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An Analytical Review on Traditional Farming and Smart Farming: Various Technologies around Smart Farming

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Abstract
In India Agriculture sector is the primary source of livelihood. Traditional farming can be described as a primitive method of food production that heavily depends on regional expertise, the use of the land, traditional tools, natural fertilizers, manual maintenance, cattle grazing, field-spread pesticides, a lack of technology, and cultural beliefs of the farmers. Due to increasing stress brought on by weeds, disease, pest infestations, and other climate change-induced pressures, many agricultural regions may see losses in crop and livestock productivity. The absence of technology in traditional agriculture over the past 40 years, there has been a surge in the production of agriculture disruptions, and over the next 25 years, this is expected to continue. Both rainfed and irrigated agriculture will continue to face difficulties if creative conservation measures are not put in place to stop the current loss and degradation of vital agricultural soil and water assets. This study paper reviews and analyses the work of numerous scholars in order to provide a rapid assessment of the various drawbacks of traditional farming and the advancement of smart farming. And also, this paper reviews the technologies i.e., IoT, Sensors, Robotic, Drones, AI, different Apps for farmers related to smart agriculture which improves the crops' yield and strengthens the soil's fertility.

Key Terms **-** Artificial Intelligence, Applications, IoT, Precision Farming, Smart Farming, Traditional Farming, Unmanned Aerial Vehicles.

Introduction

One of the greatest sectors in the world, agriculture or farming is the primary source of income for almost 58% of India's population.Agriculture and forestry have a big effect on property development and food security [1].In addition to having the greatest herd of cattle (buffaloes), wheat, rice, and cotton-planted land, India is the world's largest producer of milk, pulses, and spices.Wheat, rice, sugar, cotton, farmed fish, cotton, vegetables, fruits, and tea are among the products it produces that are second in size. From 1991 to 2021, India's agricultural output grew on average [2] by 86.14% INR billion. More than 120 countries import processed Indian farm food. In terms of agricultural industries, India is ranked 74th out of 113 nations in 2020, according to the resources. The Indian food and grocery store was ranked sixth in the entire world. The issue of wise resource use is brought on by the global population's constant rise along with a reduction in available resources [3]. Because the conventional procedures are no longer successful, good agricultural and farming applications have grown in importance and are now utilized more frequently [4]. Farming is the practice of cultivating plants and livestock. Indian people have different necessities and surrounded with various climatic conditions. Depends upon that there are different types of farmers and Farming types are there.

This essay is organized as follows: The background information on traditional farming is presented in Section II.Section III presents background of smart farming.

Section IV presents advantages and disadvantages of smart farming. Section V presents summary report of referred papers. Section VI presents conclusion and future scope.

Background of Traditional Farming

The wide term "agriculture" refers to anything involved in cultivating plants and rearing animals for food and useful products [5]. It entails processing plant and animal products before delivering them to markets for human consumption. Low-tech equipment like the axe, hoe, lawn rake, hand fork, pruners, spade, long-handled shears, etc. were widely used when people first started growing crops.

Role of Farmer In India

The backbone of India is a farmer. Agriculture is the industry in which farmers operate, providing a wide range of food items for both human and animal consumption. Farmers come in a variety of forms, from those who raise livestock to those who cultivate crops [6]. Farmers are the ones who cultivate all the livestock and crops needed for human life. Without food, the world would slowly perish, thus farmers work incredibly hard every day to maintain an abundant supply of crops and animal products on the market.Consumer expenditure in India will rebound in 2021 following a pandemic-related decline, increasing by as much as 6.6%.32% of India's overall food market is made up of businesses in the food processing sector.

Farming Types

As shown in Figure 1 [6], there are various farming methods: (i) Primitive Subsistence Small, scattered landholdings, the use of simple tools, and farming are hallmarks. The farmer doesn't use fertilizers or seed varieties that produce a lot of crops. Where there is heavy population pressure on the land. (ii)Intensive subsistence farming is practiced. A number of machines, together with irrigation, fertilizers, and pesticides, are introduced to maximize production in small spaces. (iii) Commercial farming is defined as the practice of using ever bigger dosages of modern input to increase output.

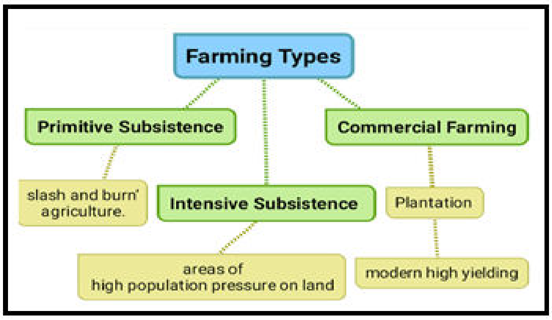

Figure 1: Farming Types [6]

Types of Farmers in India

As depicted in Figure 2 [7], a farmer may be the owner of the farmland or may work as a worker on land that belongs to others. Farmers come in a variety of forms [7]. Who in India encourages or improves the growth of plants, land, crops, or animals through work and care is highlighted in Table 1. Marginal Farmers, or those with less than 1 hectare of land, come first. Second, small farmers with land sizes of 1 to 2 hectares. Third, small-to-medium farmers with land sizes between 2 and 4 hectares.

Types of Farmers	Type of Production
Organic Farmer	Without the use of pesticides, herbicides, or chemical fertilizers, produces fruits, vegetables, cereals, or cattle.
Grain and Forage Crop Farmer	Cultivates forage crops as well as grains like wheat, barley, canola, oats, rye, flex, and peas.
DairyFarmer	Owns or manages a farm where cows are raised for milk and other everyday needs.
PoultryFarmer	Rears domesticated birds, such as chickens, turkeys, ducks, or geese.
Rancher	Raises both common livestock like sheep or cattle as well as unusual ones like bison, ostriches, emus, or alpacas.
Bee Keeper	Produces honey, pollen, royal jelly, and beeswax by keeping honey bees.
VermiCulturist	Raises worms and uses them to transform waste materials such uneaten food, garbage, grass clippings, damaged fruit, nutrient-rich soil, and organic fertilizer.

Table 1: Types of Farmers in India [7].

