



Advanced Technology in Agriculture

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Abstract

Agriculture as we know is the business of growing, developing, and selling crops. As any business, it cannot afford to remain stagnant and has to innovate and be in congruence with the paradigm-shifting changes of the day. In the olden days, agriculture was a labour intensive, poor usage of technology activity. Farmers could not say for sure whether they would reap harvests or not and relied on the gods above to grace their efforts with fruits. Today, technological advances and innovations have been introduced into agriculture with 'app-based' farming, within the confines of one's smartphone. The acceptance of more advanced technologies has shown a positive effect on agricultural productivity and production. More specifically, these have an effect on raising farmers' incomes, protecting natural resources, enhancing input use efficiency, creating job opportunities, and encouraging diversification.

Keywords: Technology advances, Innovations, app-based farming, efficiency, diversification

Introduction

Agriculture as we know is the business of growing, developing and selling crops. As any business, it cannot afford to remain stagnant and has to innovate and be in congruence with the paradigm-shifting changes of the day. The agriculture industry is facing a tremendous amount of change and difficulties evidenced by the rising costs of raw materials, difficulties in getting adequate labor and a growing desire for transparency and sustainability, amidst customers. Major players in the industry state that they need to find solutions to these challenges, which they feel can be done by making use of technological innovations in agricultural practices for increasing productivity levels and profits for the farmers. (Matushcke et al. 2007; Subramanian and Qaim 2009; Duflo et al. 2011; Mason and Smale 2013; Kumar et al. 2020). Statistics, pertaining to the last decade have revealed investments in excess of 6 billion USD in agricultural technologies in the last five years and nearly 2 billion USD in the year gone by. Innovations such as advanced greenhouse farming, vertical farming, indoor farming, utilization of automation and robots in agriculture and livestock management, biotechnological innovations for improving the quality of seeds, AI, blockchain-based security/management of digitized records and agricultural data, etc. have taken place in the farming infrastructure in the country, bringing in a radical change in the industry, once reliant on the sweet mercies of the gods of rain and monsoon. Developmental advances in agricultural technology have broadened the volume, area, speed and scope of the productive output levels of farming equipment, practices and other methods, causing for generation of higher profits thanks to more efficient ways of cultivation. Improvements have been made in the realms of seeds, fertilizers and other ancillaries along with the development of more beneficial irrigation and water lifting methods, causing for the farmers to gain

bumper harvests from their fields. A Fourth revolution is in progress in agriculture wherein AI, IoT, analytical and sensor technologies and other emerging technologies are being researched and studied for providing useful solutions in the field in a sustainable and resilient way for the benefit of the farmers. According to Joshi and Varshney (2022), the acceptance of more advanced technologies has shown a positive effect on agricultural productivity and production. More specifically, these have an effect on raising farmers' incomes, protecting natural resources, enhancing input use efficiency, creating job opportunities, and encouraging diversification.

New Technologies in Agriculture- How do they help ensure Economic Sustainability?

In the olden days, agriculture was a labour intensive, poor usage of technology activity. Farmers could not say for sure whether they would reap harvests or not and relied on the gods above to grace their efforts with fruits. Today, technological advances and innovations have been introduced into agriculture with 'app-based' farming, within the confines of one's smartphone. Such a thing was unheard in the days before but is becoming the norm now with satellite and GPS-based farming, remote-controlled tractors and other mobile equipment, drone-enabled crop dusting, smart irrigation and water management, automation and other related innovations making the work of farming easier and profitable for the farmers. These technologies are assisting farmers in managing their crops and preparing for any foreseen/unforeseen events and calamities so that their efforts will be blessed with the fruits of profit, enabling good gains to be got from the crops. We will now discuss a few such advanced technologies in agriculture:

A few examples of advanced technologies in agriculture

1. **Soil and water sensors:** Technological innovations have improved the usage and scope of soil and water sensors in agriculture. These sensors used in the field are designed to detect the presence, quality, level and type of water in the field, enabling the farmer to understand the nature of the water he is using to water his crops with, enabling him to take proper decision for the future of his crop. Soil sensors are designed to detect the quality of the soil, enabling the farmer to decide what crops he can plant as per the design, nature and the type of the soil, the sensors are also designed to detect abnormal levels of chemicals, pollutants and other unwanted substances, enabling the farmer to guarantee the quality of his harvest as per his wishes (Hegde, 2023).
2. **Weather tracking and prediction:** The weather can be called as a temperamental friend as on some days, it will be extremely happy with pleasant winds blowing rain-bearing clouds and on other days it will be violent, bring in storms, hailstorms and heavy rains that can destroy crops and the hots and colds felt by the weather can result in droughts and cold spells for the farmers. Therefore, it is necessary to develop a good level of understanding of the weather patterns in the general area of the farm so that one's crops will not be harmed. Technological innovations have developed 'app-based' weather stations, wherein satellite/drone-based information transceivers and processing is enabled, causing the farmer to learn how the weather will be over a given period of time such as a week, a fortnight or a month. These innovations can also warn the farmer in case any major storm is detected, enabling him to take quick decisions to save his crops (Hegde, 2023).
3. **Satellite imagery:** The usage of satellite imagery and tracking has been enabled for agriculture. By means of satellites, images can be beamed down to the farmers so that they can get a bird's eye view of their fields, enabling them to take proper decisions regarding the seeds sown/grown by him, the way he is using the fertilizers, pesticides and other resources in his farm for best results. The images beamed to the farmers can be

