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Improvement of Agriculture Productivity by using Artificial Intelligence and Block Chain Technology

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ABSTRACT

Agriculture plays a vital role in global food security and economic sustainability. However, the sector faces numerous challenges, such as the need to feed a growing population, resource constraints, climate change, and inefficient supply chain management. This paper explores the potential of integrating Artificial Intelligence (AI) and Blockchain technology to address these challenges and boost agricultural productivity. AI can revolutionize decision-making and data analysis, while Blockchain offers transparency, traceability, and security. By synergizing these technologies, agriculture can transition towards a more efficient, sustainable, and resilient future.
Keywords : Precision Agriculture, Supply Chain, Blockchain, Internet Of Things; Traceability, Smart, Contracts

I. INTRODUCTION

Agriculture is a cornerstone of human civilization, ensuring food security and economic stability. As the global population continues to rise, reaching an estimated 9.7 billion by 2050, the agricultural sector faces the challenge of producing more food with limited resources. Moreover, the sector must adapt to the changing climate and minimize its environmental footprint. This paper delves into the potential benefits of leveraging Artificial Intelligence and Blockchain technology to enhance agricultural productivity.

An important part of India's economy is played by agriculture, which accounts for 18% of the country's GDP and 50% of all jobs there. The largest producer of pulses, rice, wheat, spices, and spice-related items is India. Inefficient middlemen plague India's agricultural supply chain from the producer (farmer) all the way to the customer. The middle man farmer and customer receive unequal distributions of information about costs, supply, and stocks. The improvement of the aforementioned issue has been addressed by a variety of planning and management techniques, such as Material Requirement Planning, Enterprise Resource Planning, and Advanced Supply

Chain Planning and Optimisation, but there is still a dearth of Transparency, Trust, and Centralised authority [1]. To solve the aforementioned problem, we put up the unique FARMAR (FARMer And Rely) initiative for Supply Chain Management in Agriculture using Blockchain. To overcome this issue, FARMAR incorporates Blockchain Technology (BCT), a relatively new development that is crucial to managing the agricultural supply chain. Blockchain is a distributed ledger technology (DLT) that is used to record supply chain data and ensures that it cannot be altered. Each block is connected to the next by a pre-hash Signature Value. The management of the transactions takes place in fully decentralised servers in a distributed system. Once input or committed, the data in the block cannot be changed. The data is completely securely encrypted.

The blockchain is a novel method of data transmission and storage that has enormous promise for the agricultural sector, for both agribusiness and consumers. A peer-to-peer architecture that avoids centralising intermediaries, cryptography to ensure the integrity and permanence of data, and collective governance principles where each participant can see transactions and validate their legality make it undeniably appealing. In multi-stakeholder systems, the blockchain thus promises improved trust, transparency, and transactional fluidity [2].

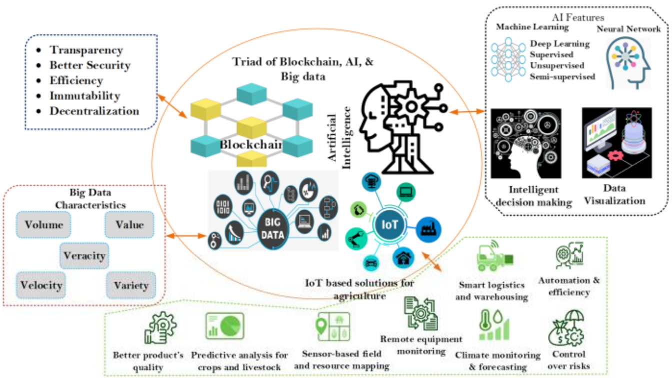

Figure 1. Characteristics of blockchain, AI, IoT, and big data for smart farming

Farmers, processing factories, distributors, retailers, and consumers are all part of the complicated food supply chain involving many stakeholders. All food processing enterprises and supply chains must now provide safe food as a crucial and legally defined need. CAC/GL 60–2006 lays forth the basics of food traceability [2]: as acceptable to the targets of the food testing and enforcement scheme, the traceability/product tracking solution must be able to distinguish at any given stage of the food supply chain (from the production process to retailing) from where the food came (one step back) and where the food went (one step forward) from where the food came (one step back) and where the food went (one step forward). National and international regulations support the implementation of these concepts (see, for example, European Union (EU) Regulation (EC) No. 178/2002 and national methods assessed by Charlebois et al. [3]. Because all actors know who their suppliers are and where their product is sold, this pragmatic one up/one down system connects all tied supply chain participants. However, because many food items have complicated multistep vertical and horizontal branching supply networks, relying relying on the one up/one down strategy makes the supply chain susceptible (e.g., multiple ingredient products).