Figure 2: Categorization of Farmers in India [7].

Traditional Farming Methods in India

Traditional farming [8] is a time-honored practice that has been applied since ancient times, as indicated in Table 2. These techniques have assisted farmers in providing ecological and cultural services to humanity throughout the ages. Figure 3 shows how maintaining traditional farming practices has improved food security, preserved biodiversity, and safeguarded the planet's natural resources.

Name of the Farming Method	Type of Production and Benefits
Agroforestry	Food, firewood, and key food crops are all produced there. It offers local communities significant social and economic advantages.
Crop Rotation	Depending on the season, growing various crops on the same ground. It helps to maintain soil productivity, lessen pests, use fewer chemicals, increase yields, and lessen dependency on a single set of nutrients.
Intercropping	More than two crops are sown at once. Excellent approach to increase yields and harvest diversity on a single piece of land while maximizing the usage of resources.
Poly Culture	It is a mechanism for growing several plants of various species in one location. Without the use of chemicals, it can control weeds, pests, and illnesses. It aids in lowering soil erosion and raising consistent production. It raises the soil's quality.
Water Harvesting	Rainwater is typically collected from roofs and used on crops or stored for later use by individuals or other agricultural uses. It offers portable water and lessens the demand on wells.

Table 2: Traditional Farming Methods in India [8].

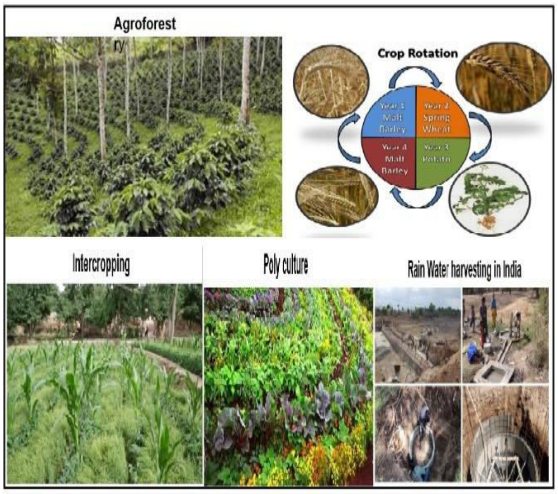

Figure 3: Traditional Farming Methods in India [8].

Characteristics, Advantages and Disadvantages of Traditional Farming

Traditional agriculture [9] is a basic method of food production and farming, as depicted in Figure 4, that heavily utilizes local expertise, land use, customary equipment, natural resources, organic fertilizer, and farmer cultural beliefs.

1) Characteristics of Traditional Farming:

- Cattle are used to create fallow ground in traditional farming.
- A lot of low-tech tools are used.
- Using techniques like "slash, burn," and "shifting cultivation."
- Absence of accountability of responsibility to the environment. No way to predict weather.
- Zone identification and geotagging are not possible.

The same set of procedures are used throughout the region for agricultural cultivation.

Figure 4: Characteristics of Traditional Farming [9]

2) Advantages and Disadvantages of The Traditional Farming:
These days, farming can take on an unlimited number of sophisticated, high-tech ways, each with countless advantages and disadvantages [10] of traditional farming are shown in Table 3.

Advantage and Disadvantage of Traditional Farming	
Advantages	**Disadvantages**
1) No need of the Artificial fertilizers, we can use the natural manures like vermicompost, cow dung manure. 2)Because they are pure, they can be sold for more money.	1) Compared to high-tech farming, traditional farming requires farmers to spend mostly approximately 15 hours harvesting the crops. 2) More number of labors need to involve in harvesting.
The cultivatable land is easily suitable for the multicrop method, as we only using the natural fertilizers.	The majority of the time is spent in decomposition. Additionally, these increase the likelihood of soil disease affecting the crops.
The spending cost to grow the crop is low in traditional method.	More number of labors need to involve in harvesting.
After decomposing, the crop waste can be used as fertilizer for the soil.	Wastage of wateraffects the environment as Depletion of soil nutrients, Deforestation, Soil erosion.

Table 3: Advantages and Disadvantages of the Traditional Farming [10].

Background of Smart Farming
The output of ancient agriculture is deficient in the use of information and technology, which have become pervasive in business and many areas of life [10] - [15].Quick action is required to protect the crops from pests, a lack of nutrients, an abundance of water, the need for fertilizers and light, etc. Together with rising chemical prices and growing concerns over agriculture's impact on surface and groundwater quality. Additionally, they must be forced to use limited resources to meet a 50–70% increase in the demand for food on a global scale. Also necessary is the transformation of agricultural systems into highly profitable and resource-efficient ones [16].

Crop stress levels are tracked and identified, which helps Aggrotech create healthy crops and boosts output. Utilizing techniques and technologies, smart agriculture [17] identifies in-field soil and crop variability in order to enhance farming methods and maximize agronomic inputs [17]. The authors of [18] conduct a thorough assessment of the literature on institutional aspects of climate-smart agriculture by looking at 137 research publications that were published between 2001 and 2017 in total, along with a few from 1996 to 1998. A capable analytical technique is required to examine, process, and analyze this enormous volume of data in order to obtain trustworthy information for accurate predictions and to create intelligent agricultural environments that can boost production.

An emerging idea is smart farming (SF), sometimes known as smart agriculture. This refers to how farmers use IoT (Internet of Things), sensors, robotics, drones (Unmanned Aerial Vehicles, or UAVs), AI (Artificial Intelligence), and Apps (Applications) to manage their farms and increase the quantity and quality of their products while reducing the need for human labor. The benefits of SF are:

- Every farm is examined to determine the best crops and water needs for optimization.
- Farms' various zones can be identified using satellite images.
- Early detection and cost-effective application to the afflicted area only.
- Prediction and analysis of the weather.
- The availability of field and financial data in one location, displaying profits, yields, and patterns with straightforward reports.
- Providing security and reliability for suppliers and consumers.

By making agricultural goods beneficial to people, modern technology, information, and communication are applied to increase the number and quality of products [19]. As depicted in Figure 5, various technologies [20] are used in smart farming. Sensors (for controlling water, soil, light, humidity, and temperature), software (for specialized farm software solutions), connectivity (for cellular), location (for GPS and satellite), robotics (for contemporary tractors), and data analytics (data channels for downstream solution).

