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An Analysis of Use of Technology in Agriculture

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ABSTRACT: ***For decades, agriculture has been the most popular pastime. It is vital to the livelihood of many people. It employs a huge number of people, making it crucial to the Indian economy. It serves as the economic backbone of a nation. Many poor nations rely on it for their primary source of revenue. Preparing the land, planting seeds, adding manure and fertilizers, irrigation, harvesting the produce, and finally storing it are all examples of agricultural operations. Previously, humans were responsible for all of these tasks, but as the human population grows, so do people's need for various foods and crops. However, the increasing need for people could not be fulfilled using outdated techniques and technologies. As a result, numerous technical advancements in agriculture have occurred, including drones, robotics, vertical farming, organic farming, smart farming, sensors, trackers, and other innovations. These technologies have improved the efficiency of the agricultural industry by making crop output greater and quicker. In this article, the author discusses the many technologies that have been introduced and how they have affected the Indian economy's development.***

KEYWORDS: ***Agriculture, Farmer, Sensor, Soil, Technology.***

1. INTRODUCTION

For most countries, agriculture has been the most important industry for economic growth. It includes anything from tiny companies to big corporations to multi-national corporations. Agriculture encompasses more than simply farming and ranching, which are its primary sources of income. With each passing day, the global population grows, forcing farmers to produce more with less in order to feed an expanding global population, minimize environmental threats, cope with rising global temperatures, survive water and energy shortages, and satisfy the new food preferences of a rising generation of digital natives, tech-savvy customers[1].

Every area and industry are now surrounded by technologically sophisticated gadgets. Every industry has become more homogenous as a result of technological advancements. It has become a significant contributor to every single activity taking place across the globe. It affects every aspect of contemporary life, including how people live, talk, work, travel, and interact. Agriculture, like every other area of our contemporary life, is being influenced by technology. It might be argued that technology is becoming the most powerful force influencing everyone's life[2].

Agriculture technology has developed and expanded quickly in recent years. Many agricultural technologies, including as soil sensors, water sensors, weather monitoring systems, vertical farming, and others, are extensively utilized nowadays by anybody working in the area of agriculture. These technologies assist farmers in increasing agricultural output while maximizing efficiency. In the next years, these technologies are anticipated to radically transform the world of agriculture. Technology is changing the field of livestock management, which manages poultry farms, dairy farms, cattle ranches, and other livestock-related agribusinesses, according to recent developments. Livestock provides us with essential renewable natural resources that we require on a daily basis.

1.1 Emerging Technologies in Agriculture:

1.1.1 Sensor Technology:

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This is the most extensively used and prevalent technology. It is inexpensive, simple to use, and comprehend. Water and soil sensors are the most often utilized sensors. Farmers place these sensors all over their property and utilize them to detect a variety of environmental variables. These sensors can monitor nitrogen and moisture levels, allowing farmers to decide when and how much to irrigate and fertilize their soil in order to achieve positive results. It aids in the more efficient and long-term use of existing resources. It aids farmers in being environmentally friendly by allowing them to use a limited number of resources, save water, reduce fertilizer levels in nearby rivers and lakes, and minimize soil erosion. These sensors are low-cost, robust, and inconspicuous, making them difficult to steal[3].

Farmers can view their crops from anywhere in the globe thanks to sensors that utilize image recognition technology. This enables for real-time tracking. Farmers may monitor and manage their crop output with these sensors[4]. As a result, these sensors are assisting farmers in bringing agriculture to a new level of efficiency, allowing them to maximize crop output and reap maximum advantages.

1.1.2 Weather Forecasting:

Weather is the most unpredictably variable aspect of nature. Climate change is irreversible, and the agricultural sector is the most impacted. Farmers confront climate challenges from year to year. Weather variations have an impact on crop quality and quantity, and farmers must deal with the consequences. Rain, storms, floods, and a variety of other natural climatic events wreak havoc on the crop, leaving farmers unsure of what to do next. Observing these issues A weather tracking system was developed, which allows weather to be anticipated using weather forecasting software and the appropriate data, and action to be taken to prevent and protect crops from the effects of hazardous weather[5].

All of the outcomes are entirely dependent on data. Rainfall, storms, floods, tsunamis, humidity levels, temperature, wind directions, air pressure, and a variety of other variables are used to compile data from past years. This information is then analyzed to assist farmers in forecasting weather conditions and managing their crops appropriately. Farmers may take care of their land and crops while managing any weather-related hazards by using real-time data on weather conditions appropriate to their present location and season. Smart IoT sensors for data collection and analysis, satellites and weather stations, and AI and machine learning systems for weather forecasts are the three major technologies that contribute to the development of intelligent weather monitoring for agriculture. Farmers may receive real-time access to information about the environment and soil via IoT technology, allowing them to plan activities ahead of weather changes. When a system gets alarming data from weather sensors, it may transmit a warning about impending frost or rainfall, allowing farmers to be alerted and take appropriate action[6].

