"EMPOWERING INDIA THROUGH DIGITAL TRANSFORMATION : A SUSTAINABLE APPROACH"

Volume - I

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Digitalization in Agriculture for Innovative Transformation in India

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Abstract

Digitalization in agriculture has the potential to drive considerable innovation and revolution in India's agricultural industry. The use of digital technologies can assist India in increasing agricultural productivity, reducing waste, increasing agricultural exports, increasing farmer income, and improving food and nutrition security. Aside from that, this will aid in the environmental protection and long-term development of the agricultural sector as a whole. The rise in internet and mobile phone usage in India has had a substantial impact on a number of industries, including agriculture, education, healthcare, and e-commerce. This obviously demonstrates that Indian agriculture is poised for digital change.

Keywords : *Artificial intelligence, Digitalization, Innovation, Indian agriculture.*

Introduction

It is clear that India has experienced rapid growth and penetration of digital infrastructure. India has the world's second-largest mobile phone market, with 1.2 billion members by December 2021. The internet penetration rate in rural India is 41%, compared to 71% in cities and towns. The report predicts that by the end of 2025, India would have 900 million internet users, with rural India accounting for 56% of the 141 million new netizens. Agriculture digitization has the potential to foster innovation and transformation in four major sectors of Indian agriculture: (i) precision agriculture, (ii) climate-smart agriculture, (iii) supply chain management, and (iv) financial inclusion.

Precision Agriculture

In this digital technologies are being used such as sensors, drones and satellite imagery. Using digital equipment, tools, software, process, farmers can monitor their crops, orchards, animals, aquaculture systems, soil, water, weather, post-production management of produce in real-time, enabling them to make more informed decisions about planting, irrigation, fertilization, pest management, harvest and post-harvest management of agricultural produce. This can help to reduce waste, improve yields and quality, and save costs. Briefs about some major precision agriculture digital technologies are given as:

Applications of sensors in agriculture: Sensors are being increasingly used in Indian agriculture to improve productivity, reduce waste and optimize resource use. Soil moisture sensors are used to measure real-time soil moisture levels, to optimize the irrigation practices. Nutrient sensors can provide real-time data to optimize fertilization practices. Weather sensors can provide real-time data on weather conditions. Crop health sensors are used to monitor the health and growth of crops. Sensor-based post-harvest management by using temperature sensors, humidity sensors, ethylene sensors and quality sensors of agricultural produce can help to reduce post-harvest losses, improve quality, and increase profitability for farmers. While monitoring quality, farmers can identify potential issues and take corrective action before the produce is shipped to market. GPS sensors can be used to track the location of harvested produce during transportation, enabling farmers to monitor temperature, humidity, and other factors that can impact quality. Further, sensor-based storage management is an effective method of post-harvest management that can help Indian farmers to increase their productivity and income, reduce post-harvest losses, and improve the quality of their produce. This can increase consumer confidence in the produce and help to build a brand reputation for quality. However, it is important to ensure that these

technologies are accessible and affordable to small-scale and marginalized farmers, who may not have the resources to invest in such technologies. This may require government support in the form of subsidies, training programme, and infrastructure investments.

Variable Rate Technology (VRT)

Variable Rate Technology (VRT) is a precision agriculture practice that uses technology to apply different amounts of inputs (e.g. seed, fertiliser, water, pesticides, feed, chemicals) to different parts of a field, orchard, or any agricultural production system, including livestock and fisheries, based on specific needs. The use of VRT in agriculture can help to increase production, lower input costs, and lessen environmental effect. However, it is critical to guarantee that the costs of these technologies are decreased in order to make them accessible and affordable to small-scale and marginalised farmers.

Drones

Drones, or unmanned aerial vehicles (UAVs), have grown in popularity in agriculture due to their capacity to collect data rapidly and efficiently from an object without making personal contact with it. Drones are used extensively in agriculture for crop monitoring using high-resolution cameras, as well as to construct detailed maps of agricultural land, soil quality, terrain, and drainage patterns. Spray crops with accurate pesticide and fertiliser treatments, in conjunction with other precision agricultural technology; assess crop damage caused by natural catastrophes; and monitor water and ecological conditions, including fish health and biomass. However, it is critical to guarantee that drones are used safely and responsibly, and that farmers are trained in their operation. Additionally, regulations around the use of drones in agriculture should be put in place to ensure that they are used legally and ethically.