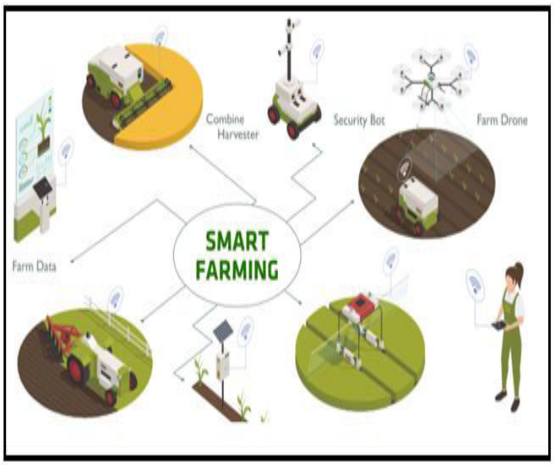

Figure 5: Smart Farming [19]

Various Technologies Around Smart Farming

Smart Farming (SF) is the application of ICT (Information and Communication Technologies) in agriculture. The development and marketing of cutting-edge technologies to help farmers on the ground is being driven by data obtained and analyzed using ICT methods to support efficient production processes [21]. This work is being done by researchers, practitioners, commercial, and public businesses.

The potential of unmanned aerial vehicles (UAVs) for aerial images and actuation, the employment of agricultural robots, a significant amount of sensor node data collection, and satellite imagery are the most pertinent technologies and approaches, according to the European Union (EU). The statement of collaboration on a smart and sustainable digital future for European agricultural and rural areas, which was signed in April 2019 by 24 EU countries, contains those indications.

1) IoT (Internet of Things) And Sensors in Smart Farming:

a) IoT (Internet of Things):

Internet of Things (IoT) is beginning to have an impact on a range of sectors and businesses, including manufacturing, health, communications, and agriculture, in order to reduce inefficiencies and improve performance across all markets.[22] – [25]. Sensors or other devices that communicate with the cloud via network protocols make up an IoT system (Wi-Fi, Cellular LoRa WAN, Zigbee, Z-wave etc.,).Open-source software tools are used for developing IoT applications i.e., Device Hive, Kaa, Arduino, Rasberry Pi, Home Assistant, Device Hub etc., [32].

A radio navigation system that depends on satellites is the Global Positioning System (GPS). The Global Positioning System does not require data transmission from the user and is not dependent on cellular or internet reception to function. Globally, the GPS offers vital positioning capabilities to users in the military, civic, and commercial sectors. Databases and software that run on servers that can be accessed via the Internet are referred to as being in the "cloud." Cloud servers are housed in data centers all around the world. The Internet of Things (IoT) technologies are essential to many agricultural applications. This is due to the capabilities of the Internet of Things (IoT), which include the basic communication infrastructure (used to connect smart objects, such as sensors, vehicles, and user mobile devices using the Internet), as well as a number of services, like local or remote data acquisition, cloud-based intelligence, and agriculture operation automation. Such capabilities have the potential to change the agriculture sector, which is now one of the least efficient in our economic value chain [26].

Figure 6 demonstrates the need for IoT system optimization for greenhouses, which is well acknowledged by academics [31]. sensors with care, data collection, optimization, setting the appropriate parameters, and rule-based control [27 - 29]. It can be challenging to regulate every parameter in a smart greenhouse, including pressure, humidity, CO_2, rain, pH, moisture, insecticides, and temperature [30], especially when there is a dearth of historical data.

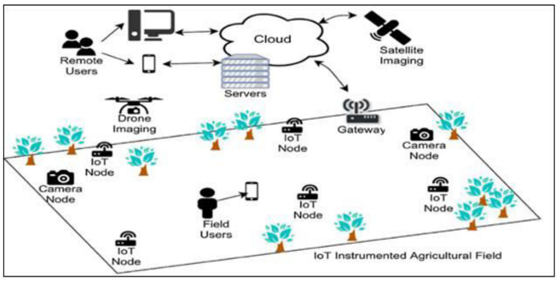

Figure 6: Core aspects of IoT-based systems for smart greenhouses [29] (Reproduced with permission from (Elsevier)from Popovic et al. (2017))

Smart farming developments are shown in Figure 7, where cloud service providers have an advantageous way to obtain computer services and provide their own infrastructure. Cloud services that have been certified are available from companies like Amazon Web Services (AWS), Alibaba Cloud, Google Cloud Platform (GCP), IBM Cloud, Microsoft Azure, Oracle Cloud ,and others. When data reaches the cloud, software processing [32] it and decides whether to take a certain action, such alerting a user or automatically altering a sensor or equipment.

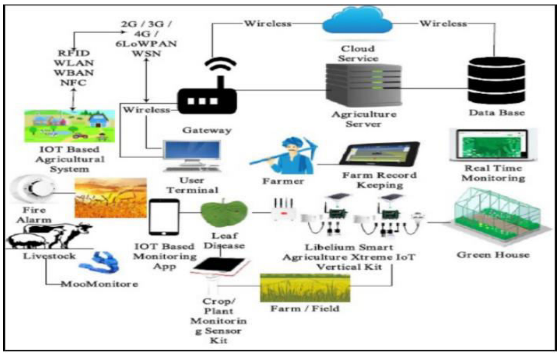

Figure 7: Smart Farming Trends [32]

Precision farming (PF) and automation in smart greenhouses are the two main aspects of agriculture that IoT can transform.

i. Precision farming[38]: Also known as precision agriculture, enables decisions to be made per square meter, or even per plant or animal, rather than for an entire field. Farmers can make insecticides and fertilizers more effective or use them sparingly.

Automation in smart greenhouses: Greenhouse gases are gases that trap heat in the atmosphere. Production loss, energy loss, and increased labor costs are the effects of traditional greenhouse management. The best results for controlling water vapor, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, etc. are achieved by IoT-driven smart greenhouses.

