Smart Sustainable Farming Using IOT, Cloud Computing and Big Data

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Abstract: Smart farming offers a promising opportunity for modernizing agricultural practices by utilizing cutting-edge technology like big data, cloud computing, and the Internet of Things. This approach involves utilizing information and communication technologies to enhance crop production and quality while optimizing labor requirements. The adoption of IoT capabilities is a crucial element of smart farming. In order to connect different devices, a network must be built for the Internet of Things. Through IoT technology, farmers can gather data, monitor crop conditions, and optimize their operations in real-time. This is achieved using devices like robots, drones, sensors, and computer imaging, combined with sophisticated tools for generating insights and managing farms more effectively. IoT is used in various facets of agriculture to increase productivity, water efficiency, crop supervision, soil management, and pesticide and insecticide regulation. In the context of smart farming, the cloud plays a pivotal role by hosting essential parameters, which are then juxtaposed with data collected from the field. Wireless sensors linked to the cloud gather information from the ground. It is subsequently analyzed by machine learning algorithms in real-time. This analysis provides farmers with valuable insights into the status of their crops. Moreover, big data contributes by offering comprehensive information on factors like rainfall patterns, water cycles, and fertilizer levels. Armed with this information, farmers can make informed decisions, such as selecting the most suitable crops for improved soil fertility and determining the optimal timing for harvesting. Smart farming employs efficient techniques, including IoT, cloud computing, and big data analysis, to manage and enhance agricultural yields. It incorporates processes like geolocation, GPS tracking, sensor utilization, and drone surveillance to monitor fields and crops. By forecasting variables like soil moisture and humidity, farmers can effectively manage irrigation practices.

Keywords: advanced agricultural methods, difficulties, and issues; crop management; sustainable agriculture; smart farming; internet of things (IoT).

Book Chapter: Smart Sustainable Farming Using IOT, Cloud Computing, and Big Data

1. Introduction:

1.1 The Importance of Smart Farming

The significance of smart farming surpasses traditional agricultural methods. Smart farming employs sensors and automated irrigation techniques to monitor crucial factors like soil quality, temperature, and moisture levels. Agriculture serves as the foundation for essential resources such as food, fabrics, wood for construction, and paper products. All of these are derived from agricultural produce. The primary aim of implementing smart farming is to harness data gathered through specialized tools and transform it into valuable information, ultimately streamlining agricultural processes. The goal of smart farming is to give the agricultural industry the framework it needs to take advantage of cutting-edge technologies, such as big data, cloud computing, and the Internet of Things (IoT), to make it

1.2 An overview of IoT, Cloud Computing, and Big Data in Agriculture

In terms of developing IoT solutions, big data analytics play a pivotal role in enabling automation and optimization. IoT serves as the primary data source; big data assumes the role of analyzing the data; and cloud computing provides the platform for storage, scalability, and rapid accessibility.

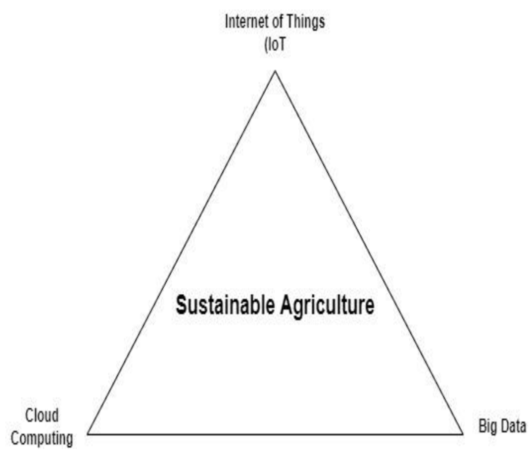

Fig 1.2 Sustainable Agriculture Using IoT, Cloud Computing, and Big Data

Precision farming, agricultural drones, hopping systems, livestock monitoring, climate conditions monitoring, smart greenhouses, and AI and IoT-driven computer imagery are a few of the significant domains that fall under the umbrella of integrating AI and IoT into agriculture. The fundamental objective of the IoT is to establish self-reporting plans that enhance efficiency and expedite the emergence of critical information, surpassing the pace of systems reliant on human intervention.

