Agricultural Technologies In India: Adoption And Impact

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Abstract
A revolutionary change has been seen in agricultural development after independence all over India. The linkage among technological change, cultivation practice and economic growth is generally highlighted with in a frame work provided by significance agriculture production where mainly out puts depend upon skilled Labour, proper techniques and supply of capital. In previous, there was only one crop agricultural practice and particularly in rainy seasons but later we will observe due to the advancement of technological improvement agriculture practice two to three times increases in a year and also rate of production increases significantly. Advantage of tube wells, canal, wells farmers started irrigating more times, chemical fertilizer are being used instead of cow – dung, various type of machine likes tractor, power tiller, harvester have stared being used. This paper shows the ways of technological changes in agricultural practices in respect of time.

Key Words: Agricultural development, technological change, cultivation practice, economic growth, chemical fertilizer, irrigating

1. Introduction

Agricultural activities play a vital role in Indian economy. It is said that one third of the total income and about two third of the total working force are connected in this concerned sector. So, the enhance of technological improvement in this regard is very much essential in developing countries as India. Here, the responsibility of planners and the policy makers are very much significance for productivity of agricultural resource. The different five years plan has been contributed various ways for increasing yield in India i, e. in the fifty plans it was proposed about some selected mechanization process through which the yield can be increased and many crops can be grown. Various policy regarding selective mechanization ware taken in the sixth plan and have it was found about not spreading of rural employment. In seven plan, special efforts have been made upon essential advanced equipment and also formed to new agricultural machinery training institute in this period.

Moreover, the use of the agricultural machinery as well as equipment is increasing in tremendous in India. The number of tractors in 1956 was only 21 thousand but in present 20 lakh more. Likewise, in present the number of electric pump-sets is near about 1.5 crore, where as in 1956 it was 47 thousand only. In the same way diesel or kerosene pump set, iron cane crushers etc. increases significantly in this concerned period. Similarly, the farmers have been gained the proper skill related to agricultural machinery activities.

2. Technological Change in Agriculture

2.1 Genetic Improvement

The major agricultural commodities have achieved through genetic improvement in India. Yield improvement, against biotic and abiotic component, improvement of quality product, adapt and mitigates climate change, consolidation of nutrients and also genetically modified commodities are the main direction of genetic improvement. It also contributes to ensure the food security, increases of farmers' income, reduction of poverty, increases the possibilities of employment opportunities and enhancement of agricultural commodities for the purpose of export **(Joshi et al. 2005)**.

2.1.1. Yield Enhancement

The technological evolution was seen through green revolution in high yielding varieties of rice and wheat. The technological progress is seen to develop resistance against various biotic and abiotic tolerance, to reduce the length of crop duration and growing season, to improve the quality of test and price and overall to build a resistance power against climate change.

2.1.2 Resistance Against Biotic and Abiotic Stress

Agricultural crops are continuously exposed to multiple abiotic and biotic stresses. In terms of development or the growth is the main obstacle regarding these stresses and also subsequently effect on less productivity and crop equality. Abiotic factors such as flood, draught, salinity, heat and fungal pathogens, insects are the main biotic factors, which are responsible stress for the growth of a plant. So, the attention should be built that towards enhancing plant tolerance and approaching real life agricultural condition from this adverse stress. The broad-spectrum strategies are applied for the improvement of stress tolerance crops and the application of sustainable technologies to improve the resistance from biotic and abiotic stresses.

2.1.3 The Improvement of Product Quality
Sustainable agriculture practices contribute crop quality enhancement. Technology related to organic farming, integrated pest management and also soil conservation practices can improve soil health, reduce the use of chemical inputs and result in healthier and higher quality crops. On the other hand, farmers are provided proper education as well as adequate resources that knowledge, skill and resource assurance them to produce high quality agricultural products.

2.1.4 Adopt and Mitigate Climate Change
Adaptation and mitigation of climate change in agriculture are not fully soluble and here, we should maintain the procedure in each particular case. Moreover, it is reminded that adapt to changing weather condition, crop practice should be considering the climate specific area, the needs and potential of farming and also apply proper methods.
Scientist are working to provide farmers with species that are more tolerant to water deficiency or excess and temperature leaps. On the other hand, effective soil management by reducing depletion, promoting carbon sequestration, sparing natural resources, eliminating chemical application and harmful emissions.