Sensors

Sensor is device that detects the change in the environment (soil, water, light, temperature etc.,) and responds to some output on the other system. Agriculture sensors are those that are utilized in smart farming [32]. In order to monitor and improve crops in response to shifting environmental conditions, farmers might use the information provided by sensors. They are precisely controllable by mobile apps created for agricultural purposes. Drones, robots, and sensors installed and fixed in weather stations are all employed in agriculture. sensors for agriculture with wireless connectivity. With the use of mobile phone applications, they can be managed directly through wi-fi or via cellular towers.

There are numerous sensors that are used in the agricultural sector. Some of these are depicted in Figure 8: (i) Optical sensors (can identify clay, organic matter, and soil moisture content); (ii) Electrochemical sensors (for identifying soil nutrients); (iii) Dielectric soil moisture sensors (which measures soil moisture levels); (iv) Mechanical soil sensors (when a sensor slices through soil, it measures the holding forces brought on by the soil's cutting, breaking, and displacement);and (v) Location Sensors (can identify range and distance a sensor is from.

Figure 8: Sensors in Smart Farming [33]

Robotic In the Smart Farming:

Smart farming is the practice of integrating technological advancements like big data, machine learning, AI (Artificial Intelligence), robotics, drones, cloud computing, and the Internet of Things (IoT) into various stages of manually operated, mechanically operated, and mechanized operations throughout the entire crop production cycle. The advent of drones, self-driving tractors, robotic seeding and harvesting, and drip/sprinkler irrigation is increasing the automation of simpler and more routine operations, claims in-depth research [34].

Agricultural Robots (AgBots), as depicted in Figure 9, are utilized in a variety of applications, including planning, watering, harvesting, and sorting crops. The successful integration of all these AgBots through a robust network of intelligent sensors created by IoT will ultimately be the key to farm automation [34].The ability of all the systems, tools, and devices to communicate with one another in real-time and dynamically is essential to a genuinely "smart" farm. Maintaining an appropriate interface with human orders while allowing autonomous operation to continue. From a bullock-driven to a self-driving tractor, from manual sowing to automated aerial seed distribution, from flood irrigation to drip feeding, from manual weeding to self-applied pesticides, and from manual picking to auto-applied pesticides.

Figure 9: Precision Agricultural Robotics [35]

There are numerous benefits of using Agriculture Robots (AgBots). (i) Protection of human workers, (ii) study work flow, (iii) reduced wastage of farm inputs, (iv) boost efficiency in the agriculture process, (v) reduced cost farming.

Unmanned Arial Vehicles (UAV) – Drones:

Agriculture is one of India's key industries. A farmer cannot control these natural elements, which include temperature, humidity, rain, and other conditions that affect crop output. Agriculture also depends on a number of other elements, such as pests, diseases, fertilizers, etc., which can be managed by treating crops properly [36].

Unmanned aerial vehicles, or drones, have been in the news for more than a decade. Growing drone use in the agricultural sector has significantly improved operational efficiency for farmers all over the world. Currently, tracking and distribution are two common agricultural applications where drones are used [37]. 1) Both plant and livestock farmers employ tracking (and subsequent analysis) to better understand the condition, resources, and output of their farms. 2) Physical resource movement around a farm is involved in distribution using drones, including the application of agricultural agents like pesticides, fungicides, and fertilizers [37].

Drone Technology quickly reestablishes traditional agrarian practices and is subsequently accomplishing them as best drone practices as shown in figure 10 as follows [37].

1. Irrigation Monitoring
2. Crop health monitoring and surveillance
3. Crop damage assessment
4. Field soil Analysis
5. Planting
6. Agricultural Spraying
7. Livestock tracking

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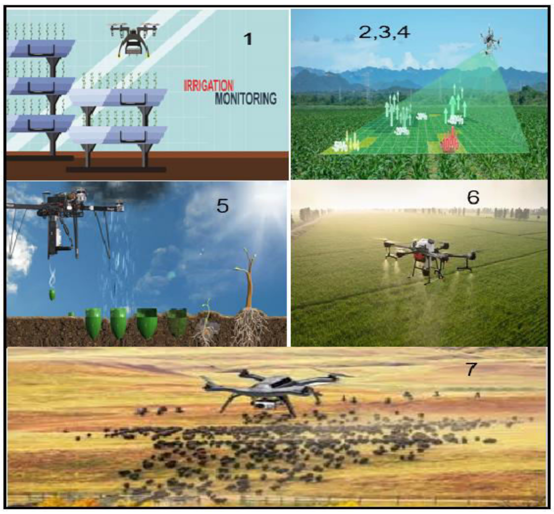

Figure 10: Best Drone practices [37]

In agriculture, drones have a plethora of advantages. (a) Enhance protection, (b) greater safety of farmers, (c) less wastage of resources, (d) efficient and accuracy rate results, (e) useful for insurance claims, (f) evidence for insurance companies.

AI (Artificial Intelligence) In Smart Farming:

Artificial intelligence-based technologies [39] enhance agriculture by enhancing conventional farming's productivity and removing the obstacles and disadvantages that traditional farmers must contend with. Artificial intelligence (AI) is the process through which people create synthetic devices that resemble human brains but are able to process larger amounts of data than the brain. Although AI and computer science are strongly associated, its use in agriculture should go beyond this field [40].

A wide range of technological gadgets and instruments have been developed using AI and have been tested and improved on agricultural fields. Figure 11 depicts some of the field-steps of agriculture that they have developed successfully. These include 1) soil testing, weeding, 2) pesticide control, 3) treating diseased crops, 4) insufficient irrigation to meet crop needs, 5) post-harvest activities like storage management, 6) optimizing storage parameters, etc. Farmers have boosted both the quantity and quality of their output [41].

Contrarily, AI can be used in agriculture to reduce environmental concerns brought on by unfavorable agricultural operations, such as the a) high use of pesticides, b) uncontrolled irrigation leading to water loss, and c) water pollution with fertilizers.

Both of these problems would be solved by the application of AI [40]. Utilizing AI-based technology is primarily intended to decrease the amount of work necessary to provide the desired output. Additionally, AI-based gadgets can readily respond to queries that people are unable to address because of their capacity to collect and analyze vast quantities of data from official websites and real-time field data. They can then offer solutions to issues that, if produced by people, would require a lot of effort and sophisticated knowledge. As these AI technologies require training with the biological skills of the farmer and vice versa, farmers who possess the requisite capabilities will also need to acquire instruction in these AI technologies [41].