In the collection, processing, and storage of agricultural data, cloud computing is crucial. Cloud-connected wireless sensors amass information from fields, which is then processed in real-time through machine learning algorithms. This real-time analysis provides farmers with enhanced insights into the growth status of their crops. Leveraging big data, farmers gain access to comprehensive information encompassing variables like changing weather patterns, rainfall data, fertilizer utilization, and more. Armed with this information, farmers are empowered to make informed decisions, such as selecting optimal crop choices for improved yields and identifying opportune harvest times.

1.3 Objectives of the Book Chapter

This chapter explores the concept of "Smart Farming," which involves enhancing both production volume and quality through the use of cutting-edge technologies in agriculture and animal rising. The core focus lies in optimizing resource utilization while minimizing environmental impact. The fundamental tenet of sustainable agriculture is to reduce dependence on outside energy sources and shift from non-renewable to renewable energy sources, such as solar and wind power, biofuels made from agricultural waste, and, where practical, human or animal labor.

IoT-smart agriculture involves gathering data on factors like weather, humidity, temperature, and soil fertility. An IoT-based investigation enables the development of horticulture goods that are intended to assist in monitoring agricultural fields using sensors and by automating irrigation systems, including products for wild plants, water levels, precise location, field interruption, field development, and horticulture. As a result, farmers and related companies may conveniently and hassle-free monitor the field situation from anywhere. The water level, wetness level, and moisture level are all checked when the IOT-based farm monitoring scheme first launches. It notifies the phone through SMS when a level is reached. When the water level drops, sensors monitor it and automatically activate the water pump. The fan begins when the temperature exceeds the predetermined level.

Cloud-based APIs and services like weather forecasting can help farmers arrange their assortment of crops and schedule their cultivation and harvest times. Smart agriculture using IoT makes use of many sensors for monitoring the climate conditions of the environment. The sensor's responsibilities are to cross-field gather data and transmit it to the cloud.

Big data promises to provide farmers with extensive information on patterns of rainfall, water cycles, fertilizer supplies, and other topics. As a result, they are able to choose the right crops to seed and the right time to harvest for increased yield.

2. IoT in Agriculture:

2.1 Understanding IoT and its Application in Farming IoT

It centers on the Internet-based connectivity and coordination of commonplace equipment. The term "things" in the Internet of Things refers to a variety of everyday items that are connected to or interfaced with the Internet. IoT is an advanced amalgamation of automation and analytics, encompassing AI, sensors, networking, electronics, and cloud messaging. This synthesis facilitates comprehensive system development for products and services.

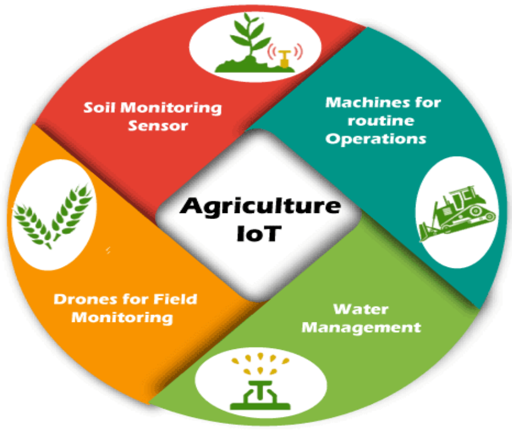

Fig 2.1: IOT in Agriculture

The phrase "Internet of Things" (IoT) refers to a network of actual physical items, or "things," that have been equipped with sensors, software, and other technologies to connect and exchange data with other systems and gadgets over the internet.

2.2 IoT Sensors and Devices in Farming

The agricultural sector embraces robots, drones, remote sensors, and computer imaging, amalgamated with dynamic machine learning tools and analytics. These technologies monitor crops, survey fields, and provide actionable data to farmers, streamlining farm management strategies and optimizing resource usage. Various sensing technologies underpin these sensors and devices:

- **Optical sensors:** Assess soil properties like clay content, organic matter, and moisture.
- **Electrochemical sensors:** These devices offer vital information for precision farming, including soil pH and nutrient levels.
- **Mechanical sensors:** Measure the mechanical resistance or compaction of the soil.
- **Dielectric soil moisture sensors:** Measure moisture levels based on the soil's dielectric constant.
- **Airflow sensors:** By measuring the air pressure required to break through the ground at particular depths, they may estimate the soil's air permeability.

