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Innovation in Agriculture: A Key Process for Economic Development

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Abstract

Agriculture sector in India is a primary source of livelihood for a majority of the population. Low and stagnant income in the sector remains a focal point of policy debate in India. The most prominent pathways to enhance farmers' income is the adoption of improved agricultural innovations. This study documents the current state of agriculture innovations in India. The literature reveals that adoption of improved technologies is the key to increase agricultural productivity and farmers' income (Matushcke et al. 2007; Subramanian and Qaim 2009; Duflo et al. 2011; Mason and Smale 2013; Kumar et al. 2020). Despite a very strong impact on the well-being of farmers, the adoption of improved technologies is low, especially in the context of developing regions and countries.

Introduction

India is home to 1.4 billion people, and globally ranks second in terms of the agricultural output. The agriculture, forestry and fishing sector accounted for 18.3% of the gross value added (GVA) in 2022-23. In contrast, the sector is serving as a primary source of livelihood for more than 50% of the country's population. Low and stagnant income across these sectors remains a focal point of policy debate in India. These sectors accounts for the majority of the poor of the country. Recent estimates show that about 220 million people are poor in India. One of the most prominent pathways to enhance farmers' income is the adoption of improved agricultural technologies and innovations.

Innovation in the context of agriculture in the India

Innovation is the implementation of something new or improved (whether technology or otherwise) in products (goods or services), processes, marketing or organizational methods. In other words, it means applying ideas, knowledge or practices that are new to a particular context with the purpose of creating positive change that will provide a way to meet needs, take on challenges or seize opportunities. Such novelties and useful changes could be substantial (a large change or improvement) or cumulative (small changes that together produce a significant improvement).(Note: Adapted from OECD,2005)

What is an agricultural innovation system?

The concept of innovation systems can be understood in a broad sense and may include a wide variety of sectors, including research, extension and other functions that promote or implement innovation. An innovation system consists of a wide array of public and private organizations, firms and individuals that demand and supply knowledge (coded - tacit) and technical, commercial and financial competencies. It also includes the rules and mechanisms by which these different stakeholders interact and relate with one another in social, political, economic and institutional settings (World Bank 2007b).

Investment in agricultural science and technology, generally in the form of research and extension services, has proved to be highly valuable for improving crop yields and lessening poverty in developing countries. Nevertheless, such investments should reflect all the parties' diverse needs for knowledge (World Bank 2007b).

It is currently understood that the performance of innovation systems depends on the interaction among the different people and institutions responsible for generating and disseminating knowledge and technology (OECD 2002), stakeholder learning processes and the creation of an innovation-friendly environment.

Some Major Innovation in Agriculture Sector

Indoor Vertical Farming

Indoor vertical farming can increase crop yields, overcome limited land area, and even reduce farming's impact on the environment by cutting down distance travelled in the supply chain. Indoor vertical farming can be defined as the practice of growing produce stacked one above another in a closed and controlled environment. By using growing shelves mounted vertically, it significantly reduces the amount of land space needed to grow plants compared to traditional farming methods. Vertical farms use up to 70% less water than traditional farms.

Farm Automation

Farm automation, often associated with "smart farming", is technology that makes farms more efficient and automates the crop or livestock production cycle. An increasing number of companies are working on robotics innovation to develop drones, autonomous tractors, robotic harvesters, automatic watering, and seeding robots. The primary goal of farm automation technology is to cover easier, mundane tasks. Some major technologies that are most commonly being utilized by farms include: harvest automation, autonomous tractors, seeding and weeding, and drones.

Modern Greenhouses

In recent decades, the Greenhouse industry has been transforming from small scale facilities used primarily for research and aesthetic purposes (i.e., botanic gardens) to significantly more large-scale facilities that compete directly with land-based conventional food production. Combined, the entire global greenhouse market currently produces nearly US $ 350 billions in vegetables annually.

Precision Agriculture

Agriculture is undergoing an evolution - technology is becoming an indispensable part of every commercial farm. New precision agriculture companies are developing technologies that allow farmers to maximize yields by controlling every variable of crop farming such as moisture levels, pest stress, soil conditions, and micro-climates. By providing more accurate techniques for planting and growing crops, precision agriculture enables farmers to increase efficiency and manage costs.

Block chain

Block chain's capability of tracking ownership records and tamper-resistance can be used to solve urgent issues such as food fraud, safety recalls, supply chain inefficiency and food traceability in the current food system. Blockchain's unique decentralized structure ensures verified products and practices to create a market for premium products with transparency.

