Agriculture 5.0: Future of Smart Farming

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***Abstract*—: As we all well know about the industrial revolution. Similarly, the revolution also started in the agricultural field and headed towards advan cement in technologies. Basically, the purpose of writing this review paper is to understand the agricultural revolution and which technique should be adopted in agriculture. Nowadays the use of AI (Artificial intelligence) and IoT (Internet of Things) is increasing and the use of these types of technologies made farming smarter and better. By using smart technologies farmer can improve their crop production as well as saves time. Due to the traditional way of farming, farmers are unable to get more crop production and they are unable to find a proper solution due to a lack of information and other required things. But with the help of AI and IOT farmers can get all information required in just one click. In order to promote the development of long-term agricultural alternatives, it is necessary to invest in technology innovation. The internet of things, sensors and sensor networks, robots, artificial intelligence, cloud computing, big data and other disciplines are all helping to speed up the transfer to agriculture 4.0. Agriculture 5.0 is the way smart farming will be done in the future. During that time, unmanned farming will become more common, which will be beneficial when labour is scarce.**

***Keywords*—** Agriculture 5.0, AI (Artificial Intelligence), IoT (Internet of Things), Smart Farming

1. INTRODUCTION

Agriculture has progressed from 1.0 to 4.0, as indicated in Fig.1, since ancient times for cultivating land and producing animals to obtain food for human existence. Agriculture has evolved over time in a gradual and methodical manner. Agriculture 1.0 ushers in the conventional agricultural age, which is based mostly on people and animal forces. Although rudimentary tools such as sticks, stones, and simple equipment were utilised for agriculture at this time, output was low due to a lack of labour.

The steam engine was discovered in the nineteenth century after the widespread usage of power, notably in agriculture. After then, in the period of Agriculture 2.0, farmers are attempting to use self-contained machinery. Agriculture 2.0 boosted efficiency and productivity, and a small amount of chemicals were utilised as a result. However, adverse impacts of chemical usage emerged in the twentieth century, including fields chemical contamination, environmental devastation, enormous power use, and natural resource wastage. Agriculture 3.0 began in the twentieth century as a result of the tremendous technological advancements brought about by the creation of computers. The computer operates with precision and accuracy. The introduction of computers brought automation into the scene. All computing techniques enabled agricultural machines to perform operations effectively and intelligently as a result of this. Whatever issues remain in Agriculture 2.0, they are completely resolved in Agriculture 3.0. The proper distribution of tasks to agricultural machinery reduced the usage of herbicides, improved irrigation precision, and so on. Agriculture 4.0 is now a reality, thanks to the use of cutting-edge technologies such as the Internet of Things, Big Data, Artificial Intelligence, Cloud Computing, and Remote Sensing. [3].

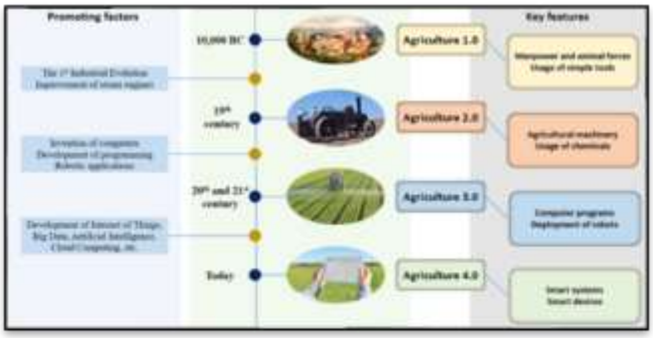

Fig 1 Revolution of agriculture [1]

Given the importance of agriculture in the Indian economy, smart farming became a must-have for farmers today [1]. Agriculture's transformation is solely dependent on clever farming methods, rapid acceptance of agricultural systems, and innovations in agriculture practices. In agriculture, AI allows the rapid uptake of diverse farming methods. Smart computing is a notion that uses a computer program to emulate the human reasoning. This leads in turbulence in Intelligence agriculture, with the system understanding, learning, and responding to diverse circumstances (depending on the gained knowledge) to make it more efficient. Farmers can be provided options via platform like chatterbots to reap advantages in the field by keeping up with latest innovations in the farming sector. [2].