The first step in incorporating AI into any industry is machine learning. The necessary data must be supplied in a machine-readable manner, and the processed result must be communicated in a language that is understandable to humans. The AI-based system should be able to obtain data from the designated databases as it processes the inputted data to address the current issue. Sometimes the AI may need real-time data to reach a decision, in which case the AI should be knowledgeable enough to comprehend the real-time parameters. Making decisions concerning the farming season requires careful consideration of weather forecasts [41].

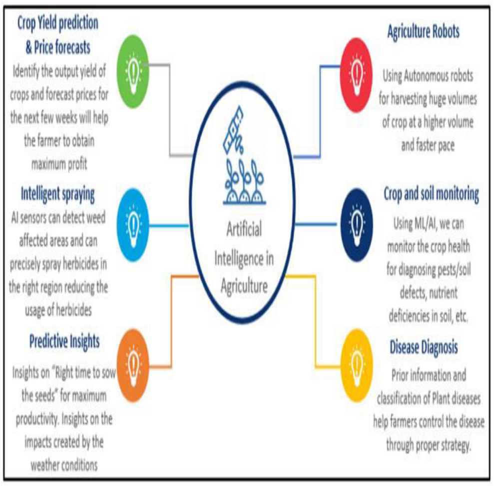

Figure 11: Artificial Intelligence (AI) in Agriculture [42]

Four techniques are used to solve problems: (i) Neuro-fuzzy logic; ii) fuzzy logic; iii) expert systems; and iv) Artificial Neural Networks (ANNs) [40]. When developing AI-based technology, ANNs are most frequently used. A machine-based ANN mimics the functions of the human brain. Electric signals go via neurons in the brain via axons and synapses. AI is used in the following areas: crop or seed selection, crop management techniques, yield prediction, insect and weed control, product storage and marketing [41], [43 – 46].

Farming Apps for Indian Farmers:
Rural India is currently making significant technological and digital transformations. By 2020, 48% of India's population would reside in rural areas, according to the Boston Consulting Group's study, "The Rising Connected Consumer in Rural India". Additionally, 58% of Indian households still rely on agriculture as their primary means of subsistence [47]. Additionally, the most practical and helpful tool for assisting farmers in farming is farming applications.

It provides you with instructions for conducting good scientific farming, crop cultivation, sowing, or vegetable harvesting. Farmers may simply resolve any issues that cause them difficulty in their farming operations, such as pest or insect attacks.
The farming apps are highlighted in Table 4. In farming, apps can be a farmer's best friend because they can increase output without costing any money at all. A farmer can easily download and utilize a farming software from the Google Play store without spending a single rupee, as shown in Figure 12 [47].

Agriculture Apps	Applications
Krish-e	gives farmers a customized crop calendar in addition to practical agricultural knowledge on topics like irrigation, weed control, pest and disease management, fertilizer management, seed care, and crop diagnostic and planning.
IFFCO Kisan Agriculture	Farmers have access to a variety of instructional modules throughout the profiling stage, including agricultural warnings, weather, market prices, and libraries of agriculture material in the form of text, photos, audio files, and videos in the selected language.
Pusa Krishi	Farmers can learn about novel crop varieties developed by the Indian Council of Agriculture Research (ICAR), resource-saving cultivation methods, and farm machinery and how to use them with this app.
Agri App	It offers thorough details on agricultural production, crop protection, and other pertinent auxiliary services. In addition, there are options for professional discussion, video-based learning, the most recent news, and online markets for pesticides, fertilizers, etc.
Crop Insurance	For farmers, it acts as a calculator and a reminder about their insurance. It can also be used to find out the normal sum insured, extended sum insured, premium information, and subsidy information for any crop that has been notified in any notified region.
Kheti-Badti	It strives to encourage and promote "Organic Farming" and offer crucial details about difficulties affecting Indian farmers.
Agri-Market	Using the Agri-market Mobile App, farmers can learn about crop prices at markets located within 50 kilometers of their own device location.
Shetkari	It offers expertise and information on government programmes, crop management, Agri-Business & regulations, market prices, and agricultural success stories.
Kisan Suvidha	It offers details on the present weather as well as a five-day prediction, market rates for goods and crops in the nearby town, and knowledge of fertilizers, seeds, machines, etc.

Table 4: Best Agriculture Mobile Apps for Farmers in 2022 [47]

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Figure 12: Farming Apps used by Indian Farmers [47].

Advantages and Disadvantages of Smart Farming

Interestingly, farming has evolved into a far more intriguing art form than it once was in the modern agricultural world due to the steady expansion in the invention and development of extremely complex equipment and tools to make the growing process much easier. Today, technology and agriculture are integrated very easily. High-end technology makes it simple and enjoyable for farmers to grow their plants, care for them properly, and eventually harvest them in great amounts without suffering any loss. Smart farming does, however, have advantages and disadvantages, just like anything else [48].

Advantages and Disadvantages of Smart Farming	
Advantages	**Disadvantages**
Data collection with smart agriculture sensors, better control over the internal processes.	Internet access must be available constantly for smart agriculture.
1. Waste reduction and saves time. 2. Precision farming and remote monitoring.	The majority of rural communities in developing nations do not meet this requirement. The speed of the internet is also slower.
Effective cost management, increased business efficiency.	Farmers' lack of education. This is a significant obstacle to the widespread adoption of smart farming across all nations.
Increase high quality crop production, makes transportation easy.	Hight maintenance cost.
Water supply easy, which reduces the efforts of the farmers.	Better sensors only would help.
1. Increase the soil's fertility. 2. Determine the crop's level of maturity. 3. Determine the growth stage and higher accuracy rate.	Robots could change the culture / emotional appeal of agriculture
Electricity costs are reduced via mobile and solar-powered pumps.	Sensors require solar energy power.