Artificial Intelligence

The rise of digital agriculture and its related technologies has opened a wealth of new data opportunities. Remote sensors, satellites, and UAVs can gather information 24 hours per day over an entire field. These can monitor plant health, soil condition, temperature, humidity, etc. The amount of data these sensors can generate is overwhelming, and the significance of the numbers is hidden in the avalanche of that data.

Automated Irrigation Systems

Automated Irrigation Systems have revolutionised the way farmers irrigate their crops, making the process more efficient, cost-effective, and environmentally friendly. Automated irrigation systems use sensors, weather data, and other technologies to optimise water delivery to crops. These systems are programmed to deliver the right amount of water, at the right time, and in the right place, taking into account factors like soil type, crop type, weather conditions

Genetically Modified Crops

Genetically modified crops, or GMO crops are created by inserting foreign DNA into the plant's genetic code, giving the plant new characteristics, such as resistance to pests or herbicides. The proponents of GMO crops argue that they can improve crop yields, reduce the use of harmful pesticides, and enhance the nutritional value of food. They also point out that genetic modification has been used in crop breeding for thousands of years and that GMO crops are thoroughly tested for safety before being approved for use.

Animal Tracking Collars

Animal tracking collars are an innovative tool that is increasingly used in agriculture to track and monitor livestock. These collars use GPS technology to record the location and movement of animals in real-time, allowing farmers to better manage their herds and improve their grazing patterns.

Agriculture Innovation's benefits and Economic Development

There is broad consensus that innovation is critically important for meeting the challenges that confront the human race, including the need to improve competitiveness, sustainability and equality in agriculture. Agriculture also needs to produce more food for a growing population, using a limited amount of farmland, while at the same time reducing its greenhouse gas emissions to avoid worsening climate change. Innovation increased agriculture productivity, create new agriculture market and innovation attract investment from both domestic and foreign countries.

Increase in cropping intensity and yield thereby ensuring better returns to the farmers will be able. It reduces the weather risk and non-availability of labour, thus reducing the post-harvest wastage of grain. Improves working conditions and provides better protection for farmers. Innovation converts uncultivated land into agricultural land through advanced tilling technologies. Custom Hiring Centers (CHCs) that rent machinery to small and marginal farmers and service centers etc. provide employment to rural youth. Reduces the cost of cultivation by reducing the dependence on manual labour, which was increased due to labour shortage. Enterprising farmers have been found to have reported a 20% increase in yield by using rental equipment.

The economic return on investment in technology in agriculture is greater as it reduces input costs and increases productivity. Advances in breeding programs have made it possible to enhance the nutritional value of food crops such as rice, wheat and maize by enhancing the nutritional value of proteins. In horticulture crops, disease-free plants are being made available through tissue culture and other state-of-the-art technology, as a result of which developed varieties are increasingly being used. Due to which better production result is also being given. This suggests that agricultural production needs to use knowledge more intensively, which means it must innovate.

In figure 1 Total production of food grains increased from 51 million tonnes in 1950-51 to 316 million tonnes in 2021-22. It is all because of innovation in agriculture sector like high variety seeds, fertilizers modern agriculture equipment and skilled farmers . Historically, agriculture has experienced three major innovations: mechanization, the introduction of chemicals and the application of modern genetics. All have significantly changed how food is produced.

