off-site nutrient resources addition of chemical nutrients from outside.
3. Integration of on-site and off-site nutrients.
4. Optimal use of all the resources.

In short this system reflects management of overall farming system.
POST HARVEST TECHNOLOGY -

It is a common experience that a substantial quantity of food crop is lost after harvest because of handling and storage problems. It is estimated that such loss is up to 9.33 percent in India. Scientists are working on various methods to prevent this loss. It is mostly required for perishable products like vegetables etc also other products like fish eggs meat etc.

REMOTE SENSING -

A system which can forecast useful information about climate moisture, etc. accurately is required to be installed at national, state and even district level. Such organizations can be encouraged even in cooperative sector or voluntary organizations.

3.10: COMPONENTS OF NEW AGRICULTURAL TECHNOLOGY -

High yielding variety program which is also called as New Agricultural Strategy was put into practice for the first time in India in the kharif season of 1966. This programme was introduced in the form of a package programme. Components of this successful strategy were, HYV seeds, fertilizers pesticides, irrigation, machinery, improved implements, soil conservation etc. In this paragraph an attempt has been made to examine the importance of all these components of new agricultural technology.
(1) **IRRIGATION** -

Irrigation is one of the fundamental factors in the adoption of the new agriculture strategy. Assured irrigation saves agriculture from the gamble of rainfall and averts severe famine and semi-famine conditions. Availability of irrigation facility encourages and creates an opportunity for multiple cropping, intensive and effective use of land, through which higher production can be achieved.

Traditional way of irrigation was dependence on seasonal monsoon and wells, very few canals were used. Management or planning part in irrigation was unknown.

There is a drastic change in irrigation due to new technology. After independence India adopted planned way of development, in agriculture too. Huge amount of money has been invested by the Union Government for constructing dams, and similar irrigation projects. This created irrigation potential and its optimum utilization.

National Water Policy - 1987 states that “The Water rates should be such that the user knows the scarcity value of water and is motivated for efficient use of water”. It was therefore expected that the water rate charges should cover annual maintenance and operation costs and a part of the fixed cost. “But only few states revised the rates so far” (Economic Survey 2000-01 pg. 159).
During last decade, the usual methods of irrigation viz. wells, canal, lift irrigation etc. were used and water given to the plants many times was much more than the required amount. Therefore ‘Drip Irrigation’ system has been developed. For example nation like Israel is a pioneer in this field.

**DRIP IRRIGATION / SPRINKLERS**

In drip irrigation a drip is kept near the stem of the plant and water dropping rate is controlled with help of special type of nozzles developed for this purpose. Another system is ‘Sprinklers’, where the requirement of water is like shower this method is useful. This system is useful for plantation crops like tea, coffee etc. Both the above systems require quite large investment of money to buy the pipe line of particular diameter and a special quality which would withstand the atmospheric conditions on the farms. Expenses are also involve in maintenance, but 30 to 40 percent water is saved which could be used for another crop.

There is a new method again, by which pipes for irrigation are put 6-8 inches underground and a particular pressure of water flow is maintained so that small holes on the tubes do not get blocked with mud. Advantage of this system is that the rate of evaporation of water is reduced to 90 percent being underground. A very cheaper and commonly feasible way to protect from evaporation is to spread some broad type leaves of trees over the ground, under the sown plants.
RAIN WATER HARVESTING -

Due to water crisis and irregularity of rains, a new concept has been developed. This system is useful both for urban water requirements as well as agricultural need. Under this system, a tank (size depends upon construction of house) is required to be constructed underground and rain water is channalised into the tank from the roof of the house. This can accumulate water which can meet the demand for water upto 30 to 40 percent of total need.

For agriculture also a big tank constructed and rain water of stored can be useful during the season of the crop. Water from tank can be lifted with the help of motor pump. The above discussed system also requires money capital to complete.