Agriculture is progressively using AI, IoT, and robotics. As a result, farming has become easier and more advantageous to farmers' land cultivation. In the field of Smart Sustainable Agriculture (SSA), there is still a scarcity of research and development, which is accompanied by complex issues stemming from the fragmentation of agricultural processes, such as the control and operation of IoT/AI machines, data sharing and management, interoperability, and the storage and analysis of large amounts of generated data. As a result, this research first examines existing IoT/AI technologies used in SSA, and then establishes an IoT/AI technical architecture to underpin SSA platforms, in order to address fragmentation in conventional farming processes and enhance future intelligent agriculture research and innovation globally through the organisation of a Smart, Sustainable Agriculture forum as a remedy[4].

Warming trend has an impact on agricultural development. It may be easier to determine sensible outcomes in the excellent framing if the weather is observed using IoT technologies. Since it is the principal source of food grains and other crude resources, commercial activity is regarded as the cornerstone of life for the human species. It assumes critical function in the economic development of a country. It also provides them with a sufficient number of job opportunities. The advancement of the state's financial state is dependent on growth in a geographical region. Regrettably, many ranchers continue to cultivate using traditional methods, resulting in low harvest yields and organic products. Nevertheless, wherever mechanization had died and individuals had been replaced by programmable hardware, the productivity had increased. Then, in order to increase yield, contemporary research and innovation must be implemented within the commercial company environment. The usage of a remote sensing element network, which gathers data from many types of sensors and then communicates it to the principal employee by remote convention, is mentioned in a large fraction of the articles. The obtained data provides data on a range of natural factors, which aids in the framework's inspection. Assessing natural factors isn't a sufficient or full solution for increasing harvest output. Profitability is influenced by a number of different factors. [5].

As indicated in the graph above, agriculture has increased from 1.0 to 4.0. Agriculture, which accounts for more than 80% of India's land area, is becoming more simple and contemporary, which is excellent news for farmers. Using new emerging technology, we can continue to grow in the agricultural industry. But one thing is certain: in Industry 4.0, the farmer's adaptability should be enhanced.

2. LITERATURE REVIEW

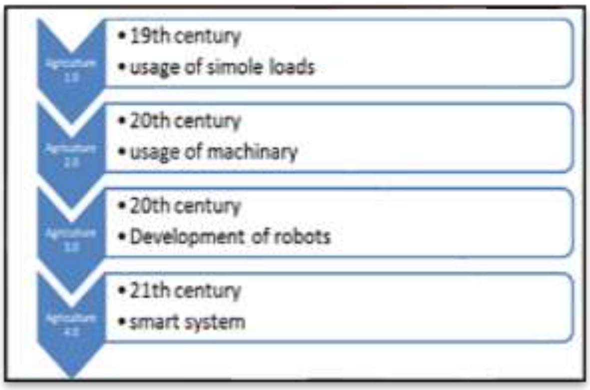

Fig 2 Century wise evaluation

The notion of precision farming was born out of the increased demand for information and communication technology (ICT) in agriculture applications. In this regard, innovative methods in agriculture have been developed and accepted, giving rise to the so-called Agriculture 4.0, based on the major aspects of the Fourth Industrial Revolution (Industry 4.0) championed by the European Community. Farmers may boost their output and distribute resources more efficiently because to advancements in automation, modern information systems, and Internet technology. Agricultural decision support systems (DSS) for Agriculture 4.0 have become a particularly fascinating research issue as a result of these factors. DSSs are interactive tools that help users to make educated choices concerning unstructured problems. They can be totally computerised, human-assisted, or a mixture of the two. A DSS analyses and synthesises huge volumes of data to aid decision-making in generally. This study proposes a unique decision support system solutions for coconut oil producers to meet the challenges they confront when making strategic decisions, particularly when comparing alternative methods of oil exploration. More specifically, the accepted approach explains how to address issues with coconut oil extraction in order to reduce production time and costs while also conserving energy. [6].