Table 5: Advantages and Disadvantages of Smart Farming[48]

Ref. No	Outcome of the Paper	Future Scope
[1]	1. Trends in agriculture and forestry's supply and consumption. 2. How climate change will affect peatlands, grasslands, and croplands. 3.Tradeoffs and connections between biodiversity, food, water, and the land.	Implement several potential landscape change ideas in the future across all regions.
[3]	1. Created a system that uses RGB-D cameras or laser scanners to quickly analyze the state of the soil. 2. Described a method for analyzing soil properties based on eyesight.	1. Focus on putting the sensing component on an unmanned aerial vehicle (UAV) and switching the Xtion Pro sensor for the newest Kinect v2.0, which has a higher resolution and won't obstruct typical light emissions. 2. The UAV's inertial unit and sensor fusion can be used to integrate the reorientation.
	1. WSNs with solar energy harvester nodes were equipped with a new Distributed CDS	1. In order to increase the network lifetime,

[4]	(Connected Dominated Sets) algorithm to increase their lifespan when utilized in precision agriculture applications. 2. The algorithm simulation findings also suggest that variances in the outcomes of different simulations are caused by the placements of harvester and ordinary nodes, the neighbors, and the residual energy levels.	the cut vertices in the topology of the network should be kept active for as long as is practical. 2. As a result, in future development, variables like cut vertex identification and choosing them as harvester nodes will be taken into account.
[10]	1. Several advantages, uses, and difficulties of IoT in agriculture have been noted in this research. 2. Additional considerations include the IoT (Internet of Things) Ecosystem and the role established by various communication technologies in the deployment of IoT system. IoT and DA (Data Analytics) together enable smart agriculture.	1. One significant topic that is anticipated to draw a lot of research attention is the application of LPWA (Low Power Wide-Field) communication technology for agricultural uses. 2. Among the LPWA technologies, the NB-IoT (Narrow Band-IoT) is anticipated to stand out. This is due to the 3GPP open standard and telco firms' adoption of it.
[11]	1. Ascalable network architecture for managing and monitoring agriculture and farming in remote areas has been found. 2. Examined the network topology based on performance, latency, and coverage area.	In the future, it will be crucial to identify threats, protect user privacy, and secure individual devices so they can interact on their own through networks like the Internet, fog, and clouds.
[12]	1. This article describes the architecture of agricultural sensor systems and shows how, depending on the application domain, intelligence levels change. 2. Wireless Sensor Network for intelligent agriculture system. 3. Data Analytics into Farm-based WSN System, its benefits and challenges.	The deployment of several WSN systems on every farm in the future will provide an integrated environment that will cover a variety of farm management functions. Future farming will be improved with the use of clever understanding gathered from the settings.
[13]	1. This article discusses leading research initiatives, standards and technologies, platforms, and recent advancements in wireless sensor network technology. 2. In addition, a recent development in WSN research that looks at the interplay between sensor networks and other technologies demonstrates how this can help sensor networks realize their full potential.	It will be important in the future to look into more security-related issues, such as the assessment of security-related energy consumption, data assurance, authentication level and kind of security required, and QoS-security evaluation.
[14]	1. It goes over how the Extended Kalman filter (EKF) is used to separate the system state from the associated noisy measurements, such as the temperature and moisture levels of the soil that have been identified. 2. In addition, each crop's suboptimal irrigation water use is proactively calculated based on the crop's needs, the anticipated system status, and the soil conditions. 3. When the simulation results are compared to those of other conventional irrigation schemes, it shows that the proposed OHI (Optimally Heterogeneous Irrigation) approach improves water utilization, satisfies the needs of heterogeneous crops, manages various soil types, prioritizes crop classes, and ultimately increases crop yields.	A random bit climbing optimization technique will be applied in the future to enhance more optimizable results and predict the suboptimal water volume for each place.

[15]	1. The advantages of employing thermal imaging in smart irrigation are discussed in this research. Implementing automated irrigation powered by the cloud. 2. The Applicability of Temperature Distribution Measurement in Thermal Imaging Irrigation Security and regulatory issues.	It is difficult to create legislative and regulatory frameworks that are adaptable enough to keep up with the complex and continuously changing technical and danger landscape.
[16]	1. A wide range of national approaches to agricultural development and associated pollution are found in this paper's historical analysis of agricultural nitrogen-use efficiency (NUE). 2. In addition, examples of nitrogen consumption were looked at, and goals were suggested per crop type and area in order to meet the Food and Agriculture Organization's projected 2050 world food demand.	For additional benefits, other technological developments may be necessary, including more affordable slow-release fertilizers, nitrification and urease inhibitors, fertigation (the administration of fertilizer via irrigation water), and high-tech techniques for precision agriculture.
[17]	1. The research addressed here examines the state-of-the-art and potential uses of thermal remote sensing in PA (precision Agriculture). 2. Potential uses for thermal imaging in PA include crop maturity mapping, yield estimation, soil property mapping, residue cover and tillage mapping, plant disease identification, and plant water stress monitoring.	Its usage is complicated by a variety of practical issues, including as air attenuation and absorption, calibration, meteorological factors, crop growth stages, and intricate soil-plant interactions.
[18]	1. The interest in institutional views of CSA (Climate Smart Agriculture) technologies is demonstrated in this research. 2. Although the study recognizes the significance of some institutions (such as the market) in the adoption of CSA technology, other viewpoints, such as the involvement of the private sector in agricultural development, have received less attention.	1. In the future, the institutional and political aspects of CSA technologies require additional focus. Rethinking this strategy for CSA technology promotion, which builds on institutional enablers as well as technology packages, may offer chances for efficient CSA option scalability. 2. Improving the layout of CSA research and supporting policy need this understanding.
[20]	1. A number of control strategies for automating agriculture are reviewed in this study paper, including Internet of Things (IoT), aerial photography, multispectral, hyperspectral, NIR, infrared, and RGB cameras, as well as techniques for machine learning and artificial intelligence. 2. Additionally, various automated and control approaches make it simple to address issues in agriculture such plant diseases, pesticide control, weed management, irrigation, and water management.	In order to modernize agriculture, there are goals to provide a potential road for further research into advanced control systems. Systems are more effective when they use architectures based on artificial intelligence.
[21]	1. According to this study, smart farming can offer a concerted exit from locked-in technologies and practices that are characterized by high market segmentation and polarization.	In the future, both proponents and