II. RELATED WORK

This isolation creates a negative information imbalance among all supply chain stakeholders, a lack of transparency across numerous supply chain processes, and the potential for fraud to be promoted or concealed. Although several technologies for product traceability have previously been employed, such as bar codes, RFID tags, and Electronic Data Interchange (EDI), Bosnia and Gebresenbet [4] stated that more technical applications for food supply chain traceability are needed. Moreover, existing IoT-based tracking and provenance systems for agri-supply chains are layered on top of centralized structures, leaving an opportunity for unresolved issues and key concerns such as data integrity, manipulation, and single points of failure. In reality, obtaining verified and confidential data in a supply chain is difficult because it necessitates a high degree of confidence between cooperating parties, and trust necessitates the development of a specific quantity of verified and communicated information [5]. Although scholars and practitioners believe that somehow a third party is required in the chain to ensure information quality and security, the incentive for supply chain stakeholders to increase transparency in the agri-supply chain varies [6]. In this way, blockchain may operate as a decentralized certificate authority, verifying transactions, and delivering tamper-proof cryptographic information to any point in the chain upon demand.

Globally known food companies have begun to collaborate to accelerate the implementation of distributed ledger technology in agri-food supply chains, and early prototype models are emerging. Novel design concepts for such a system have been offered in the literature. Globally known food companies have begun to collaborate to accelerate the implementation of distributed ledger technology in agri-food supply chains, and early prototype models are emerging. Novel design concepts for such a system have been offered in the literature. In this context, researchers have begun to implement blockchain-enabled supply chain product traceability models [7], however, preliminary findings are only accessible for latency, network traffic, and CPU load. Tian [13] has recently expanded the initial application to real-time food monitoring based on HACCP (Hazard Analysis and Critical Control Points), however widespread adoption of blockchain technology in the food processing sector and supply chain is difficult and may face several problems [9]. On the other hand, by far most of the existing logistic information systems in Agri-Food supply chains like Costco, Walmart, Cargill, Albert Heijn, etc., just store, track orders, and supplies, without giving characteristics such as transparency, auditability, and traceability.

These characteristics in an agri-food supply chain will certainly improve the food quality and safety, thus are in demand from consumers. Therefore, numerous R&D communities both in industries and academia have engaged their efforts in developing efficient food chain traceability systems based on emerging technologies like the IoT and blockchain technologies, to facilitate remote monitoring at every stage all along the supply chain, from farm to fork. The above-mentioned companies have recently started experiments with blockchain for their supply chains.

The contributions of the work can be summarized as: (i) we performed a comprehensive study of the state-of-art of IoT and blockchain technologies in agri-food supply chain and highlighted the prospective applications of these technologies, (ii) we identified and provided a comprehensive discussion on different research challenges of agriculture supply chain alongside the IoT security problems and existing defense mechanisms, (iii) we also presented the application of IoT and blockchain in different domains of agriculture sector such as food composition, quality, safety monitoring, food supply traceability, and farm and food waste management, (iv) we have also given the special consideration to security and implementation challenges of these technologies and smart contracts in blockchain-based agriculture sector, and (v) finally, we introduced a new blockchain-based Agri-SCM-IoT architecture to solve storage, security, and some other challenges in the agriculture supply.

To effectively manage the supply chain, and thus the human behaviors it includes, all stakeholders must agree on the information to be recorded on the blockchain, from raw materials to finished goods. The fundamental objective is to choose the information that is useful to all areas of the supply chain, with a particular focus on customer needs and applicable standards blockchain may be utilized as a marketing technique along with operating as a traceability system. Blockchains may be used to improve a company's image and reputation [9], promote loyalty among existing consumers [2], and bring new clients since they are entirely transparent and participants can manage the items in them. In reality, organizations may simply set themselves apart from rivals by stressing product flow transparency and monitoring across the supply chain. Furthermore, quickly identifying a source of food contamination can boost a company's brand image and mitigate the negative impact of media criticism.