WATERSHED DEVELOPMENT -

A watershed (or catchment) means a geographic area that drains to a common point. It becomes an ideal planning unit for conservation of soil and water. A watershed may cover one or several villages. The watershed approach enables a holistic development of agriculture and allied activities in the area taking into account land use based on crops, horticulture, agro forestry, and forests etc. But experience of some past years had been pessimistic, as far as community active share is concerned.
However the Tenth Five year Plan (2002-07) has a target of treating 15 million hectares of rainfed land under the various Watershed Development Programmes.

The world area under drip and other micro-irrigation systems went from 56 thousand hectares in mid 1970s to 208 million hectares in 1998. Studies conducted in Israel, Jordan, Spain, and India have shown that drip irrigation reduces water use by 30 to 70 percent and raises crop yields by 20 to 90 percent. In 1985 only about 1000 hectares of land was under drip irrigation in India. In 1998 this increased upto 2,25,000 hectares.

According to some experts, there is a potential to install drip irrigation systems in 10 million hectares of agricultural and in India, mostly in water scarce state of M.P. Gujarat, Rajasthan, Maharashtra, A.P. and Tamil Nadu. In Maharashtra Sugarcane area under drip system resulted in 50 percent improvement in the yield and 25-30 percent saving in fertilizers. (Indian Agriculture - 2003).

(2) H.Y.V.SEEDS -

High yielding variety of seeds is a second and most important component of New Agricultural Technology. These seeds are considered to be neural to scale and can be adopted by small farmers also.

---

6: Indian Agriculture - 2003 Page No. 54
Pub. Indian Economic Data Research Centre New Delhi.
The problem of HYV seeds is that it requires regular irrigation and fertilizers for its implementation. As it requires often heavy investments, small farmers may lag behind large farmers in adoption. But with the passage of time, all types of farmers realized its importance.

Research and development in this field is continuous in the country. HYV Seeds are more prone to diseases and other pest infections, therefore, scientists are engaged in finding such varieties which can withstand the infections due to fungal or other organism. They have been successful to a great extent.

Through the genetic diversity, the scientists in India have been able to evolve over 2600 high yielding varieties and hybrids of various corps which have helped in enhancing the yields of wheat and potato by 7-fold, rice, sorghum, sugarcane and cotton by 3-fold and maize by more than 4-fold, during last 50 years.

Amazing progress has been achieved by the use of these H.Y.V. seeds in the country as a whole. Progress made in this respect in Maharashtra and Ahmednagar District has been separately discussed in detail in the corresponding chapters.
Tissue Culture is an established method of micro-propagation of plants including cash corps, flowering shrubs and trees. Tissue culture technology is particularly useful for aforestation as trees take long time to grow and many of the conventional methods of propagating such as through seeds, rooting of cuttings and grafting are slow, difficult and not satisfactory. In tissue culture propagation or multiplication, plant-lets are first produced in a test tube from plant tissues. They are then induced to flower by supplementing the culture media with appropriate quantities of plant growth regulators under strictly sterile and hygienic conditions.

One of the advantages of tissue culture propagation is that the plantlets are true copies of the parent plant, while marked variability exists in the natural population. The productivity can be increased significantly by cloning of superior individuals. Virus can be eliminated by culturing the shoot of meristem and a pathogen free stock can be maintained by routine micro propagation. Mass propagation drastically reduces the time required for raising the second generation of plants. The problem is that, all this process involves high costs and hence, the system is suitable for more valuable plants.

Tata Energy Research Institute has done valuable research work and during last five years more than 8 million tissue culture plantlets of forest trees and cash corps like sugarcane, banana, potatoes etc. have been planted in about
10000 hectares of forests land and farmers fields. Government of India has set up two Tissue Culture Pilot Plants Facilities, in 1989. One at Teri near Delhi and another at National Chemical Laboratory (NCL) in Pune.

The tissue culture regeneration does not help only in the mass production but also improvements in the quality and yield. If the parent material is disease free, the plant-lets produced are also disease free. This saves the loss resulting from planting of diseased seeds in the conventional cultivation process. Survival rate of good plantlets is more than 95 percent.