1.1.3 Vertical Agriculture:

It is a farming technique that involves producing food in vertical stacks, one on top of the other, in a regulated and enclosed environment. It employs CEA (Controlled Environment Agriculture) technology. Instead of growing vegetables and other crops on a single level, such as in a field or a greenhouse, this technique grows them in vertically stacked layers, which are often incorporated into other buildings like as skyscrapers, shipping containers, or converted warehouses. Artificial lights are utilized in lieu of sunlight in the growth process. Temperature, humidity, light, and gas concentrations are all intentionally controlled. Lighting efficiency is improved using technologies such as revolving beds. It is a part of urban agriculture, although it may be utilized to make better use of land in any location. Vertical farming may boost agricultural yields, overcome land constraints, and decrease farming's

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environmental effect. Indoor farms are becoming more popular in many nations as a result of their capacity to grow all year. It's comparable to using artificial sunshine and metal reflectors in a greenhouse. Its main aim is to increase agricultural production in a small area[7].

Figure 1: Stacks of Vegetable grown by using Vertical Farming in Agriculture

1.1.4 Organic Farming:

Organic farming, also known as ecological agriculture, is a farming method in which crops are grown and cultivated using natural methods. It entails the use of biological materials and the avoidance of synthetic chemicals in order to preserve soil fertility and ecological balance, as well as to reduce pollution and waste. It is a farming technique that prohibits the use of genetically modified organisms, industrial fertilizers, and pesticides. Organic waste, crop rotation, biological pest management, manure, mineral and rock additions are all used exclusively in this system. Pesticides and fertilizers are allowed in organic farming only if they are deemed natural; otherwise, petrochemical fertilizers and pesticides are avoided. It is said to be a superior technique than others that utilize chemical fertilizers. Chemical fertilizers deplete the soil's productivity over time. It's a system that keeps soils, ecosystems, and humans healthy. Organic agriculture has a unique place in the world's agricultural systems.

People have begun to choose organic goods over chemically manufactured because organic foods are high in nutrients such as vitamins, enzymes, minerals, and other micronutrients. Organic food is more nutritious and healthier than chemically manufactured food. Organic food has a more natural flavor[8]. Organic farming's primary aim is to create businesses that are both sustainable and environmentally friendly. Crop rotations, crop variety, crop residues, animal manures, legumes, green manures, off-farm organic wastes, bio fertilizers, and mechanized cultivation are all encouraged in organic farming. It is in tune with the natural world.

- *Components of Organic Farming*:

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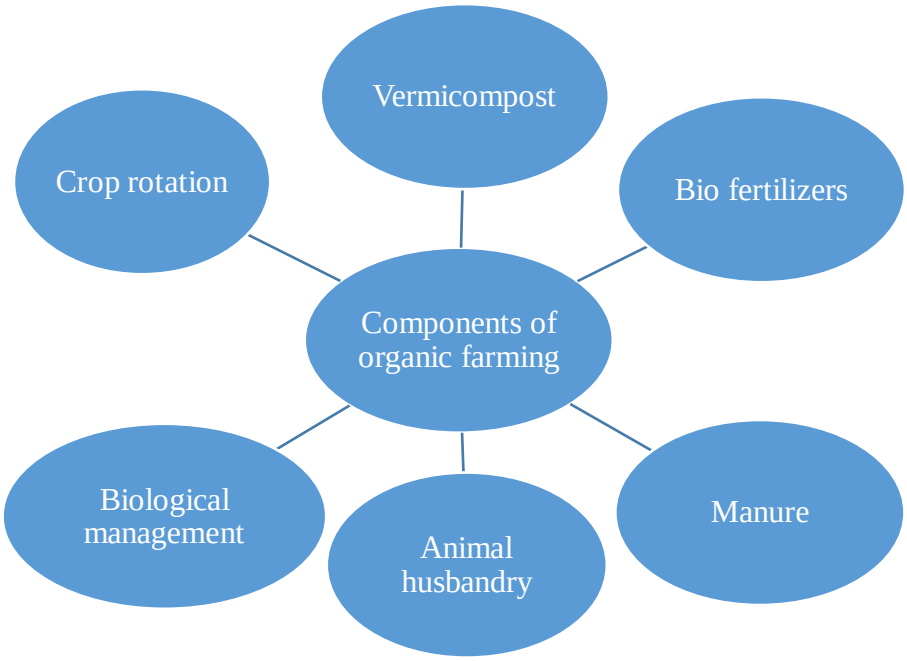