With the globalization of business, supply chains are growing more complicated, making it more difficult to track things across their intricate webs. In reality, stakeholder relationships are frequently complicated. As a result, suppliers can be divided into tiers, with a first-tier supplier supplying the organization directly with metal cans, for example, and a second-tier supplier supplying the raw materials needed to manufacture the cans [3]. Organizations sometimes have several suppliers at various levels involved in a single product; also, suppliers are frequently non-exclusive to a single firm. Aung and Chang [4], as well as Golan [5], have identified three key goals for traceability to enhance product-supply chain administration, product differentiation strategies, and quality assurance, and improved detection of non-compliant items. Compliance with applicable legislation and standards is another factor in ensuring traceability.

III. BLOCKCHAIN BASED AGRI-SUPPLY CHAIN MANAGEMENT

Agri-food supply chain system comprises multiple levels of transactions, each level with different terms and conditions [5]. Different systems with diverse characteristics and functions have collaborated in a supply chain, including food processing, transportation, storage, and distributors. All these levels maintain a record of all the products from processing to packaging, transportation to storage, and distribution, which are very long and complex processes. Smart contracts can assist in simplifying the whole process and enhance transparency throughout the supply chain. Integrating blockchain-based smart contracts with IoT devices enables tracking of the location of goods, allows tracking of inventory, and the change of ownership rights across the supply chain. This helps companies to prepare well for any disruption or incidents. Besides this, smart contracts enable companies and customers to determine the quality of the food products by tracing back all the information. The characteristics of smart contracts [6] enable their use in diverse applications or domains. Several of such characteristics are acquired from the core blockchain technology.

Furthermore, blockchains are often open and transparent, allowing all supply chain players to view, update, and check data, while modifying or deleting blockchain secured data is practically hard, resulting in increased transparency of all supply chain activities. As a result, supply chain providers may publicly advertise their availability to the whole market, as well as the capacity they have, enhancing their market position and increasing their independence from transportation brokers. This is an option for smaller suppliers and SME participants in a supply chain to combine their production outputs to fulfill large orders, allowing them to sell products directly to retailers or ultimate clients rather than through intermediaries.

Due to the increasing global population and the growing demand for food worldwide as well as changes in weather conditions and the availability of water, artificial intelligence (AI) such as expert systems, natural language processing, speech recognition, and machine vision have changed not only the quantity but also the quality of work in the agricultural sector. Researchers and scientists are now moving toward the utilization of new IoT technologies in smart farming to help farmers use AI technology in the development of improved seeds, crop protection, and fertilizers. This will improve farmers' profitability and the overall economy of the country. AI is emerging in three major categories in agriculture, namely soil and crop monitoring, predictive analytics, and agricultural robotics. In this regard, farmers are increasingly adopting the use of sensors and soil sampling to gather data to be used by farm management systems for further investigations and analyses.

This article contributes to the field by surveying AI applications in the agricultural sector. It starts with background information on AI, including a discussion of all AI methods utilized in the agricultural industry, such as machine learning, the IoT, expert systems, image processing, and computer vision. A comprehensive literature review is then provided, addressing how researchers have utilized AI applications effectively in data collection using sensors, smart robots, and monitoring systems for crops and irrigation leakage. It is also shown that while utilizing AI applications, quality, productivity, and sustainability are maintained. Finally, we explore the benefits and challenges of AI applications together with a comparison and discussion of several AI methodologies applied in smart farming, such as machine learning, expert systems, and image processing.

IV. BACKGROUND ON ARTIFICIAL INTELLIGENCE

AI is an emerging topic of importance in the field of computer science. Computers and machines use AI methodologies to understand, analyze, and learn from data. There are many application areas for AI, such as robotics, e-commerce, social media, computer vision, face recognition, healthcare, agriculture, military usage, and games, and AI methodologies are also used in smart farming. Machine learning, smart sensors, image processing, computer vision, and expert systems methodologies can be used to solve problems in agriculture. AI information systems improve the quality, productivity, and sustainability of farming.

Machine Learning in the Agricultural Sector

Machine learning is a part of AI technology and it contributes to the agricultural sector by monitoring and controlling agricultural activities, thereby increasing productivity and improving the quality of the crops that are cultivated. Machine learning algorithms play essential roles in precision agriculture by detecting objects in agricultural fields. Treboux and Genoud [6] showed 94.27% accuracy with machine learning algorithms in detecting specific objects, clearly reflecting the immense impact of these applications in smart farming. Machine learning algorithms allow machines to learn about particular agricultural lands, the geographical structure of farming areas, and plants and crops using supervised and unsupervised learning methods. Datasets are organized and predefined in the former case, whereas datasets are not classified in the latter. Once the machine has learned about agricultural activities, it can perform actions such as monitoring and predicting temperature and humidity, soil moisture, crop yield, and plant diseases [7].