Robotics

Robotics is the field of technology that deals with the design, manufacture, and operation of robots. In recent years, robots has been extensively used in agriculture to improve efficiency, lower labour costs, and boost output. Robots can be successfully used to harvest crops such as fruits and vegetables, improving efficiency and lowering personnel costs. For example, robotic arms can be used to select fruits and vegetables, plant and seed with precision to detect and eradicate weeds, water crops with accuracy, and spray chemicals that are hazardous to human health. Overall, robots has the potential to transform agriculture in India by increasing efficiency, lowering labour costs, and increasing production. However, the application of robotics in agriculture necessitates major investment in technology, research, and development. Additionally, farmers and farm workers must be trained in the use of robotics technology to ensure that it is used effectively.

Artificial Intelligence (AI)

Artificial intelligence (AI) has the potential to transform Indian agriculture by allowing farmers to make data-driven decisions and maximise crop output. It can be applied to (i) predictive analytics, (ii) precision agriculture, (iii) pest and disease management, (iv) soil health management, (v) livestock herd management and dairy automation, (vi) aquaculture automation and management, and (vii) market prediction. In the case of predictive analytics, AI can be used to examine previous weather and crop data to forecast future crop yields. This can assist farmers plan planting and harvesting timetables, as well as optimise crop management procedures. AI can assist identify pests and diseases early on and offer proper treatment solutions. This can help farmers to minimize crop losses and reduce the need for chemical treatments. AI can be used to analyse soil data and provide recommendations for optimizing soil health. This can help farmers to reduce soil erosion, improve water retention and increase crop yields.

Protected Cultivation

Protected farming is the method of producing crops in a controlled environment with structures like greenhouses, shade net houses and polyhouses. This type of cultivation is gaining popularity in Indian agriculture because to its capacity to protect crops from bad weather conditions, pests, and illnesses. This minimises crop management costs while also improving crop quality. This is especially useful for high-value crops like vegetables and fruits, which require high-quality produce in order to command higher market prices. Protected agriculture is a productive and profitable approach for Indian farmers. However, it is important to ensure that the structures used for protected cultivation are sustainable and do not have adverse effects on the environment. Additionally, farmers should be trained in the use of protected cultivation techniques to ensure that they are used effectively.

Vertical Farming

Vertical farming is the process of cultivating crops in vertically stacked layers under artificial lights in a controlled environment. This form of cultivation has grown in popularity in Indian agriculture due to its capacity to provide large crop yields in a small space while minimising environmental effect. Aside from the benefits of covered cultivation, vertical farming makes optimal use of space by allowing farmers to produce crops in a compact space, making it perfect for urban agriculture and locations with limited land. This can help to enhance agricultural productivity in cities while lowering the carbon impact of transporting food from rural areas. It can be seen that vertical farming is an effective method of cultivation that can help Indian farmers to increase their productivity and income, particularly in urban areas.

Aquaponics and Hydroponics

Aquaponics and hydroponics are two modern methods of cultivation that have become increasingly popular in recent years. Both methods involve growing plants without soil, using water as the primary growing medium. Aquaponics is a method of cultivation that combines aquaculture and hydroponics. In this method, fish are grown in tanks, and the waste produced by the fish is used to fertilize the plants grown hydroponically, whereas, Hydroponics is a method of cultivation that involves growing plants in a nutrient-rich solution without soil. The nutrients supplied by the fish waste help to produce high-quality crops, making aquaponics ideal for high-value crops such as herbs and leafy vegetables, whereas, in case of hydroponics we apply highly reduced chemical pesticides and herbicides. The aquaponics and hydroponics are effective methods of cultivation that can help Indian farmers to increase their productivity and income, particularly in urban areas or areas with water scarcity.

Challenges in adoption the major challenges in adoption of these technologies are:

- Extent of profitability should be beyond of a threshold through in usage of the technology;
- Amount of uncertainty and risk involved in adopting a technology including cost of the technology;
- Availability and suitability of technology in the agricultural production cycle;
- Requirement of skills and learning curve for adoption of the technology;
- Eco-environment and digital infrastructure availability in a particular region;
- Level of agricultural production system;
- Ease of flow of agricultural credits, and
- Overall policy support for promotion of a technology.

Conclusion

In developing countries, electronic extension services and social media are increasingly being used to disseminate planting guidance, weather updates, early warnings of disasters, and pest outbreaks. According to studies, technologies are adopted separately, then merged and packaged together to answer specific agricultural production concerns. It was also reported that the US, UK, Australia, and Denmark had the greatest rates of Global Navigation Satellite System (GNSS) adoption, with rates of up to 60% in the US and 77% in Australia, respectively. In addition, machine guidance technologies were found to be significantly more widely adopted than VRT in all nations. Adoption rates were higher for larger farms than smaller farms.

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