(3) **FERTILIZERS**

Fertilizers is the third important component of new agricultural technology. Organic manures and chemical fertilizers are essential inputs for boosting the output of various crops. Every tonne of fertilizer increases food grain yield by 10 to 12 tonnes. Fertilizers provide additional nitrogen, phosphorous and potash to the crops. Their use in optimal quantity is essential for maintaining the fertility of land to obtain the benefit of high yielding variety seese. Land is a limited resource, hence use of fertilizers becomes all the more important not only for increased yield for higher income for the farmers but also to meet the basic food requirements of the growing population.

In the new agricultural strategy fertilizer has been assigned the role of king-pin because it increases yield tremendously.
An F.A.O. (Food and Agriculture Organisation of the UNO) annual study has described the importance of fertilizer use as a “Spearhead” of agricultural development, because wherever efforts are made to raise agricultural efficiency and production for expanding populations, more fertilizer and manures have been invariably needed. Perhaps more important, on many soils they make possible good yields of valuable crops that would not grow at all without them, or would grow more poorly. "This possibility of diversification is more profitable system of farming, to be more flexibled in farm management, and to adjust more readily to changing economic conditions."^7

**BALANCED USE OF N.P.K.-**

At the Indian National level Nitrogen, Phosphate and Potash (NPK) use in the ratio of 4:2:1 has been referred as an optimum ratio for balanced use of chemical nutrients.^8

This ratio is mainly for food crops like rice and wheat, plantation, and horticulture crops. However ratio may vary according to soil nutrient status and crop needs. To encourage balanced fertilizer use, the Central Government

---


continues to provide subsidy on urea and as well on decontrolled phosphate and potassic fertilizers such as DAP; MOP, SSP and complexes. Central Government has spent a very huge amount on subsidity so far. To formulate the policy on subsidy for fertilizers, High Powered Fertilizer Policy Review Committee and Expenditure Reforms Commission has been organized by the Government.

Use of all types of chemical fertilizers, and increase in production thereby has been discussed in detail at national, state and Ahmednagar district, in the corresponding chapters.

A recent trend is to minimize the use of chemical fertilizers because continuous long term use of chemicals causes serious degradation of soil, and it becomes saline. It is very difficult then to restore the original production capacity of soil. Production of organic manures with the help of decomposition of farm side organic material using earth worms is being encouraged for this purpose.
ORGANIC MANURE -

According to a study made by the scientists of the Tamil Nadu Agriculture University, if crops residues of rice, maize, sugarcane sorghum, pearl millet, pulses and biomass from aquatic and wasteland weeds are processed properly into organic manure, they can produce fertilizer equivalent of 2.20 million tonnes of N.P.K. About 8 million tonnes equivalent N.P.K. can be made from 2027 million tonnes of cattle manure and 7 million tonnes of NPK from 7.5 million tonnes of organic waste produced in urban areas. About 24000 million tonnes of agricultural waste is produced every year in India, which can be converted into 14.22 million tonnes of fertilizers.

Many farmers in the country have now started using organic manure in place of chemical fertilizers, though the number is very small. The compost helps in storing soil nutrients and prevents its leaching from the soil. It strengthens the rooting system which improves nutrients absorption and soil fertility. The manures can be used for diverse crops like banana sugarcane, coconut and vegetables. The main problem with manures is that the quality of organic manure is often inconsistent and the products are not standardized.

BIO-FERTILIZERS -

Bio-fertilizers are living cells of different types of microorganisms (viz. bacterial, algae, fungi etc.) which have an ability to mobilise nutritionally important elements from non usable to usable form. They require organic mater
for their growth and activity in soil and produce valuable nutrients to the plants in the soil. These are of three types, biological nitrogen fixers, phosphate solubilisers and mycorrhizae.