Simulatenously, machine learning algorithms are used to classify various agricultural datasets according to soil and land types. Such classifications help farmers select suitable crops. Machine learning algorithms such as random forest, naive Bayes, and K-means can classify these datasets to predict the most suitable crops for each area [8]. Applying these techniques will undoubtedly assist farmers in different agricultural activities for efficient and cost-productive crop production.

Therefore, machine learning in the agricultural sector is applied with the aim of developing computer programs that can handle the input data to make predictions such as the most ideal time for sowing or harvesting, irrigation methods and levels, selection of soil type, temperature, and plants. These inputs train the machine learning model to make appropriate decisions in the field, thereby helping farmers identify ideal farming opportunities. The selection of machine learning algorithms is highly dependent on the availability of data, size of the training data, accuracy and/or interpretability of the output, speed or training time, linearity, number of features and the modeling process involves regression, classification, learning, and clustering. In smart farming, machine learning systems work with the help of computer vision techniques (such as Image Classification, Object Detection, Panoptic Segmentation and Keypoint Detection) to recognize and evaluate various objects in an agricultural field. The data can be acquired through different sensors to be used in modeling the system, including training and testing with various machine learning algorithms. For example, to maintain controlled water irrigation, an automatic drip irrigation system can be implemented and controlled based on data such as temperature, light, humidity, and rain captured using various sensors in the field [9].

Furthermore, the support vector machine (SVM) algorithm is identified as one of the best classification algorithms and accuracy rates of 90%-97% were found in various studies where it was used to detect diseases in certain plants. These studies showed that the K-nearest neighbor (KNN) and SVM algorithms are suitable for classifying data and producing excellent overall accuracy [10]. Figure 3. ML Algorithm – categorization shows a brief categorization of machine learning algorithms based on their behaviors in the machine learning modeling process. They are divided into supervised and unsupervised learning categories.

V. SENSOR TYPES FOR SMART FARMING

Innovation is rapidly improving traditional farming practices. Technologies such as satellite imaging, unmanned aerial vehicles (UAVs), and sensor technologies are revolutionizing the agricultural industry. Smart farming applies information technologies for the optimization of complex farming systems. The objective of smart farming is to access and use data collected to solve a problem or optimize a solution. The main goal is to find a way to use the collected information in a “smart” way [5]. Smart farming embraces almost all operations of a farm [6]. Farmers can use portable devices such as smartphones and tablets to monitor real-time data (irrigation, climate, fertilization, etc.) that will aid farmers in reacting to situations based on the collected data and making informed decisions supported by smart algorithms. There are many types of sensors that can be used to read and process agricultural data. Below, we list the most common sensors used in smart farming and their specifications:

Water content sensor: This is used to measure the ratio of the amount of water in the tested soil to the total amount of the tested soil, which is the ability of a substance to hold an electrical charge. It measures changes due to the change in the dielectric permittivity of the soil. Values range from 0 (dry soil) to the saturation of the porosity in the tested soil [7] where porosity saturation is the ratio of the pore volume to the total volume of the soil sample. The measurements depend on the soil type; consequently, the sensor needs to be calibrated for different locations.

Volumetric water content sensor: This type of sensor measures the water content of soil [8]. It works by evaluating the water suction in the soil, reflecting plant roots’ efforts to extract water from the soil. It provides an estimation of the amount of water stored or the irrigation required to ensure the needed amount of water in the soil.

Electrical conductivity sensor: This is used to measure the saline content in soil by estimating the solute concentration, which can be hazardous for crops if the soil salinity is too high [9]. Soil salinity around the roots of plants is mainly caused by salt build-up from irrigation water, which can potentially cause long-term damage to the land itself.

pH sensor: This type of sensor is used to measure pH values, reflecting the acidity and alkalinity of the soil. Ideally, soil pH values range between 6.0 and 7.0. Values outside of this range indicate a lack of nutrients in the soil. Farmers need to regulate the pH value by using alkaline or acidic fertilizers, which improves production [2].