Figure 2: Basic components of Organic Farming in the field of Agriculture

1.1.5 Smart Farming:

Smart farming is the use of Internet of Things (IoT) technologies in the agricultural sector. It may be defined as the use of contemporary information and technology to improve product quality and quantity. It entails gathering real-time data on soil, weather, crop maturity, equipment, and labor to apply predictive analysis to make smart choices in agriculture. Smart farming uses technology (IoT) and software to collect data and provide actionable insights for all agricultural activities, both before and after harvest. The data is well-organized, always available, and full of information on all aspects of finance and field operations that can be seen from anywhere in the globe[9].

In agriculture, IoT refers to sensors, drones, and robots that are linked to the internet and work automatically or semi-automatically to conduct activities and collect data in order to improve efficiency and predictability. Agriculture automation and robots, often known as Agrobots, are beginning to gain traction among farmers in response to rising demand and labor shortages across the world. Agrobots have gained in popularity as a result of recent advances in sensor and AI technologies that allow machines to learn on their environment. These semi-automatic robots can identify weeds and spray pesticides on the damaged plants, saving both time and money on pesticides. Harvesting and lifting are two more applications for these robots. Heavy agricultural tractors may also be directed from the comfort of their own homes through phone screens to do chores, and GPS can monitor their whereabouts at all times[10].

Drones with cameras and sensors that may be used for mapping, imaging, and surveying farms are available. These drones may be commanded remotely, or they can fly themselves using software-controlled flying planes in their embedded systems, which operate in tandem with sensors and GPS. Crop health, irrigation, spraying, planting, soil and field, plant counts, and yield prediction may all be gleaned from drone data. Sensor data on humidity, temperature, moisture precipitation, and dew detection aids in predicting the weather pattern in farms so that appropriate crops may be cultivated. The study of soil quality aids in identifying nutritional value and drier regions of farms, as well as soil drainage capacity and acidity, allowing for the adjustment of irrigation water requirements and the selection of the

most advantageous kind of cultivation. Computer imaging entails the employment of sensor cameras placed across the farm or drones equipped with cameras to generate pictures that are then processed digitally. Quality control, illness detection, yield sorting and grading, and watering are all done using the pictures.

1.1.6 Robots:

Agricultural robots are radically changing and revolutionizing the agriculture sector. A robot that is utilized in agriculture is known as an agricultural robot. Planting seeds, harvesting crops, cloud seeding, weed control, soil analysis, and environmental monitoring are just a few of the uses for agricultural robots. Agro-bots are another name for agricultural robots. The goal of robotics is to decrease human labor and replace it with robots that can do the same tasks more efficiently. Farmers are increasingly using robots to do all agricultural chores such as irrigation, harvesting, fruit picking, planting, weeding, soil management, spraying, and other activities on their fields. All of these tasks seemed to be too difficult for robots to do in the past, but they are now feasible thanks to improved technology. Crop production has risen as a consequence of the use of robots, resulting in better yields.

1.1.7 Drones:

Drones are now being utilized for a variety of applications. For delivery services at a number of large corporations, as well as film and picture shoots at different weddings and other events. Drones have also found their way into the agriculture sector. Farmers have begun to use drones for a variety of reasons, including taking pictures of their property from various locations to analyze crop and soil health, and video recording of their fields to monitor crop development. Various temperature and humidity sensors may be added or connected to drones, allowing farmers to monitor temperature and humidity from the comfort of their own homes.

1.1.8 Automation Technology:

Agricultural automation is a kind of technology that improves farm efficiency by automating the crop or animal production cycle. Drones, autonomous tractors, robotic harvesters, automated watering, and seeding robots are all being developed by a growing number of businesses. Various gadgets that fall within the category of automation technology have been introduced. These are the following:

- *Pick Automation:* A variety of robots have been introduced to harvest fruits, vegetables, and a variety of other crops without hurting them. Robots have successfully harvested a variety of fruits and vegetables, no matter how fragile or flexible they are.
- *Autonomous Tractors:* Autonomous tractors are tractors that do not need human intervention to operate. These are self-driving vehicles that harvest land without the need for a driver by using the Global Positioning System (GPS) and other wireless technologies. These autonomous tractors have provided many benefits to farmers, including reduced labor requirements, 24/7 working capacity, the ability to react to weather data, and the ability to stop automatically when weather conditions deteriorate. As a result of all of these advantages, many farmers are turning to autonomous technologies.
- *Planting and Weeding:* Many farmers have begun to use robots for seeding and weeding in their fields. These robots use radiation to identify the crop and image screening to see whether there are any weeds in the crops, and then spray the medications appropriately.