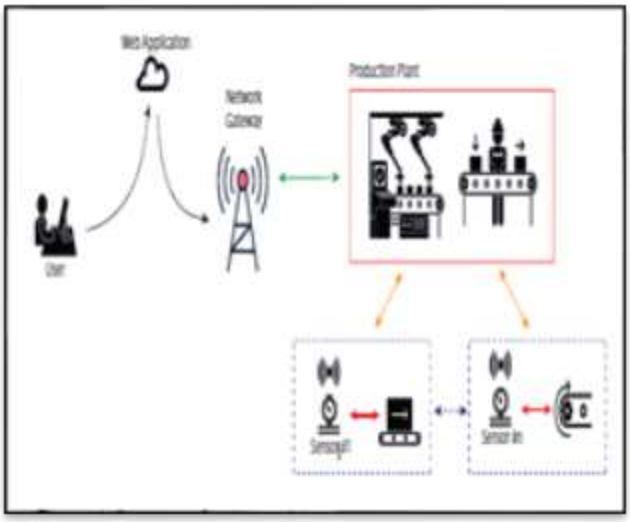

Fig 3 IoT connectivity

Farmers used it to utilise these simple tools previously. In the last few decades, the use of cultivated seaweeds as a feedstock for a variety of industrial uses has grown in popularity in the Western world. Norway's long coastline and very well aquaculture industry provide ideal circumstances for the development of large-scale seaweed biomass farming in monoculture and Integrated Multi-Trophic Aquaculture (IMTA) systems.. Recent research, business, and government efforts have focused on building a Norwegian bio-economy based on cultivated seaweed, with a concentration on biomass cultivation and processing. This paper examines the state of seaweed aquaculture in Norway, based on the production data collected since the first professional seaweed growing licences were issued in 2014. Even though there are currently few novel product breakthroughs, industry 4.0 concepts based on grown biomass are being addressed. System that combines from test growing schemes to commercial production necessitates a detailed examination of the hazards and advantages of seaweed aquaculture, as well as the development of an industry-specific regulatory framework. I Genetic interactions between farmed and wild crops, (ii) impacts of seaweed agriculture on adjacent ecosystems, (iii) epiphytes and diseases, (iv) land usage, and (v) threats from climate change are all issues that need to be addressed when scaling up macroalgal production. By addressing these concerns and changing production processes, a developing sector based on cultivated seaweed biomass in Norway will be able to maintain its environmental and economic viability.[7]

In today's farming, progress is more significant than at any other period in recent memory. The business, in general, is facing huge challenges, including rising provisioning costs, a labour shortage, and shifting buyer preferences for transparency and supportability. Agribusiness firms are increasingly acknowledging that solutions to these problems are required. Farming innovation has experienced remarkable growth in speculation over the last ten years, with $6.7 billion invested in the last five years and $1.9 billion in the last year alone. Indoor vertical farming, mechanisation and mechanical technology, domesticated animal innovation, modern nursery rehearses, precision farming and man-made consciousness, and square chain have all seen significant developments in the sector. According to the paper, regardless of how food is determinedly produced, we should be able to produce 70% extra food by 2050. However, a significant portion of global GDP has shrunk just to 3%, down from 33% a few years ago. Craving has a negative influence on around 800 million people worldwide. Furthermore, under current circumstances, 8% of the global population (or 650 million people) will be undernourished by 2030. Square chain, precision agriculture, and man-made awareness.

In any case, no progress has been made recently, and there is nothing to suggest that food scarcity and requirements will not be a problem in the coming years. To overcome these issues, governments, financial backers, and innovative agriculture developments will need to work together. Agriculture 4.0 will eventually stop relying on uniform application of water, compost, and pesticides over full areas. Farmers will use the base sums required and target extremely specific domains after taking everything into account. The paper goes on to say that farms and agrarian enterprises should be managed in an unusual way, owing to advances in technology such as sensors, devices, machinery, and information development. Robotics, humidity and temperature sensors, aerial images, and GPS improvements will all be used in future agriculture. Fields will be more useful, profitable, secure, and environmentally friendly as a result of these fundamental contraptions, precision farming, and automated structures. [8]

1. Sensing Technologies
2. Software Applications
3. Communications Systems (Cellular)
4. Telematics Positioning Technologies
5. Hardware and Software Systems
6. Data Analytics Solutions