2.3 Integration of IoT with Farming Technology

The integration of AI enhances the utilization of sensor data through monitoring and intelligent management. Challenges of smart agriculture encompass sensor integration, data linkage with analytics, dynamic automation, and responsive actions. IoT has the potential to revolutionize agriculture by rationalizing processes. Flow sensors, light sensors, and pressure sensors, among others, permit automation and standardization of various farming operations. Smart farming powered by the internet of things involves automating irrigation systems, enabling remote field evaluation, and monitoring fields using sensors to measure light, humidity, temperature, and soil moisture.

2.4 Challenges and Benefits of Implementing IoT in Agriculture

While IoT adoption offers manifold benefits in agriculture, it also confronts challenges such as information gaps, high implementation costs, and security concerns. Educating farmers about IoT's advantages through practical demonstrations of drones, sensors, and other technologies is crucial to foster awareness. Addressing issues like hardware compatibility, networking, data security, and governance is pivotal to ensuring the seamless uptake of IoT in agriculture. These solutions aid in risk mitigation by promptly identifying anomalies and inconsistencies in crop production, reducing waste, controlling costs, and boosting overall output.

In terms of smart agriculture, there are a few unresolved problems and difficulties that must be solved right away. These problems involve networking, infrastructure, hardware, signal interference, data security, and administrative difficulties. In terms of interoperability, connectivity, data processing power, explicit data governance, data security, and privacy, the adoption of IoT in agriculture faces significant obstacles on both a sectoral and technological level. IoT agricultural solutions reduce some of the dangers associated with farming. Farmers may reduce waste, manage costs, and increase crop productivity by quickly spotting abnormalities and discrepancies.

3. Cloud Computing for Agriculture Data Management:

3.1 Introduction

Cloud computing is a convenient way to gather, analyze, and store agricultural data. To provide farmers with improved understanding of how their crops are developing, wireless sensors linked to the cloud gather data from the field, which is then processed in real-time by machine learning (ML) algorithms. Cloud computing provides more elasticity and reliability, improves performance and efficiency, and helps reduce IT costs. It also accelerates digital transformation, allowing organizations to bring products to market faster and incorporate AI and ML into their strategies. The three primary types of cloud computing services are as follows:

- **Infrastructure as a Service (IaaS):** This offers networking, servers, storage, and other computing infrastructure as a service. Users can scale their resources up or down according to their needs because it is a pay-as-you-go business.

- **Platform as a Service (PaaS):** This gives developers, administrators, and users a platform on which to create, deploy, and manage applications. It encompasses the resources—such as programming languages, databases, and runtime environments—that programmers need to create and use applications.

- **SaaS (Software as a Service):** This offers software programs as a service. Applications can be accessed by users from any internet-connected device. SaaS applications are frequently maintained and hosted by the cloud provider. Cloud computing can be used for a variety of agricultural applications, such as:

- **Precision agriculture:** This uses data collected from sensors to improve crop yields and efficiency. For example, sensors can be used to monitor soil moisture, temperature, and nutrient levels, and this data can be used to determine the best time to plant, irrigate, and fertilize crops.

- **Livestock monitoring:** This uses sensors to track the health and location of livestock. For example, sensors can be used to monitor the temperature and heart rate of animals, and this data can be used to identify sick animals or animals that have wandered off.

- **Food traceability:** This uses data to track the movement of food from the farm to the consumer. This can help to improve food safety and security.

- **Supply chain management:** This uses data to optimize the flow of goods and materials through the supply chain. This can help to reduce costs and improve efficiency.

Cloud computing is a powerful tooling that can be used to improve the efficiency and sustainability of agriculture. It is a rapidly growing field, and there are many new and innovative applications being developed all the time.

3.2 Cloud Computing-Based Data Storage and Processing Farming

The Dropbox computer or mobile apps can be used to create an account by running them and selecting Sign Up after installation. Drop Box is a service for storing data in the cloud. Dropbox offers a central location for online file storage, file syncing, and file sharing. Whether you are at work or on the road, your files are instantly accessible and synchronized across all of your devices. Dropbox provides a number of choices for cloud storage. Using Dropbox for cloud storage enables you to properly store anything on the cloud and access file uploads from a variety of devices, regardless of whether you are an individual, a small business, or a large corporation.