	2. And also discusses how ICT (Information and Communication Technologies) and data management can open up new pathways to a successful, socially acceptable agriculture that benefits species diversity, the environment (such as soil, water, and climate), and farmers by using proactive policy development to support the essential legal and market architecture for smart farming.	opponents of farming technology will need to carefully evaluate new ethical dilemmas.
[22]	1. This study provided an overview of the burgeoning IIoT technologies, which offer continuously improving industrial connectivity. 2. Concentrated on outlining its architecture, a number of technologies, and the protocol ecosystem that is developing as a result of standardization activities.	The high sensitivity of the managed information presents security concerns for the IIoT.Additionally, it must be reliable and available for long periods of time.
[23]	1. Wireless sensors and their applications are the main topic of this study. The findings act as a trial run for locating fresh research problems. 2. A wealth of sensor-based prototypes offers a clear road map for expanding the use of wireless sensors.	1. To address new difficulties, such as extended battery life and material robustness in the face of harsh and inhospitable conditions, new improvements of wireless sensors are necessary. 2. It is certain that many of the limits will be resolved in the near future given the present advancements in sensor manufacturing processes and the rise of multidisciplinary research and development.
[24]	This research paper examines IoT topologies, including the traditional three-layer architecture and the SoA-based four-layer architecture, as well as supporting technologies, security and privacy issues, in order to support a variety of applications.	Additionally, smart cities can benefit from effective sub-applications and services made possible by the fog/edge computing-based IoT.
[25]	1. This study reviews the most recent developments in IoT deployment for applications related to protected agriculture. 2. It also focused on the importance of sensor, data communication, cloud, edge, and machine learning (ML) IoT technologies in protected agriculture.	1. Protected agriculture should be the focus of IoT's future potential. 2. To adapt to the complex and shifting agricultural environment, hardware devices must be substantially modified to further increase their universality, dependability, expansibility, endurance, and intelligence level while reducing costs and operating challenges.
[26]	1. This article discusses the possibilities of wireless sensors, IoT in agriculture, and the difficulties that should be anticipated when fusing the technology with conventional farming methods. 2. Available sensors for various agricultural applications are given, including soil preparation, crop condition, irrigation, and insect and pest detection. 3. An explanation of how technology assists farmers at all crop-related stages,	IoT developments for agriculture in the future are highlighted, along with prospective research obstacles.

	including planting, growing, harvesting, packaging, and transportation. Additionally, crop observation using unmanned aerial vehicles (UAV).	
[27]	1. This paper assisted in gathering the actual soil and water moisture levels from the greenhouse and tank using IoT devices. 2. 2. The creation and use of an objective function that uses user-specified parameters, system limits, and data from real-time sensing to determine the ideal soil and water moisture levels for a greenhouse and tank. 3. To save energy, water pumps were turned on with the required flow rate and runtime using a rule-based expert system. 4. Several experiments are performed to establish the ideal water and soil moisture levels in a real greenhouse and water tank setup.	The proposed system will be tested and developed for actual greenhouses and water tanks in future work, along with the consideration of additional environmental parameters and their control.
[28]	1. In this study, an unique optimization strategy that intends to achieve a trade-off between energy consumption and desirable greenhouse environment settings, including temperature, CO2 level, and humidity, was given. 2. In addition, performance evaluation has been demonstrated, and an impromptu emulation of the greenhouse environment has been created. 3. Other greenhouse climate-related factors, such as lighting intensity and watering schedule, can be accommodated by the system. with aplomb.	In order to achieve energy efficiency, extend this model by taking into account additional crucial greenhouse characteristics and conduct a thorough experimental examination of the suggested model in an actual setting.
[29]	1. In this article, the end-user needs have been determined using a collection of high-level scenarios that describe the situation and show why the platform was built. 2. The system is in the process of being utilized to prototype end-user analytical functionalities and will be used for data collecting. 3. The case study explains how the platform was used in practice and the lessons learned.	1. More work is planned to provide support for more IoT protocols (MQTT, CoAP), as well as a more complex interface with Open-Source programming languages like R and Python, in order to improve the solution and give it full data analytics capabilities. 2. Future work will also focus on developing metrics and thoroughly evaluating performance, scalability, and reliability through experiments.
[30]	1. This study discusses smart farming with IoT using the Preferred Reporting Items for Systematic Reviews (PRISMA) methodology. 2. The main goals of this study are to define the most important IoT tools, platforms, communication standards, data processing methods, and agricultural applications of smart farming.	1. Future research could build on this study by incorporating other pertinent publications and supplementary analyses of project costs, usability, and regional problems unique to IoT applications. 2. Examining the use of edge and fog computing in smart agriculture as a way to overcome problems with conventional centralized cloud systems, such as excessive

		connection latencies, could be another significant future research path.
[31]	1. By removing obstacles to the widespread commercial adoption of IoT systems, this paper explains how IoT can help agriculture combat the negative effects of climate change and global warming by optimizing crucial parameters like temperature and humidity, intelligent data acquisition, and rule-based control. 2. In addition, technology has helped to develop sensors over time for preventing frost, remote crop monitoring, preventing fire hazards, precisely controlling nutrients in soilless greenhouse cultivation, achieving power independence through the use of solar energy, and intelligently controlling feeding, shading, and lighting to increase yields and lower operating costs.	1. 1. The IoT application's reducing cost in optimizing the greenhouse microclimate prevented smallholder farmers from commercializing the technology. 2. Make use of cutting-edge technology, such as the LEO constellation, to help provide global broadband internet coverage in rural locations. This will assist in removing the infrastructure and financial obstacles to the broad deployment of IoT in commercial agriculture.
[32]	1. 1. This article has suggested agricultural solutions based on embedded systems, IoT, and wireless sensor networks for Agri-farm fields and livestock farms. 2. It also contains a description of the systems' electronic circuitry as well as information on the network protocols that are utilized, smart remote monitoring software for PCs and smartphones, etc.	Future applications of pertinent technology in smart agriculture.
[34]	1. Using more robotics, IoT, and Artificial Intelligence (AI) applications, this study highlights several agricultural activities and elements that can be automated or already are. 2. Modern greenhouse techniques, a workforce that is robotic and autonomous, drones, and the “connected farm” are also mentioned. Agriculture industry automation after COVID-19.	Future perspectives are covered, including significant technological advancements centered on “connected farms,”“smart farming,”“precision agriculture,”“vertical farming,”“new greenhouse methods,” and “autonomous and robotic workforce.”
[36]	1. This study explains the issues with food regulation, agricultural tracking technology, and greater agricultural manufacturing. It is conceivable to unveil the agricultural system on a large scale with the aid of intelligent drones and the most recent satellite picture statistics. 2. How to apply A major examination of a significant place harvest is conducted in conjunction with the department of vegetation and planting using the most recent satellite television information as a concept.	Given that 60% of the agriculture sector may decide against having a drone in the future, the future of the current generation appears bright.
[39]	1. The smart technologies, AI, IoT, and robotics used in this paper's advanced farming applications can be very helpful to farmers. 2. These technologies have lowered the amount of manpower required for the processes, which has decreased the number of errors caused by humans and optimized the processes, leading to high production efficiency and high yield.	Future research and development are required to address the drawbacks of these sophisticated farming methods.