2.1 Agriculture 5.0

Besides Demand and Supply, the problem of nourishing the future is frequently viewed against by the worldwide context of population growth and the rise of middle-class consumers who demand more resource-intensive diets. According to these considerations, farming must become 70% more productive by 2050. Experts expect huge societal and political repercussions if farmers fail in this mammoth undertaking. To put this in perspective, The Economics claims that growers will have to produce food in the next generation than all farmers have ever generated since the first agricultural revolution 10,000 years ago. Other important aspects must be considered in addition to the problem of producing more food while maintaining global health. The both number of hungry and obese people is increasing nowadays. Nutrition chronic diseases like diabetes are among the worlds largest most significant public health issues, while 30 percent of the worlds largest food is thrown away. Nevertheless, there is some great news. Not just to would we be healthy if everybody adopted the diets advised by dietitians, but we would also require fewer arable, which provide greater room for biodiversity and sequestering carbon. .[9] Nigeria's agricultural industry is known for providing food and nutrition, with poultry production accounting for 19% of the country's meat supply (SAGTAP, 2012). The poultry production business in Nigeria is valued at N80 billion ($600 million) and it is the most industrialised sub-sector of the livestock sector (Bello et al., 2015). The commercial poultry business employs around 25 million people directly and indirectly (Bello et al., 2015). The subsector accounts for more than a quarter of all agricultural GNP (APPCT, 2012). Poultry products are nutrient-dense and provide an excellent return on investment for humans. Ability to connect such as Artificial Intelligence (AI), Internet of Things (IoT), drones, sensing devices, mobile apps, and others were developed to assist successful agricultural output in order to raise production efficiency, minimise drudgery in producing, and improve poultry products. [11].

2.2 AI Techniques used in farming

Artificial Intelligence (AI) is one of the most important areas in computer science research. AI is rapidly becoming prevalent due to its robust applicability in situations that cannot be solved well by people or traditional computing architectures, as well as its rapid technological improvement and broad range of applications. Crop management systems, in general, provide an interface for the complete management of crops, which includes every part of farming [21]. In their paper "Expert Systems for Agriculture," McKinnon and Lemmon explored the idea of employing AI in crop management for the first time in 1985. Insect pest infestation is one of the most concerning issues in agriculture, resulting in significant financial losses. Researchers have attempted to alleviate this threat for decades by building computerised systems that can identify active bugs and recommend control methods [23]. Crop diseases are another major source of concern for farmers. To diagnose an ailing plant and conduct the appropriate recovery actions, you'll need a lot of knowledge and experience. Computer-assisted methods are utilised all over the world to detect ailments and recommend treatment options. Apart from monitoring pests and diseases, agriculture also includes storing, drying, and grading of produced crops. Various artificial intelligence-based food monitoring and quality control systems are discussed in this section. In agriculture, soil and irrigation management are extremely important. Crop loss and quality degradation are caused by poor irrigation and soil management. This section highlights some recent research in artificial intelligence-assisted soil and irrigation management. [12]