Dropbox is a reputable supplier of cloud storage or file hosting. Private individuals and businesses can manage, place, store, and distribute digital content from a single location thanks to this technology. Files can be stored in online folders and synced between devices by Dropbox users. Dropbox is an illustration of an IaaS for file storage. The address for all of your work is Dropbox. Whether you are working alone or with peers and clients, you may gather and share files, collaborate on projects, and realize your grandest ideas. With Dropbox, all of your files are online-accessible cloud backups.

In data centers all around the country, storage servers are present. In addition, qualified Dropbox business users can access storage servers in Australia, the European Union, Japan, and the United Kingdom. You can access your files from anywhere with Dropbox cloud storage and file management features. With features like folder suggestions and calendar pairings that aid in helping you stays focused on your most crucial tasks, Dropbox is the sole place you should have all of your data organized.

Sign up for a Dropbox account:

- Register for a Dropbox.com account.
- To compose an email (your email address will serve as your Dropbox account's login).

- To write your first name, last name, and a special password.
- Check the box to accept Dropbox conditions.
- Select a paid plan, or click Continue with the 2 GB Dropbox Basic Plan.
- Select your user preferences.

3.3 Security and Privacy Concerns in Cloud-Based Agriculture

Agriculture 4.0 systems are susceptible to environmental factors, climatic changes, and human activity. The system's dependability and trustworthiness could be impacted by lax security measures, which could leave it vulnerable to physical damage, remote control, and unintentional usage of tainted data. Rapid cloud development has increased product elasticity, cost savings, and scalability, but it has also created a significant number of privacy and security problems. There may be unforeseen safety precautions that need to be followed because the concept is still relatively new and expanding daily. Here, we discuss the top 7 privacy issues that cloud computing users face.

- **Data Privacy Concerns:** When outsourcing extremely small and sensitive data to a cloud service provider, data privacy is a crucial concern that needs to be taken into account. One way to ensure that privacy is protected is by using strong access control policies and conventions. Private data should be made inaccessible to those who do not have the required authorization to access it.

- **Problems with Data Thrashing:** One of the main security obstacles that cloud providers must overcome is data thrashing, or data theft. More than 60% of consumers would not use the cloud services offered by a cloud dealer if the dealer has previously reported data thrashing or theft of substantial or responsive material data. Businesses like Dropbox, Microsoft, Amazon, and others frequently use cloud services.

- **Data Storage Concerns:** Since cloud communications are dispersed across various geological locations around the globe, it is frequently likely that the user's data is stored in a location outside of the legal authority, which raises questions from the user about the legality of local law enforcement and the policy on data that is stored outside of their province.

- **Multi-Tenancy Safety Issues:** The multi-tenancy standard is based on the idea that different tenants can share computing resources, data storage, applications, and services. Then, at the location of the cloud service provider, this is hosted on the same significant or coherent platform. The provider can maximize earnings by using this strategy, but the client is in danger.

- **Lucidity Concerns:** In terms of cloud computing security, lucidity refers to a cloud service provider's willingness to divulge various information and characteristics on its level of security vigilance. Some of these data concern the safety, isolation, and service level standards and rules for conciliation. When measuring clarity, it's crucial to consider other factors like temperament and security keenness in addition to keenness and temperament.

- **Hypervisor-related problems:** Because the hypervisor controls many virtual machines, it is a target for attackers. Multiple virtual machines will therefore be at risk as a result of the hypervisor's cooperation. Adversaries now have new ways to take advantage of the system thanks to the advancements made in hypervisor technology, such as isolation, security hardening, access control, etc.

- **Managerial Challenges:** Cloud privacy issues have both technological and managerial components in addition to non-technical ones. Examples of this include the absence of control, safety, and privacy management for virtualization, the creation of detailed SLAs, the interaction with cloud service providers and users, etc.

4. Big Data Analytics for Precision Farming:

4.1 Introduction

One of the most crucial tools for precision agriculture is a geographic information system (GIS), which is computer software that collects, analyzes, and displays spatial data on maps. GIS can help you control various types of data and analytics to improve your farm's decision-making and planning in many ways. Precision farming's main equipment is:

- Geographic Information Systems.
- Remote Sensing.
- Geographic Positioning Systems.
- Variable Rate Technology.
- Normalized Difference Vegetation.
- Nutrient Expert Systems.
- Site Specific Nutrient management.
- Bio-Intensive Farming.
- Real-Time Nitrogen Management.
- DRIS Diagnosis Recommendation Integrated System.
- Soil Testing and Analysis.
- Yield Monitoring System.