2.1.5 Fortification of Nutrients
Fortification of a component means to increase its efficacy so that the soil is enriched from basic, macro and micronutrients to well development and growth of crop and enhance the biological activities inside the soil as well as enhance the efficiency of crop competitors controlling measures. These advancements significantly contribute to the economic sustainability of agriculture.

2.1.6 Genetically, Modified Commodities
Genetically modified organisms exhibit prospects to improve crop tolerance, lower the need for pesticides and increase yields. In another way, it provides certain advantages to producers and consumers, modified plants, like- initially help to protect crops by providing resistance to a specific disease or insect, ensuring greater food production.

2.2 Natural Resource Management
Proposed technologies regarding natural resource management are related to enhancing water use efficiency / irrigation practice, increasing input use, especially of fertilizer and conserving of soil and water resources.

2.2.1 Techniques of Water Use
Water is every essential factor for agricultural practice and it also comes either from the rain water or from irrigation from any stored or underground water. In recent, under the planned of agricultural development of five years plans the irrigated area has reached to more than 40% through ground, surface and other sources. Moreover, abundant availability of water, the World Resource Institute categorised India into the high-water stress category. It is mainly due to the fact that the ground water level is significantly falling in India and its condition is highly alarming in states like- Punjab and Haryana (**Singh et al. 2020**). In this adverse situation, conserving ground water and enhancing water use efficiency are an utmost priority for the sustainability of agriculture. According Dhawan, 2017 to third of the cultivable land in India is rainfed while the remaining 39 million hector land is irrigated by ground water and 22 million hectors by canals. Adaptation of water efficient technologies is one of the most effective ways to address the sustainability of agriculture. The assessments are the micro-irrigation technologies, land-levelling technology, agronomic practices and multiple water use system. The total irrigated area was 22.6 million hectors in 1950-51 and in 2020-21 the irrigated area has reached 119 million hectors.

2.2.2 Chemical Fertilizer
In ancient time the farmers used only cow dung with a small amount for agricultural practice because maximum portion was used for cooking. In present time, they have started using chemical fertilizer and pesticides in a large quantity for considerable increase in agricultural production. There are three challenges in optimum use of fertilizers and pesticides such as (1) affordability of fertilizers and pesticides (2) balance and judicious use of fertilizers and pesticides and (3) environmental degradation as a result of their injudicious and indiscriminate use. By the processes of planned economic development to maintain both demand and supply side the chemical fertilizer are increasing. The consumption of chemical fertilizers increased from 3 lakh tonnes in 1960-61 to 165 lakh tonnes, in 1997-98 and in 2020 it has reached to 218 lakh tonnes.

2.2.3. Water Shed
Regarding natural resource management water shed techniques is an important factor for agricultural production. It is mainly seen at rainfed areas. The objectives of this management are enhancing the agricultural production and control soil erosion with the help of conserved rain water. This program was planned by the Indian Council of Agricultural Research (ICAR). Institutional arrangements, financial support, capacity development for greater people's participations and management of watersheds by effective governance. The watershed management provide not only the advantage of agricultural practice but also provide farmer's income, controlling soil erosion and conserving rainwater.

2.3 Farm Mechanisation
Tractors, power tiller, seed-drills, harvesters combine ete. are the major machinery technological agricultural items that saves the labour. Mehta et al. 2014; Ahmad and Goodwin 2016; Nabard 2018; Joshi et al. 2019; Sarkar 2020 stated that

labour saving technologies are not only reduce the production cost but also enhance labour efficiency as well as farmers income. The agricultural productivity has been increased up to 30 percent and at the same time the cost of the agricultural practice decreases up to 20 percent according to the Intensive Agricultural District Program (1960). The technologies related to the agricultural activities, mentioned above are saving labour in agriculture nearby 30 percent and which is supplied in non-farming sector.

2.4 Conservation of Agriculture

Convention of agriculture practice is a very essential challenging factor for enhance the agriculture production. The various adverse situations are facing serious challenges like declining organic matter content, extensive tillage and imbalance use of nutrients, falling of ground water table, increasing wages, labour scarcity and rising fuel prices which are directly or indirectly impact on soil, water, air and over all agricultural Productivity. To promote the concept of agriculture practice are needed to overcome the arising effective problems. So, the conservation of agriculture practices is encircling such as minimum tillage, improvement of soil health, cover crops in both annual and perennial crops and incorporation of crop residues. Food and Agriculture Organisation (FAO) of the United Nations exhibited that the resource-saving agricultural crop production is possible when to incorporated of farm income as well as soil health through conservation of agriculture.