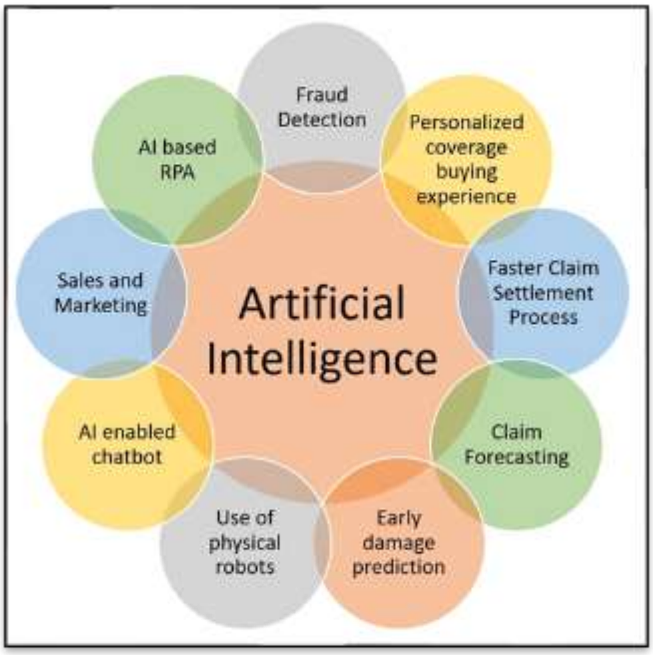

Fig 4 AI Techniques

2.3 Robots and Drones Used in farming

Farming faces numerous economic hurdles in terms of productivity and cost-effectiveness, and the growing labour shortage is attributable in part to rural depopulation [18]. Population growth, urbanisation, an increasingly degraded environment, an increasing trend toward intake of animal proteins, changes in food choices due to ageing populations and migration, and, of course, climate change should all be seen as global issues. [20]. Furthermore, precise detection, identification, and quantification of infections and other factors affecting plant and animal health must be maintained in order to avoid economic costs, trade disruptions, and even human health hazards. As a result, a more advanced agriculture must be established, characterised by the adoption of ad hoc production techniques, technologies, and equipment developed from scientific breakthroughs, research, and development. [12,19].

Fig 5 Drones in Agriculture [https://www.iberdrola.com/innovation/smart-farming-precision-agriculture]

2.4 IoT used in Farming

The As the human population of the globe rises, there will be a greater demand for nourishment, which will require a rise in the amount of automation in industry. The Internet of Things is an exciting new technology that is delivering a wide variety of creative ideas to modernize the agricultural sector in order to close the gap that exists between different industries. Research organizations and scientific groups are working on developing products and solutions that depend on the Internet of Things (IoT) in order to address many problems of agriculture. In this study, a systematic review of the literature (SLR) is conducted on technologies related to the Internet of Things (IoT) and how they are now being applied in a variety of agricultural application domains. The SLR that serves as its foundation was developed by analysing research articles that were published in recognised journals between the years 2006 and 2019. [16]. A total of 67 papers were selected thoughtfully and categorised by the application of an organized process. This wide-encompassing study's [15] primary objective is to compile all previously conducted research that is pertinent to Internet of Things (IoT) agricultural applications, sensors/devices, communication protocols, and network types. It also discusses the significant difficulties and challenges being investigated in the field of agriculture. In addition to this, a framework for agriculture based on the Internet of Things has been presented, which contextualizes the depiction of a wide variety of agricultural technologies that are now in use. Additionally, country policies about agriculture that is dependent on IoT were examined. Finally, a list of outstanding concerns and challenges in the field of IoT agriculture has been provided to assist researchers in considering future options. [17].

2.5 Digital Farming

In this era of increasing agriculture, unmanned farming is gaining appeal. Farming does not demand labour, but it does necessitate the management of all systems by qualified men. This system is primarily built on Internet of Things (IoT), Big Data, Artificial Intelligence (AI), and 5G technology. Unmanned farming use modern sensor technology to track growth, plant health, animal health, and the environment. Automation is vital in that industry, and AI and IoT are required for such automation [22]. There are four different stages of automation, as seen in fig 4. When it comes to automation, there are three layers that must be considered.

The first layer is the foundation. 2. The layer of application 3. The layer of decision-making. The foundation layer is made up of sensors, cameras, and other sensing devices. The Indecision layer AI is used, and a variety of AI techniques are used to make decisions. The final layer is the application layer, which comprises robots, various machines, and automatic components. [14].

Agriculture 5.0 is booming in European countries right now. Agricultural engineering and agriculture coupled to precision farming are referred to as 5.0 digital farming in agriculture. Precision farming for the general population began after GPS signals were made available. Precision farming increases operational accuracy and allows for site-specific monitoring and vehicle guidance. Agriculture production, weather forecasts, and agriculture-related information are all available in digital farming with only one click.