Bio-fertilizers are ecofriendly and environmentally safe as against chemical fertilizers which could be harmful. They are low-cost substances which form a part of the integrated nutrient system of plants. The most commonly used biofertilizers are azospirillum phosphobacteria, blue green algae, azolla, and mycorhiza.

The root exudates of the crop provide nutrients for the survival and the multiplication of bacteria. Azospirillum also absorbs phosphorus and silicon to some extent and makes the plant drought tolerant in cases of delayed rainfall or irrigation. The average nitrogen fixing capacity of blue green algae is 15 kg per hectare. It oxygenates, the water impounded in fields excretes organic acids that solubilise phosphorous. Algae mat in field also protect moisture loss from soil.

Seaweeds provide a very good source of macro and micronutrients vitamins and plant growth regulators such as cytokinins and the biofertilizers in different concentrations can be prepared from them. Liquid seaweed fertilizers can be used as sprays in soils or for soaking the seed in it before planting. Bio-fertilizers catalyse the germination of rice black gram and green gram seeds significantly.
Seaweed fertilizers can increase the yield of cucumber by 40 percent and potatoes by 20 percent. They also increase the yield of maize and other corps like fruits and vegetables. It has also many more beneficial effects.

The union Government has sponsored a project called “National Project on Development and use of Bio-fertilizers” Under this project a National Biofertilizer Development Centre has been set up at Ghaziabad with six regional centres at Hissar, Jabalpur Bhubaneshwar, Bangalore, Nagpur and Imphal, in 1998-99. These centres produced 310 tonnes of biofertilizers. They have conducted 14 orientation courses 6 refresher courses and held 70 field demonstrations on applications of biofertilizers. These centres now are producing about 375 tonnes of biofertilizers every year.

(4) **CORP - PROTECTION**

This is also an important component of new agriculture technology. Plant protection is very important in order to reduce crop losses and improve crop yield. The nature of new agricultural technology is such that it yields more production although expensive. Therefore cultivator would not like to lose even a part of his corp. Crops while growing in the fields and when output stored, are prone to damage through pests and diseases.

When crops are in the fields many worms, pests, insects and fungal infections attack them and destroy the plants ultimately yield is poor.
In the godowns or storage places, rodents and other various insects damage grains or even vegetables and fruits to a very large extent.

Quick growth of plants with use of irrigation and fertilizers has created problems of pest attack and diseases, as new varieties of seeds are prone to diseases, and pests. Therefore a need arise to control them. Though pesticides, fungicides and other chemicals are costly, they are profitable. Unlike fertilizers they do not increase productivity of land. They merely protect crops from losses. In India BHC and DDT were imported and used extensively. After 1960-65 other chemicals also were imported and used. The use of chemical pesticides continued to increase in the decades of 1970s and 1980s and 1990s but after that there was a decline in consumption, but in fact the data of recent dates had excluded the crops other than serials. Almost all chemicals are produced in India and some of them are exported.

Advanced techniques have been developed in western countries for spraying etc.

INTEGRATED PEST MANAGEMENT -

To prevent excessive use of chemical pesticides in various crops, efforts are being made to popularize the concept of integrated pest management, since the beginning of Seventh plan period. Under this scheme, alternative techniques of pest control like cultural, mechanical, biological methods are used.
Significant progress has been made by Indian Scientists in developing a plan for integrated pest management, for various corps like cotton, rice, pulses, oilseeds, sugarcane, citrus fruits grapes and vegetables.

To promote the concept of cheaper and environment friendly integrated pest management, Indian Council of Agricultural Research (ICAR) has launched a mission-mode IPM Programme for crops like cotton pigeon pea, chickpea, groundnut, tomato cabbage, apple and mango in different agro-regions in the country. These corps account for about 70 percent of the pesticides consumed in the country.

**BIO-PESTICIDES**

In the country, at present (2004) there are some 70 companies in the small, medium and large scale sector manufacturing or marketing biopesticides, mainly neem based. But there is a need of study on the efficacy and shelf life of their products in actual field application. These companies have received provisional registration by the Central Insecticide Board in Jan. 1998.