Farmers are provided with information on all crucial subjects, such as crop status, weather forecasts, ecological changes, etc., based on the aforementioned data. Large-scale information from big data is available to farmers on topics including rainfall trends, water cycles, and compost availability. All of this knowledge enables farmers to make accurate and reliable decisions that maximize the productivity of their land cultivation.

4.2 Importance of Big Data in the Smart Agricultural Industry

Big data offers farmers granular information on things like fertilizer availability, water cycle patterns, and rainfall patterns. They can then decide which crops to grow for greater fertility and when to harvest, among other wise decisions. Agricultural data are useful in estimating, planning, and forecasting the agricultural operation of a given unit of area at a particular point in time.

- **Big Data Improves Productivity and Operation in Farms:** Big data plays an imperative role in improving farming productivity as it allows crop production forecasting and the progress of crop yields. It enables farmers to make smart business decisions. Businesses and farms in the agriculture region are as perceptive to market price fluctuations as any other industry.

- **It has condensed the waste of food on a global level:** Throughout the many phases of the supply chain, about 30% of the food is lost or wasted. Big data is the key to falling food prices, as it allows for the collection of data on stores and other parts of the supply chain to sense where and why the cost reduction is taking place.

- **Allows Farmers to Optimize Farm Equipment:** Farming equipment and machinery can be equipped with sensors that detect and record vital data related to fuel levels and service due date reminders. Data applications can further process and analyze customary information, which can be used to make essential decisions that can help optimize agricultural equipment.

- **Improves supply chain organization:** The supply and demand gap between producers and the market can be filled by tracking down the number of food liberation trucks and their routes. This helps to remove any food waste that is likely to occur due to the lack of big data.

- **Allows for the supervision of pesticide usage:** Big data provides farmers with integral instructions relating to safe quantities and correct timings for pesticide relevance. As a result, they can manage their expenses better by cutting expenses due to excessive pesticide usage while also avoiding the probable health risks.

- **It is Vital to Cater to the Needs of a Growing Population:** Big data in agriculture may provide vital information on climatic trends, fertilizer availability, and soil moisture levels. Raising the per-acre agricultural output must be tested in order to ensure enough food supply.

- **Its Condensed Immigration of the Agricultural Labor Force to Other Industries:** The latent potential for growth and new stirring opportunities make this industry attractive for specialists and prevent them from switching industries in search of new opportunities.

4.3 Big Data Analytics for Crop Supervision in Precision Farming

Precision agriculture (PA) is a method of managing agriculture that focuses on monitoring crop irregularities both within and between fields. Satellite crop management and site-specific crop management are other names for precision agriculture. With the aim of regularly optimizing the inputs and outputs of the various systems, this is used to create a result-support system for total farm management. Examples of precision agriculture include the use of GPS, drones, and irrigation technologies.

Digital farming, also known as smart farming, is a contemporary method that enhances precision farming efficiency and maximizes resource use by utilizing digital and smart devices, such as sensors, cameras, satellites, drones, and the Global Positioning System (GPS).

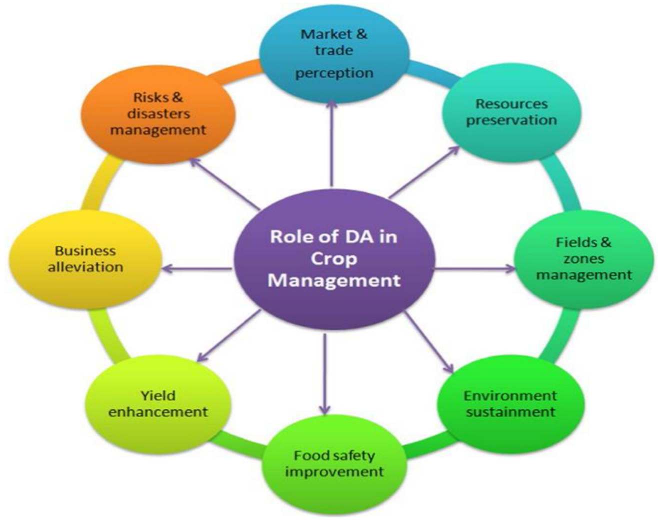

Fig. 4.3: Role of Digital Agriculture in Crop Production

5. Smart Sustainable Farming Framework:

5.1 Overview of Smart Farming

Agriculture has evolved through four main eras:

- **Traditional agriculture (1.0):** This era relied on manual labor and animal power. It began in the Neolithic era, around 10,000 years ago.
- **Mechanized agriculture (2.0):** This era began in the 19th century with the introduction of steam-powered machinery. It led to increased productivity and efficiency, but also environmental problems such as pollution and soil degradation.
- **Intelligent agriculture (3.0):** This era began in the 20th century with the development of computers and electronics. It allowed for more precise farming practices, such as precision irrigation and pest control.
- **Digital agriculture (4.0):** The utilization of emerging technologies like the Internet of Things, big data, and artificial intelligence characterizes this most recent era, which it predates. These technologies are being used to improve agricultural productivity, sustainability, and efficiency.

The agricultural industry is constantly evolving, and it is likely that new technologies will continue to be developed in the future. These innovations could change agriculture and assist in addressing the problems associated with feeding an expanding population. Here are some of the specific technologies that are being used in digital agriculture:

- **The Internet of Things (IoT):** The Internet of Things (IoT): The IoT refers to the network of physical objects that are embedded with sensors, software, and network connectivity. These objects can collect and exchange data, which can be used to monitor and control agricultural operations.

- **Big data analytics:** The analysis of vast amounts of data to spot patterns and trends is known as big data analytics. This information can be utilized to make better agricultural decisions on things like crop planning and pest control.
- **Artificial intelligence (AI):** AI is the ability of machines to think and learn like humans. AI is being used in agriculture to develop autonomous robots that can perform tasks such as weeding and harvesting.
- **Cloud computing:** the distribution of computing resources such data storage, software, and processing power via the internet. Agriculture uses cloud computing to store and analyze data and execute programs that demand a lot of processing power.

These are just a few of the technologies that are being used in digital agriculture. These technologies have the potential to change the agriculture sector and assist in addressing the issues of feeding a growing population as they continue to advance.

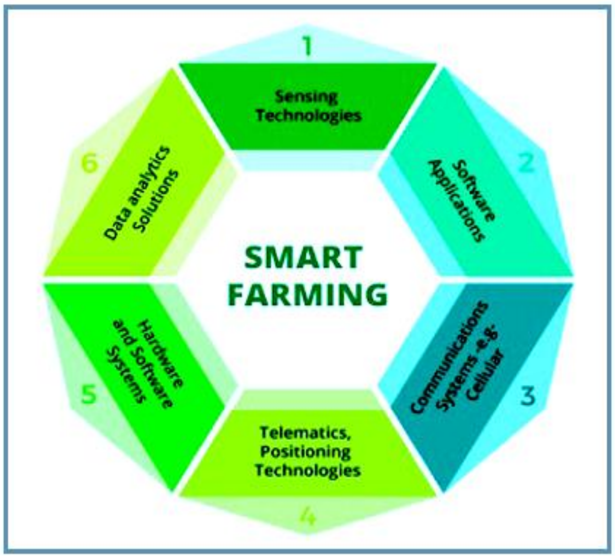

Fig. 5.1: Smart Farming Tools

5.2 Technologies Used in Smart Farming

Technology is used in precision agriculture to gather and evaluate information about crops, soil, and weather. Informed decisions about crop management, such as when to plant, how much fertilizer to use, and how much water to irrigate, are made using this data.

Precision agriculture makes use of the following technologies:

- **Global positioning systems (GPS):** GPS is used to map fields and locate farm equipment.
- **Sensors:** Sensors are used to measure soil moisture, nutrient levels, and plant health.
- **Remote sensing:** Remote sensing is used to collect data about crops and soil from the air or space.

- **Geographic information systems (GIS):** GIS software is used to store and analyze data collected by GPS, sensors, and remote sensing.

Farmers may increase crop yields, lower input costs, and save resources with the use of precision agriculture. By lessening farming's impact on the environment, it can also help increase the sustainability of agriculture.

Here are a few advantages of precision farming for sustainability:

- **Reduced water use:** Precision irrigation systems can help reduce water use by applying water only where it is needed.
- **Reduced fertilizer use:** Precision fertilizer application systems can help reduce fertilizer use by applying fertilizer only where it is needed.
- **Reduced pesticide use:** Precision pesticide application systems can help reduce pesticide use by applying pesticides only where they are needed.
- **Improved soil health:** Precision agriculture can help improve soil health by reducing soil erosion and compaction.
- **Increased crop yields:** Precision agriculture can help increase crop yields by optimizing crop management practices.