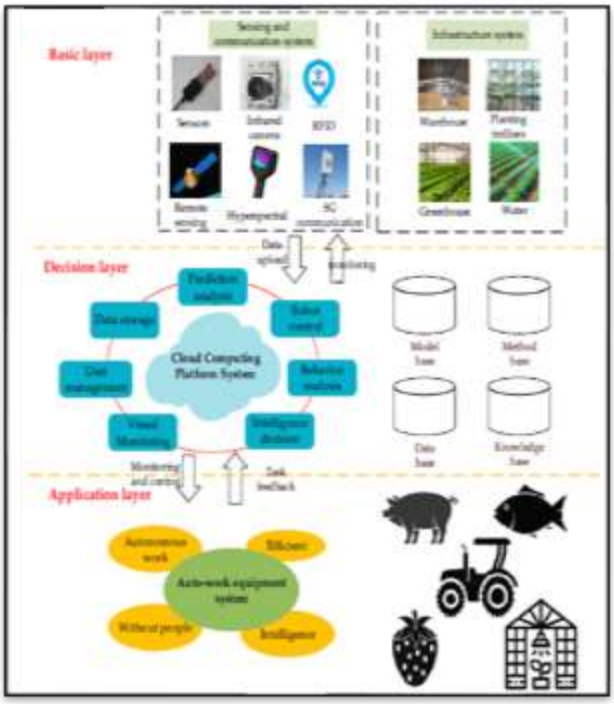

Fig 4 Layers of Automation [13]

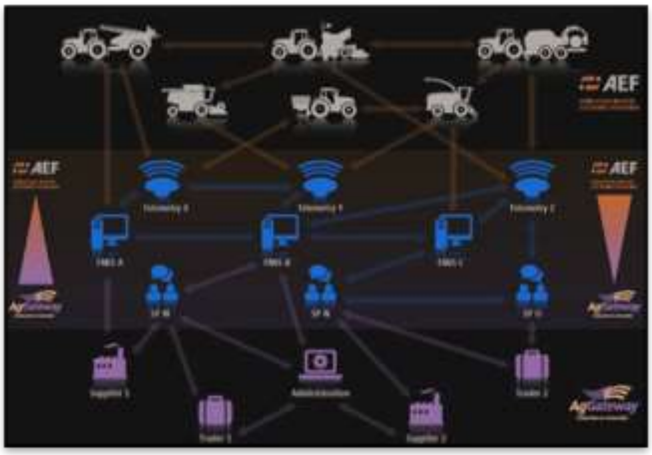

Fig 5 Respective areas of expertise of AEF and AG Gateway [CEMA aisbl - European Agricultural Machinery]

Reference	Year	AI	IOT	Robots and drones	Application
[1]	2021		°		Smart farming using IoT and sensors 1. To improve production 2. To mitigate problems between the old method and the new method
[2]	2018	°			Robotics in digital farming 1. Yield management using AI 2. AI adoption in agriculture
[3]	2020	°		°	Smart irrigation support system 1. Fuzzy decision support system 2. GIS-based Decision Support System
[4]	2019	°	°		Smart sustainable agriculture using IoT and AI 1. Monitoring crop and soil 2. Predictive analysis
[5]	2021	°	°		Crop growth analysis system 1. Weather forecasting 2. Image analysis
[6]	2022			°	study of coconut oil extraction using robots
[7]	2017			°	Weather forecasting and image analysis
[8]	2021			°	Smart modular farming 1. Organic farming 2. Indoor vertical farming 3. Livestock farming technology
[9]	2022	°	°	°	Smart farming 1. Remote sensing 2. Smart farming in the animal industry
[10]	2019	°			Agriculture 5.0
[11]	2018	°			Impact of ML in precision agriculture to increase productivity and maximize yield
[12]	2019			°	Use of drones for precision agriculture
[13]	2019		°		By using IoT technology 1. Automated irrigation system 2. Frost protection system
[14]	2021	°	°	°	Unmanned farming 1. Autonomous farming using AI, ML, IoT
[15]	2020		°		By using sensors crop monitoring system 1. to identify dieses on crop
[16]	2017		°	°	wireless robot for moisture sensing
[17]	2008		°		GPS based animal tracking system
[18]	2014		°		Development of webbed based weather station for irrigation
[19]	2019			°	Using drones for precision agriculture
[20]	2009			°	Thermal and narrowband multispectral remote sensing unmanned aerial vehicle
[21]	2020	°			Co-operative smart farming by using the cyber-physical system and AI
[22]	2020	°	°		IoT based smart farming system using AI & ML
[23]	2022	°			By using AI techniques to explore the susceptibility of smart farming

3. CONCLUSION

The goal of this review paper is to bridge the gap between agriculture's future potential and recent advancements.

1. We can accomplish unmanned farming with AI.
2. Using various AI strategies, farming will become more easier.
3. Smart farming will be led by the mobile farming concept.
4. Farmers with a big area of land can use drone technology to automate their operations.
5. We can apply IoT for smart farming in practically every field of agriculture.
6. IoT allows farmers to do real-time analyses.

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