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1.1.9 Machine *Learning:*

Machine learning (ML) is a new branch of artificial intelligence (AI) that may be used in agriculture. Machine learning is the discipline that enables computers to execute tasks without the need for human involvement or even rigorous programming. In the agricultural industry, machine learning is used in a variety of ways. It may be found throughout the whole growing and harvesting process. It starts with a seed being planted in the ground, progresses through soil preparation, seed breeding, and water level assessment, and concludes with robots picking up the harvest and using computer vision to determine maturity. It is vital at each and every stage of the process.

In agriculture, machine learning enables for more precise disease detection and crop disease prediction. Farmers are using AI and machine learning algorithms to comb through data and derive valuable insights that will help them improve efficiency, production, and yields. It is critical to choose the appropriate specie and gene of seed in order to maximize crop production. It uses data from different fields of various species to analyze crop performance and yield under various weather circumstances, as well as the novel features produced in the process. Machine learning is also used in soil management, water management, crop management, crop quality inspection, disease identification, weed detection, livestock management, and other fields.

1.1.10 Block chain:

A blockchain database is a kind of database that stores data in linked blocks. Every time a new data input is made, a new block is created. Although Blockchain was first developed for the finance sector, it has a wide range of uses in agriculture. Food fraud, safety recalls, supply chain inefficiencies, and food traceability may all be addressed using blockchain's capacity to maintain ownership records and resist tampering. The path of a food item from farm to table may be tracked in real time. It allows for confirmed transactions and provides a transparent marketplace.

In the agricultural industry, blockchain technology enables peer-to-peer transactions to take place openly and without the need for an intermediary such as a bank or a broker. By removing the requirement for a central authority, the technology shifts the way confidence is established, placing it in cryptography and peer-to-peer architecture rather than an authority. As a result, it aids in the restoration of confidence between producers and customers, lowering transaction costs in the agri-food industry. Blockchain technology provides a secure way to track transactions between anonymous parties. As a result, fraud and faults may be identified immediately.

1.1.11 RFID(Radio Frequency Identification) Technology:

Radio waves are used in these technologies to identify or detect objects, animals, or people. It uses relatively little power and is readily adaptable to diverse conditions, therefore it is extensively utilized in a variety of areas. It identifies and tracks tags attached to things using radio frequency waves. It's utilized to keep track of all kinds of things. Agricultural inventory can be managed using RFID tags and RFID readers. Data from RFID tags can be read without having to look at them. Farmers use RFID tags to ensure the security and safety of their goods and shipments. Farmers may use a computer network to track their wares. A tag may be used to check produce, speeding up the inspection process. A judgment may be made whether or not a temperature change would damage a fresh agricultural produce by reading

the information contained on an RFID tag. RFID may also be used to track weather conditions while traveling.

2. DISCUSSION

Agriculture has proved to be the most fundamental and vital industry since it produces food, which is essential for human existence. Agriculture is a massive undertaking. It entails a number of steps that must be completed in order to produce a certain crop. Different fruits, vegetables, and fruits are produced at different times of the year and in different climates. The kind of seed sown, the amount of water needed, the presence of pests, the usage of pesticides, soil quality, the type of fertilizers used, temperature, humidity, and a variety of other environmental variables all affect the production, yield, quality, and quantity of a crop. After verifying the land appropriateness, various crops are grown on different areas based on different needs.

Every human being has a fundamental need for food. As time passes, population expansion accelerates, making it more difficult for farmers to fulfil the demand and requirements of various crops. As a result, numerous technological advancements have been developed in order to produce more food of higher quality and quantity on the same area in less time. All of these technologies have been covered in this article, including how they operate and how they have totally altered the agricultural industry.

3. CONCLUSION

Agriculture is the most important contribution to most emerging countries' social and economic development, as well as their economic growth and stability. The agriculture sector is advancing thanks to technological advancements. Many large corporations are interested in the agricultural sector. Agriculture has changed dramatically during the last century as a result of the use of contemporary technology. New equipment and process methods for production, postharvest management, and agrobusiness are being developed as a result of these innovations. Farmers are finding it easier to monitor and care for their crops as new technology emerge. This article discusses a variety of technology that farmers are using in their agricultural operations. Various technologies and gadgets, such as autonomous tractors, robots, drones, and other instruments, have made every procedure in the agricultural industry simple and quick. As people get increasingly involved in agriculture on a daily basis, the demand for and usage of these equipment grows, expanding their future potential.

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