2.5 Climate Smart Technologies

In recent, climate change is a very common matter. Agricultural production is depended on the conditions of climate change as well as adverse climatic condition. In this regard, human beings are the main responsible for climate change. The Small farm holders are more vulnerable to climate change. Maximum farm holders are suffering from the least capacity of technologically, financially affected because they have less resources (**Joshi and Tyagi 2019**).

2.6 Biotechnology and Genetic Modified Crops

Biotechnology as well as nano-technology are the main direction of modern science to enhance the genetic potential of agricultural productivity. It is also a scientific tool and techniques which reduce the risk of biotic and abiotic stress. The genetic potential. comprises genetic engineering, molecular markers, molecular diagnostics, vaccines and tissue culture etc.

Tissue culture is one of the very popular techniques for propagating planting material of fruits and vegetables. The different goals of tissue culture are i. mass propagation of the desired line of the plants, ii. obtain virus-free plants, iii. rapid mass production of plants for breeding purpose, iv. preserve germplasm, v. produce haploids for the breeding programme. Basically, the tissue culture has been seen in papaya, banana, grapes, guava, orange and pomegranate.

2.7 Bio-fortification

The conventional plant breeding method supply the nutrient density of food crops which is known as bio-fortification (**Bouis et al. 2011**). Generally, in case of under developed and developing countries economic condition is a main obstacle for consumption of nutritious food that leads to standard of health. So, bio- fortification play a vital role in improving nutritional security to the poor as well as the population who are under below poverty level (Meenakshi, et al. 2010). The important nutrients process by bio-fortification are zine, iron, calcium, protein etc. and these are 1.5 to 3.0 times more nutritious than the traditional varieties. Moreover, these varieties provide higher yields and resistance to several biotic and abiotic stresses.

2.8 Frontier Technologies

The development of agricultural food system is possible due to the techniques of frontier technology. Protected agriculture, precision agriculture, vertical farming, hydroponics etc. are the different way out for frontier technology. These techniques are seen mainly in developing countries mainly in east and south east Asian countries (Joshi et al.2019). These technologies are used mainly in fruits, flowers and vegetables and in this agricultural practice the economic return is tremendously high (Gondkar et al. 2016). Education level, experience tenure in this farming, social interaction are the main criteria for development of such kind of agricultural practice.

2.9 Digital Technology

Digital technology is one kind of techniques in agriculture which can co - operate in transforming agricultural system towards sustainability. This technology includes artificial intelligence, robotics, remote sensing image analysis, optical sensors and equipment design for monitoring etc. According to Shang et al. (2021) main controlling factors of digital technologies are - farm size, biophysical condition, complementary technologies, labour availability, use of computer, innovative farmers, capacity development, technology attributes, behavioural factors etc. So, such kind of techniques of digital technology are needed for development of agricultural system.

3. Benefits

3.1 Economics of Agriculture on a Large Scale

The farmers have to saving whenever the mechanisation and technological change have come to the cultivation process. The activity of human labour is very little but the machine can produce a huge. In terms of time, machine takes a small

time but the men take more time regarding a same cultivation practice. So, it is clear to us that our civilization is more benefitted due to the use of mechanisation as well as technological improvement in agricultural system.

3.2 Reduction in Production Cost
Cultivation process involved different step which need huge skilled labour. And these huge labours are not available in a particular time. To avoid such kind of problems machines are used in the field of agriculture with limited time as well as huge work and there is a remarkable reduction in the production cost. So, the mechanisation or the technological use reduce the production cost significantly.

3.3. Commercial Agriculture Possible
In ancient time, farmers farmed without taking any technology or machinery help for their livelihood. In present due to population explosion and fulfil the expectation farmers cultivate huge production two or three crops in a year with the helping of modern technology chemical fertilizer and pesticides. This huge production is helping to commercially export except fulfil their daily demand.

3.4 Agricultural Possible on a Large Scale
The invention of various technologies related to agriculture practice remined that large scale agriculture is possible due to the use of such kind of machinery use. Large field can be ploughed with machines, crops can be harvested in large quantities and the production can be transported to the market very easily. Without technological help there is not possible to do the agricultural practice in the large area field.

3.5 Increase in Production Per hectare
On the eve of technological development in agricultural field, the use of chemical fertilizer, pesticides and for farming use of machines indicate the high range production. With these technological held help the production of agricultural grains increases per hectare significantly.