The use of precision agriculture has great promise for enhancing agricultural sustainability. Technology is going to become more crucial in assisting farmers in producing food more effectively and responsibly as it continues to advance.

The following are a few difficulties with precision agriculture for sustainability:

- **Cost:** Precision agriculture technologies can be expensive to adopt.
- **Data collection and analysis:** Large volumes of data need to be gathered and analyzed in order to practice precision agriculture. This can be a challenge for farmers who do not have the resources to collect and analyze data.
- **Acceptance by farmers:** Precision agriculture is a new technology, and some farmers may be reluctant to adopt it.

Despite these difficulties, precision agriculture has the potential to significantly advance sustainable farming. Farmers are likely to embrace the technology more broadly as it continues to advance and costs drop.

5.3 Sustainability

Environmental protection, a greater supply of the planet's natural resources, and improved soil fertility are all expected benefits of sustainable agriculture techniques. Sustainable agriculture aims to: raise gainful farm income by pursuing a number of objectives. Encourage good environmental management.

Data accessibility is essential for sustainable agriculture. Through a combination of navigation satellites and earth observation data, smart farming supports both sustainable and cost-effective agriculture, making it simple for farmers to make educated agricultural decisions. There are primarily three forms of sustainability.

- **Ecological Sustainability:** At the ecological level, sustainability prevents nature from being used as an endless source of resources and ensures that it can be used normally and without interference from many factors (Islam & Huosong, 2016). Realistic adaptability includes, for instance, an interest in sustainable power sources, natural safety, and water conservation.

- **Social Sustainability:** At the social level, sustainability can sow the seeds for the growth of people, communities, and societies to support reasonable and actually isolated individual pleasure, medical services, and education all over the world in 2007 (Bornstein).

- **Economic sustainability:** Business operations and the corresponding movement of financial resources will support alternative pillars of viability for a comprehensive improvement (Unger, 1998).

5.4 Sustainable Agricultural Framework

Sustainable farms encourage the conditions necessary for the natural decomposition of wastes or make use of natural predators or competitors to reduce vermin. The "Farm Bills" from 1977 and 1990 more precisely define sustainable agriculture as "an integrated system of plant and animal production techniques with a site-specific approaches that, over the long term:

- Persuade people of the importance for food and fiber

- Improve the environment's quality and the natural resource base that underpins the agriculture.

- Make the most efficient use of agriculture and nonrenewable resources, taking into account any relevant natural biological cycles and limitations.

- Maintain the viability of agriculture operations economically.

- Enhance the standard of living for farmers and society at large.

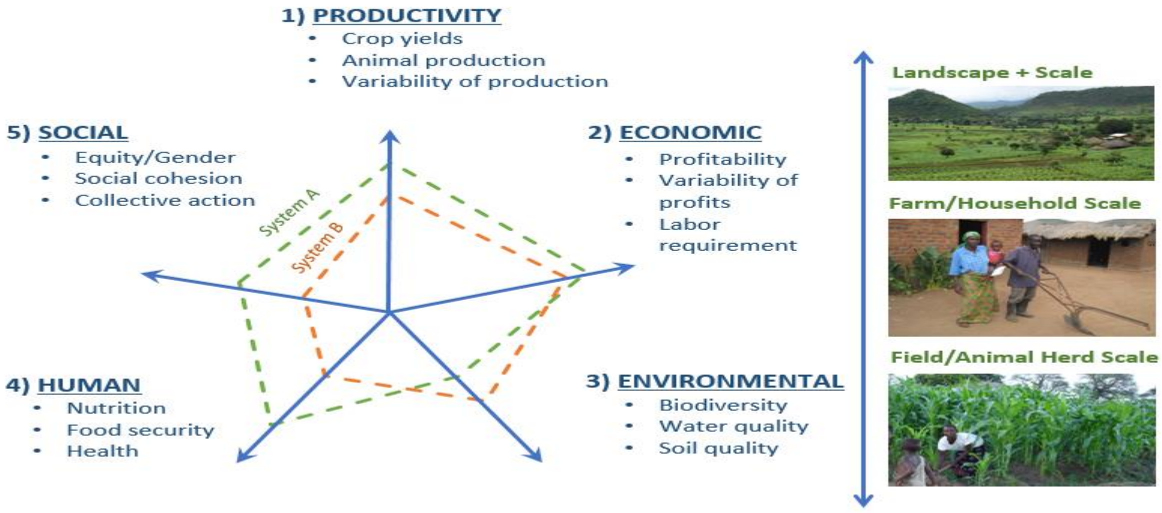

Fig 5.4: Sustainable Farming Framework across the five domains of sustainable growth