configured to deliver various fields of data such as soil quality, water quality, air quality, etc. (Hegde, 2023).

4. **Drone-based agriculture:** Drones are becoming as indispensable to farmers as tractors in the field. They are literal workhorses who can carry light to medium loads, and loiter over an area for observation/data gathering enabling the farmer to get real-time information about the status and quality levels of his crops. Drones are also being developed for airborne dusting, scaring away pests, picking fruits from trees, herding and rounding up livestock, etc. (Khetibuddy).
5. **App-based e-commerce input markets:** The development of app-based e-commerce markets is becoming very beneficial for the farmers as it enables them to contact the customers directly, contact other farmers selling similar or different products and other activities. The platform gives the farmers access to various related services and products, enabling them to get the best value for their harvests (Khetibuddy)
6. **Greenhouse and indoor farming:** Advancements in green housing technologies have enabled the development of temperature and humidity-controlled greenhouses, enabling various types and varieties of plants and crops to be grown. For example, certain varieties of apples require a cold temperature between a specific range in Celsius, wind temperature and speeds between a certain range and other inputs between a specific range. This can be managed in greenhouses enabling high-quality produce to be grown. Also advances in greenhouse technologies have resulted in the development of indoor farms, wherein crops can be grown within a controlled environment in large buildings and warehouses enabling farmers to get good profits (Masschallenge).
7. **Hydroponic agriculture:** hydroponic agriculture is a method of agriculture wherein plants are grown in a nutrient-filled liquid solution instead of soil. This technology enables the roots to get nutrition in a more direct way and by means of technology, a careful level of control can be maintained reducing crop losses to a very low extent. In addition, IoT and computer-based sensors can signal alerts in case they detect any abnormalities, enabling the farmers to reap benefits from this method of agriculture (Masschallenge).
8. **App based data processing and farm management:** Technological innovations in agriculture generate a diverse field of data in voluminous terms. This data is collected by the installed sensors which work with the Apps to process the data into information, displaying the results on the farmers' smartphones. This innovation has helped farmers get valuable insights into the quality of his farm, soil, crops and other inputs enabling them to take proper decisions on time (Masschallenge).
9. **Livestock management:** Farms have livestock such as cows, sheep, goats, buffaloes, oxen, chickens, etc. who need to be managed and cared for in a proper way. For example, cows need to be milked on a regular basis, for which technological innovations such as milking robots have been developed so that this task can be handled in a more efficient way. Sensors can detect the health levels of the livestock, alerting the farmer in case they may detect any diseases or symptoms of any diseases for immediate action. Also, robots have been developed which collect the dung and other excreted materials for disposal or processing into biogas. In addition, robot dogs are being developed for herding sheep, and goats into specific areas in the pastures and back to their pens (Masschallenge).
10. **Nanotechnology:** Nanotechnological solutions such as Nano fertilizers have been developed so that they will provide the correct amount of nutrients to the soil and other similar innovations for the benefit of the farmer (Masschallenge).

Benefits of Advanced Techniques in Agriculture

1. Economic sustainability through optimal production quantity, quality and volume at reasonable production costs
2. Delivery of data and information on demand to the farmer via app-based systems enabling him to take quick decisions for his farms.
3. Increased ability for the farmer to guarantee a certain level of quality of his crops through technological innovations and interventions
4. Development of a proper paper trail, enabling the farmer to know the stakes and the stakeholders involved in his agricultural activities.
5. Reduction and further elimination of wastage, crop losses and other undesirable elements from the fields.
6. Guaranteed returns for his investment at the right price for the farmer and his crops.
7. Convenience as everything can be done, directed and monitored from a central location

Negative Impacts of Agricultural Technology

1. Loss of biodiversity due to reliance being placed more on non-local, cash crops in the interest of profit
2. Release of greenhouse gases from the conversion of forest and pasture land into agricultural lands
3. Technological illiteracy keeps the farmers without or with a poor level of knowledge and experience of technology from operating and making use of various agricultural technological innovations and products
4. High cost of maintenance of the technological equipment which may not be affordable to the small farmers
5. Blind reliance on the technology itself is a bane, not a boon because technology can manage the crop, it cannot grow it.

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