3.6 Saving in Animal Related Expenses
The participation of animals is not seen now in agricultural practice due to the evolution of technological development. In every step of agricultural practice such as for irrigation purpose pump set is used, the field are ploughed by tractor and others activities to be done by machines. In this situation, it is clear that the agriculture practice is done without needed animal or very little required, so the cost of keeping animal is saved.

3.7 Effective Agricultural Extension Service
The effective extension service is an essential factor for the adoption of agriculture technologies. The educated farmers were improved agricultural technologies and management practices proposed by agricultural extension system, India (1953) as the national extension service. Actually, in respect of time, the agricultural extension system of India gradually updated according to the need of farming community. Various concept such as Training and Visit (T & V) programme, National Agricultural Technology Project (NATP), Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra's (KVKS) were established as a policy for refine technology to the welfare of effective agricultural extension service.

3.8 Access to Credit
The adoption of modern agricultural technologies provides a significant role regarding credit facility of farmers (Feder et al. 1985; Wossen et al. 2017; Fang and Richards 2018). Although, credit is not a direct agricultural input rather it cooperates to the farmers to meet any kind of critical situation whenever need regarding adoptation of improved agricultural technologies. In two ways the farmers can access the credit facilities either from formal financing institutions such as commercial bank, cooperatives or from informal sectors with high interest rate.

3.9 Human Capital
It is said that human capital is an essential factor in adopting improved technologies and returns more. Not only capital but also education level and learning out comes are another effective factor for the adoption of improved agricultural technologies **(Patrinos et al. 2020).** Skill is not a far away from the choice of technology to its appropriate application. So, it is concluded that the status of education, training procedure and skill development are very essential for adopting improved technologies and ensuring higher returns.

3.10 Direct Benefit Transfer
Direct benefit transfer means the cash transfer scheme which is very important regarding credit facility of adoption of improved agricultural technology. The government provided cash transfer scheme i.e., PM-KISAN support to farmers income for their needs regarding agricultural practice. This need involves to purchase seeds, fertilizers and others related to cultivation processes. The farmers are being move benefitted by the effective such kind of scheme.

4. Defects
4.1 Small and Scattered Holdings

It is fact that in developing countries as well as under developed countries the size of agricultural land holding is very small. This small holding is located in different corner of the village. Due to small holding the technology are not applied.

4.2 Fear of Unemployment

It is true that due to modern civilized mechanisation processes the labour force remain useless. Each machine works equal to many labourers. Due to upgraded the agricultural technologies a huge number of agricultural labours lost their activity and it is very much tough to provide employment to such a large number of agricultural labours in industries other than agriculture.

4.3 Requirement of Higher Capital Investment

Development of agricultural process needed a huge number of technological machinery parts. The investment of machinery parts is very much expensive and required a huge amount of capital. The farmers who are under developing or under developed countries does not have sufficient capital. So, capital is a major obstacle for growing technological agricultural system.

4.4 Waste of Animal Power

It is fact that the evolution of agricultural development was established only because of the mechanisation process. In the same, this mechanisation process wasted the huge number of animal power. So, it is very difficult to replace in other work of these additional animal.

4.5 Illiteracy and Ignorance of Farmers

Education is the backbone of society. Any kind of social activities needed a proper education. So, in case of development of agricultural evolution the education of the farmers is very much essential to ensure agricultural production. Therefore, it is true that the agricultural mechanization will be successful if the farmers take appropriate education. In this regard, farmers can be educated and cooperation can be obtained from them.

4.6 Lack of Energy Fuel

On the eve of agricultural mechanization, the fuel such as diesel, petrol and others related oil is very much essential factors for smooth running the machines. In our developing country, where it is already lacking. Therefore, it is not a good sign to do the agricultural mechanization. So, in case of developing country as well as under developed country the progression of agricultural system is very much troubled.

5. Conclusion

The world population has to be reached about 9 billion by 2050 and it is not reverse condition of India for population growth. In this situation, it is needed to find out ways for producing enough to survive the next generation. Under these circumstances, the improvement of technology in agricultural practice addresses the only way to food-secure future. Not only technological progress provide food secure but also provide to save foreign exchange for countries, surplus productivity and led to the improvement of overall standard of living condition of farmer communities. In India, it is observed that the adoption of modern agricultural practices run long through the advanced technology. It is possible only for India to be "*Atmanirbhar Bharat*" if the technological advancement is seen in agricultural practice.

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