The biopesticides are more suitable on small farms which are easy to look after and manage. These pesticides do not work (are of no use) on large scale planting. Whenever a pest attack takes place the farmer has no other choice but to use chemical pesticides otherwise his crop is completely destroyed.
Farm Mechanization refers to the use of mechanical power in farm operations. It may be defined as the process of performing certain agricultural operations, which are usually done either by animals or men or by both, with the help of suitable machines.

This includes the use of machines for tillage operations, harvesting and threshing of the farm produce. It also includes power lifts for irrigation, transportation of farm produce, processing machinery, dairy appliances, cotton ginning, rice handling, etc. In short mechanization means the use of mechanical power along with machines that go with it.

**NEED OF MECHANIZATION**

Nowadays, the high yielding variety seeds are used, and chemical fertilizers are used as nutrients, this gave opportunity for multiple cropping pattern.

These miracle seeds and other inputs can show their production potential if all operations of farming are conducted at the proper time. For example seed-bed preparation should be of good quality and done at proper time, there should be uniform application of fertilizers, assured irrigation at the proper time and in proper quantity, harvesting and threshing should be early to sow the next crop. All these operations mentioned above if performed with human and animal energy can neither be satisfactory nor be finished in time. Therefore, timely
farm operations of satisfactory quality can only be achieved by using sufficient
and well adopted machinery and implements.

Thus taking into account the modernization of agriculture for getting
more output, and consequent economic betterments mechanization is needed
invariably.

History shows that mechanization in agriculture has revolutionized the
farming in the western countries and United States of America.

It is true that mechanisation of agriculture results in increase of
production and reduction in the costs. Besides, agricultural machinery has been
useful in reclaiming barron lands. This is why the prosperity and richness of
peasantry in the western countries has been due, largely to the extensive use of
farm machinery. Naturally there is now a common belief that progressive
agriculture is impossible without mechanisation of agriculture.

EMPLOYMENT & MECHANIZATION - A CONTROVERSY -

Mechanisation in agriculture may be of competing nature or of
complementary nature to human labour, depending upon the circumstances
under which it is resorted\(^\text{10}\).

\(^{10}\) Fundamentals of Agricultural Economics by Dr. AN Sadhu and Amarjit Singh, Page 579
For example in western countries due to demographic reasons the labour was very scarce hence mechanisation was alternately used. But this was not the case with Asiatic countries like India and China where labour is abundantly available and at cheaper rate, in this case mechanisation would be complimentary.

Mechanisation may be complete or partial. It is called as partial when only a part of farm work is performed by machines. On the other hand when all farm operations are completely performed by machines, it is called as complete mechanization.

In Indian conditions mechanization of farms has to be viewed from two different angles. The first is that of agriculture is completely mechanized, it would give rise to the problems such as displacement of labour and animal power. Another problem is feasibility of adoption of mechanisation, because of poor economic conditions of vast majority of our farmers. If poor farmers could not buy enough machines, they would have to borrow, it on rent from the rich farmers, in that case the hire charges of machines like tractors would be possibly higher than the cost of use of animals and labourers.

Therefore it is useful here to study, the case for mechanisation of agriculture and a case against mechanisation.
CASE FOR MECHANISATION OF AGRICULTURE -

Firstly, mechanisation of agriculture is based primarily on advantages of large scale production. Man by himself can produce only very little, but with help of machinery he can produce much more. For example if a farmer with a pair of bullocks can plough a certain area (acre) in 10 days, a tractor can do this work in one day, and in better way.

Secondly, machinery relieves man of much of the heavy work. For example land digging and carrying earth, land reclamation, ploughing etc. works are very heavy jobs. Mechanisation makes it easy. Thirdly, Large scale production is possible with machinery use. Large plots can be ploughed, in short time, crops can be harvested quickly and transportation becomes easy with machines than bullock carts. Time is saved, and cost of production is reduced. Example of Western Countries, USA and Russia can be cited, where extensive mechanisation of agriculture has taken place and productivity raised manifold. Though the population depended on agriculture is much less, these countries are able to export agricultural goods to the world to a very high extent.