6. Challenges and Future Direction of Smart Farming:

The main obstacles to smart agriculture include disease prediction, automatic watering, constant monitoring, and energy collection [14]. Crop loss due to various illnesses is a serious problem that occurs in farming. The average size of farms, poor infrastructure, a lack of utilization of farm technologies and best farming practices, decreased soil fertility due to over-fertilization, and continued pesticide use are the key factors contributing to India's low agricultural yields.

Numerous problems are overwhelming farmers everywhere. Both directly and indirectly, these issues affect the farmer's way of life. Agriculture-related activities and practices can often be time and money-consuming. In the food sector, issues encountered by farmers are typically disregarded. The primary issues that farmers face are:

- Demand for infrastructure
- Demand of insurance
- Provisional water rights
- requirement for a living wage

Farmers who practice smart farming have a better understanding of key elements like water, scenery, features, plants, and soil kinds. This enables farmers to decide how to manage scarce resources in their production area in an environmentally and economically viable way. Precision farming, hydroponics, aquaponics, and vertical farming are just a few examples of modern farming methods that are gaining popularity among farmers. These methods increase competence, diminish waste, and provide new and sustainable produce for consumers. Accurate agriculture is made possible by a variety of technology, including sensors, smart irrigation, drones, automation, and satellite and GPS systems, which also help with efficient reserve utilization.

7. Conclusion of Smart Sustainable Farming:

Smart farming refers to providing the agricultural sector with the communications needed to access cutting-edge technology for tracking, monitoring, automating, and analyzing operations, such as big data, the cloud, and the internet of things (IoT). Ecological wellbeing, economic productivity, and social equality are the three fundamental objectives of sustainable agriculture. These objectives have been influenced by a variety of beliefs, laws, and practices.

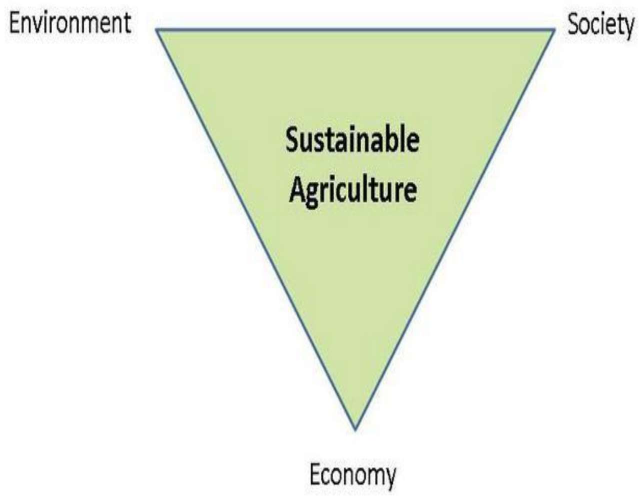

Fig 7 Sustainable agriculture gives equal weight to ecological, communal, and financial concerns in agriculture.

The system mainly monitors parameters such as temperature, damp level, moisture, and water level of the farming field. A statistical model can be planned with the existing data from various sensors. Users can monitor and control the field motors based on the soil structure, crop condition, irrigation, and bug and pest detection. While climatic predictions and sensors that assess soil moisture result in watering just when necessary and for the appropriate amount of time, production rates for farming and livestock rearing are increased. Farmers who use smart farming are more productive and capable while utilizing fewer resources. In comparison to conventional farming, smart farming enables farmers to boost yields, reduce expenses, and practice better ecological stewardship.

In smart agriculture, by replacing dirt with a nutrient solution that already includes the minerals plants require, smart agriculture allows you to grow fruits, vegetables, and flowers happily. This eliminates the need for plants to search for the necessary minerals in the soil and instead allows plants to quickly and immediately absorb nutrients from the nutrient solution. Our capacity to connect this data and use it to make current decisions about every element of our operations is key to the success of smart farming in the future.

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