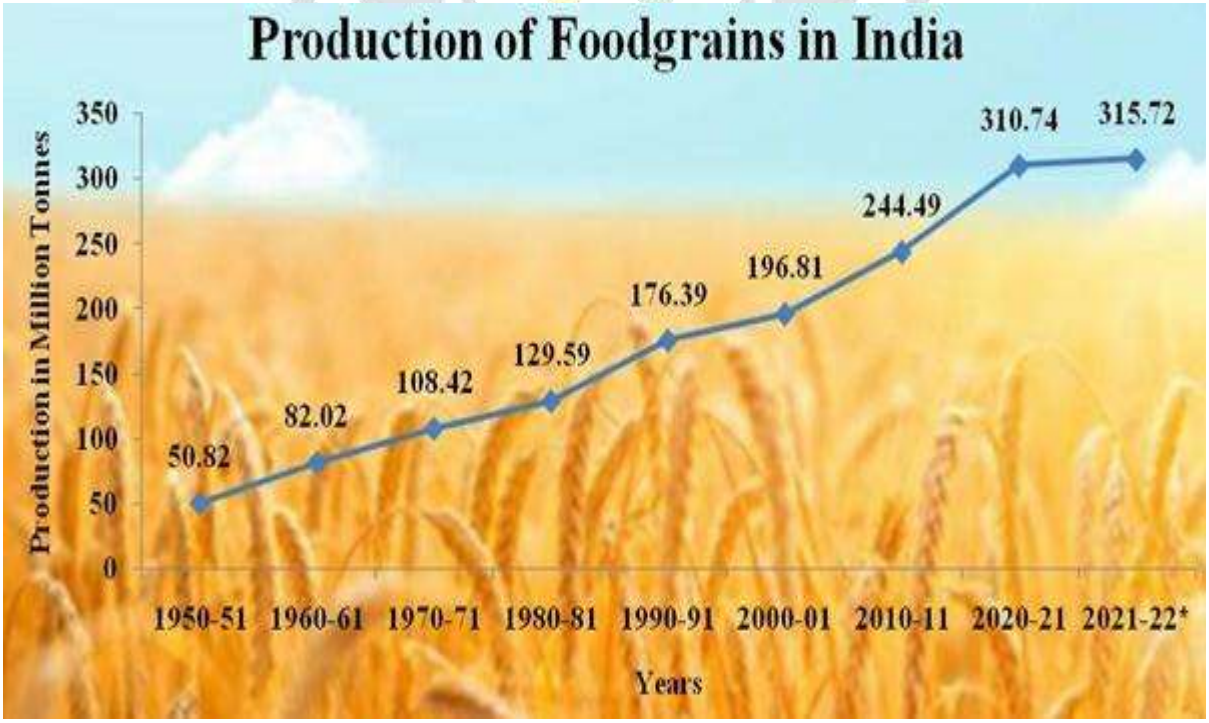

Figure:1 Agricultural production (million tonnes) Sources: Ministry of Agriculture; PRS.

Innovation in farming has led to higher crop yields which, in turn, have allowed more land to be spared from farming than would otherwise have been the case.

Raising yields further to feed a growing global population will require new technologies to be embraced, including genetic modification, gene silencing and editing, as well as developments in precision farming and robotics. Economic incentives can be structured to align such innovation with environmental gain, through concepts such as habitat banking and environmental credits. Innovative policy making can bring rewards to habitat creation, wildlife enhancement and ecological benefits, in a form that is both effective and affordable.

Whilst many farmers and landowners already deliver some conservation on their land, mechanisms to facilitate greater and larger-scale participation by them will be paramount to restoring biodiversity in the India

In addition to an expansion in sustainable food and farming systems in the coming decades, technological advances provide opportunities to increase efficiencies and provide land for biodiversity restoration.

Suggestion for Innovation Implementations

The Indian economy starts with the farming communities, so in order to strengthen the foundation of the economy, the farming communities have to be empowered by equipping them with modern technology. In which the following suggestions may prove useful -

1. At present, there is a need to promote research work in the agriculture sector by adopting a socio-economically and politically integrated approach so that modern innovations can increase productivity and quality by making agriculture resistant to the effects of climate change.

2. By removing policy inertia, the implementation of policies should be implemented with strength.

3. Technology-based transformation of small scale agriculture and fisheries can be a beneficial result. Like- sea cage farming.

4. The complex process of patent, subsidy and protection of technologies created by innovative farmers should be simplified.

5. There is a need to create an institutional framework to take the latest and developed technology to the farmers so that the farmers can earn profit by adopting the new technology with immediate effect

6. Need to improve agricultural information technology because information technology acts as a bridge between farmers, scientists and the government.

7. Special training should be given to the farmers of every region in order to get the real benefit of the technical changes made by the government in the agriculture sector so that with the trickle down effect, other farmers will also get trained. Like - E-NAM Scheme, Crop Insurance Scheme, Kisan Suvidha App, AIM Portal etc.

8. To attract attention on how to move away from traditional methods of agriculture to income generating methods through modern innovations, through which we can reduce the vulnerability created by climate change in the agriculture sector. Therefore, there is a need to move forward keeping in mind the approach of smart agriculture.

Conclusion

Innovation is a driver of economic growth and well-being in the countries. It is a dynamic, holistic process that generally occurs in India and worldwide . If the work of diverse participants is strengthened – research, agricultural extension and other forms of support for innovation– the India can become more efficient and competitive. This can happen if all stakeholders can develop and strengthen their own capabilities, and if relationships among them are bolstered. The new India vision of innovation for agriculture revolves around a comprehensive, broad-based approach whose cornerstone is innovation work and whose efforts are directed toward promoting a welcoming environment that includes public policies and an institutional framework to reward and support innovative, entrepreneurial work, strengthen and promote promising technologies with the potential to have an impact on the territories and the high priority value chains. The tools for achieving this will depend on the context or reality being addressed; this means there are no recipes for promoting a culture of innovation, but that solutions may arise from many different sources, stakeholders or types of innovations.

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