In India there is considerable scope for mechanisation yet. For example tractors are useful in reclamation work and soil conservation, which is needed in India. Besides this there is a good scope for other machinery like electrically operated pumps, threshers, cane crushing oilseed crushing etc.
Experience of many developed countries show that with development, human and animal labour become costlier compared to machines. According to Dr. C.H. Hanumantha Rao “Technical progress and industrial development contribute, in general, to increasing the ease with which capital can be substituted for labour and also to reducing the cost of machines and fuel. On the other hand economic development and the growth of per capita income raise the cost of biological sources of energy by increasing demand for labour in the non-agricultural sector”. 11

Farming is a seasonal production activity, and requires labour urgently during certain operations. For example when the crop is ripe for harvesting there is greater demand for labour to harvest the crop within time. Sometimes labour is not available, this type of bottleneck can only be done away with help of machines.

Mechanisation leads to commercialization of agriculture. It widens the base of industrialization and creates off-farm jobs, consequently pace of prosperity is speeded up.

MECHANISATION MODIFIES SOCIAL STRUCTURE IN RURAL AREAS -

Traditional agriculture involves hard work and drudgery. Mechanization helps in freeing the farmers from this drudgery and allows them to enjoy more leisure and work under agreeable conditions. According to Prof. Hanumantha Rao “It may even raise the participation rate among those who could afford to abstain from drudgerous manual work”. The whole out look of a farmer changes with the introduction of mechanisation. Farmer can think of better perspective and his general well being.

CASE AGAINST MECHANISATION -

Following are some of the arguments which are put forth against mechanisation of agriculture in India (developing country).

The first is that Mechanisation has no scope in India because of the majority of very small size of holding (between 3 to 12 acres). Such tiny plots are scattered in the villages. A tractor can not be used to plough a half an acre plot, hence existence of large size farm is an essential condition. Farms should be large and compact and not scattered as in care of India. In USA and Canada average size of a holding is about 60 and 90 hectares respectively. Best use of machanisation therefore was possible in there countries. This is not possible in India.
The second and important argument against mechanisation is that mechanisation in agriculture will result in unemployment of too many agricultural workers. Non agriculture sectors would not be able to absorb such huge number of unemployed persons from agriculture, taking the slow growth of industries in India. In western countries, USA and Canada, the real problem is shortage of labour hence machinery is used. But this is not case in India, where there is abundant labour.

This problem can be solved by creating opportunities in rural areas by expansion of rural industries.

The third argument is that, the cattle population will be surplus, and feeding them would be a heavy burden on farmers.

The fourthly, farm machinery would require petrol and diesel. India imports oil and one or the other way there is shortage of this fuel. This would create bottleneck. Finally, increase in the productivity of land is important than increase in labour productivity. Japan is the country which could increase productivity of land without mechanisation, and doing intensive agriculture.

SELECTIVE - MECHANISATION - THE CORRECT APPROACH -

It is a fact that full mechanisation like advanced countries is not possible or desirable in the country like ours. Therefore it is suggested to develope suitable labour intensive machinery, which can be used on small size farm also, this will minimize displacement of labour. Recognizing this need, in the fifth plan and policy of selective mechanization was proposed to be adopted.
In the Sixth Plan it was decided that “unrestricted mechanization of agricultural operations will not, however, be in the interest of our country as it severally worsen the rural unemployment problem. As such a policy of selective mechanisation will be adopted.  

RECENT TRENDS.-

Apart from the favourable and unfavourable effects of mechanisation, during last 2-3 decades the rate of mechanisation continued to rise. This fact was also revealed in the area under study of this work.

A separate detailed data and findings on mechanisation and its development in the country particularly in Maharashtra and Ahmednagar district have been separately dealt with and presented in the corresponding chapters.

******