[40]	1. Artificial intelligence has been used in this paper to choose crops and assist farmers in choosing fertilizers. 2. 2. The machine talks to itself to decide which crop is ready for harvest and which fertilizers will encourage the fastest growth. The database that the user has collected and provided to the system is used to do this. 3. Using deep learning gives machine learning an edge over it and gives it more depth.	1. The growing need to conserve agricultural land and the numerous flaws in this system drive the development of farm automation. 2. This study provides a proposal to create a system using sensors, IOT, and machine learning to automate the traditional agricultural operations in the future for the advancement of farm automation.
[41]	1. Technology can help to address performance issues such inefficient irrigation systems, weeds, difficulties with plant monitoring due to crop height, and issues with extreme weather. 2. It can be enhanced with other AI-driven techniques, such as automated watering using GPS and remote sensors to determine soil moisture content. 3. Farmers have to deal with the issue of precise weeding methods defeating the significant number of crops lost during the weeding process. 4. These self-driving robots not only boost productivity but also reduce the need for unnecessary herbicides and insecticides.	1. Nevertheless, each implementation requires a substantial amount of data that is difficult to gather because the production process only happens a few times a year. 2. In the future, farmers integrate AI to bring a digital revolution to agriculture as a way to adapt to the changing environment.
[43]	1. The goal of this review was to investigate how seed vigor and crop output relate to one another. If plant populations fall below a certain level, yield reductions may be indirectly attributed to poor seed vigor. 2. Annual crops were separated into types that were gathered at various stages of growth, including vegetative growth (eight species), early reproductive growth (four species), and complete reproductive maturity (nine species).	Utilize more Vegetative growth is impacted by seed vigor, which is frequently correlated with yield in crops harvested vegetatively or in the early stages of reproductive growth.
[44]	1. The main goal of our research was to present data on the usage of automated monitoring and controlling methods in aeroponic systems. 2. The system might produce a great set that motivates people who wish to live in cities to live sustainably. 3. The aeroponic system has amazing prospects to improve its capacity, dependability, and accessibility among farmers and producers.	The method offers a variety of data that plant scientists may need in the future to better understand how various environmental and nutritional characteristics connect to plant growth.
[45]	1. This research looks into machine learning-based yield prediction. 2. The most popular models are gradient boosting trees, neural networks, linear regression, and random forests. In the majority of the research, different machine learning models were tested to see which one made the best predictions.	Aim to build on the findings of this study and concentrate on creating a crop yield prediction model that is DL (Deep Learning) based in future work.
	In order to accurately spray on the desired	1. Future algorithms (variable rate technology, or VRT) will be

[46]	target/location and separate target weeds from non-target objects (such as vegetable crops), a smart sprayer was developed using machine vision and artificial intelligence. This reduces increased costs, crop damage risk, pest resistance to chemicals, environmental pollution, and product contamination.	developed to modify the quantity of chemicals utilized based on the size of the weed canopy and the speed of the moving vehicle (measured from multiple sensors e.g., GPS, odometer, radar). 2. For the VRT component of the smart sprayer, a sensor fusion algorithm will also be developed. In commercial produce fields, the smart sprayer's skills for precise weed control will also be put to the test.

Conclusion and Future Scope

In a nation's economy, agriculture is crucial. In this essay, we thoroughly examined the role of the farmer, various agricultural practices, different types of Indian farmers, traditional farming practices themselves, as well as the benefits and drawbacks of traditional farming in India. Traditional agriculture production lacks the knowledge and technology that have been widely used in commerce and other areas of life.

In this work, numerous smart agricultural technologies developed by diverse researchers are reviewed. Aggrotech can develop healthy crops and increase production by leveraging technology such as IoT, Sensors, Robotics, Drones, Artificial Intelligence, and farming mobile apps used by Indian farmers. The chosen papers are for monitoring and identification of the stress level crops. Numerous agricultural applications, such as yield estimation, crop sowing dates, crop land monitoring, land surface temperature, irrigation forecast using satellite images, agriculture greening, prediction of water dynamics in the soil, elimination of slavery and human trafficking from space, and disaster management support, all greatly benefit from technology. These applications have been thoroughly studied to understand their significance in achieving global sustainable goals.

The Internet of Things (IoT) used in precision farming, automation in smart greenhouses, and sensors give data that aids farmers in crop monitoring and environmental condition optimization. Throughout the whole crop cycle, from planning and watering through harvesting and sorting, agricultural robots (AgBots) are used. Utilizing unmanned aerial vehicles (UAVs) significantly improves farmers' operating efficiency in the agricultural sector. To reduce environmental concerns brought up by undesirable agricultural practices, artificial intelligence (AI) can be used in agriculture.

Additionally, the most practical and helpful tool for assisting farmers in practicing the correct scientific method of farming is a farming app. It has been noted that the quality and quantity of technology available for smart farming is expanding quickly. The scope of this study will eventually be expanded to include identifying various cyber-attacks on IoT devices, communication networks, robotics, drones, the cloud, the edge, etc.

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