Weed seeker sensor: This sensor uses advanced optics and processing power; it detects and eliminates resistant weeds. When it passes over a detected weed, it sends a signal to the attached spray nozzle to precisely deliver herbicide to the weed. The sensor consists of an active light source and a chlorophyll-identifying selective spray sensor. This allows for detecting and spraying only weeds, significantly reducing the amount of chemicals applied by up to 90%. As a result, optimized use of chemicals is achieved, which also reduces the cost [2].

Temperature sensor: This sensor gives an alert if the temperature deviates from the normal range. The soil temperature determines what types of crops can be cultivated in a field. Temperature is important for plant growth processes such as water absorption and transpiration by plants through photosynthesis. Each crop has a different temperature range for its growth. The enzymes necessary for growth will not be active if the temperature is outside of the normal range [2].

Wind speed sensor: This sensor aims to measure wind speed at a certain surface level. It is necessary to observe the changes in wind speed patterns and directions. The height at which this sensor is mounted depends on the crop [3].

VI. CHALLENGES OF ADOPTING AI IN AGRICULTURE

AI has provided great opportunities to the agricultural sector; however, there are still many challenges faced by researchers in this area, such as collecting the required data for building the knowledge base. In addition to external factors, challenges from sowing to harvesting have led researchers to improve and create AI techniques such as artificial neural networks, fuzzy systems, expert systems, and agricultural robots. These systems are widely used in many farming applications such as crop and soil monitoring, weed management, pest management, disease detection, yield prediction, and general efforts to overcome challenges. Environmental sustainability is a key factor in farming, as climate change will cause decreases in water supplies and increased costs of production.

Crop management systems provide interfaces that cover many features of the management of crops. This approach was first introduced by McKinion and Lemmon [5]. The designing of such systems is important for guarding crops from many different kinds of damage. Another challenge in farming is crop pests and the selection of measures to control them. Drone technologies were developed by different companies to help farmers virtually visit all their crops and provide full monitoring systems, which can be used to discover dead soil, diseases, irregular crops, and pests, in addition to recommending solutions to these issues.

VII. CROP AND LIVESTOCK MONITORING

According to the World Resources Institute, there will be nearly 10 billion people on earth by 2050. To feed this many people sustainably, it will be necessary to increase food production by 53% to handle the overall expansion of agriculture lands and lower emissions by 67% [9].

One way to meet these demands is by smart farming. Incorporating IoT devices, wireless and wired networks, cloud computing, artificial intelligence, and software management systems, we can monitor and improve farming outputs. Farming can be monitored in two main areas: crops and livestock monitoring. Each category has its own specifics and needs.

Crop Monitoring

Crop monitoring takes into consideration one or more of the following points:

Environmental conditions including humidity, temperature, solar radiation, fertilization, and pesticide application, for which data can be collected through WSNs and IoT sensors [8].

Crop diseases, including visual data that can be collected with high-resolution cameras, which may be fixed or mobile via UAVs [8].

In both cases, the information collected with these devices needs to be further processed for anomaly classification, prediction, and risk estimation [8].

Bauer and Aschenbruck [8] proposed an IoT-based farm monitoring system. Their focus of analysis was the leaf area index, which provides information on the photosynthetic processes and vital conditions of plants. WSN clusters of sensors were used to measure solar radiation (including temperature, humidity, and light) to calculate the photosynthetically active radiation range. Raspberry Pi was used at each cluster node, exchanging data with the central base unit through the LTE modem. The data were subsequently processed within a farm management information system for generating reports and making decisions.

Bagheri [4] developed a remote sensor system with high spatial and temporal resolution to improve the monitoring processes for temporal changes in agriculture via a UAV. The system architecture consisted of a main onboard system and ground station subsystems, with multispectral cameras for high-precision capturing, a GPS tracking system, and a telemetry system to transfer data among the subsystems. This monitoring system could speed up the monitoring processes and increase the accuracy of crop classification. After image capturing, multispectral imaging classification maps were developed with a maximum likelihood model. The results were very promising, with accuracy of 94% and a kappa coefficient of 0.9.

A similar study was developed in a vineyard [5]. The images captured were used to detect grape leaf stripe disease via the application of the normalized difference vegetation index, which facilitates analysis at the level of a single plant. This system allowed for the detection of anomalies near the infrared wavelength, which is not possible for the human visible spectrum. Thus, this study confirmed the benefits of using smart monitoring for plant protection.

In another previous study [6], the aim was to implement an integrated plant protection architecture and tree protection architecture by combining UAVs, cameras, and a WSN. After extensive research, a system with the following components was proposed:

Environmental data acquisition– Libeliu's Plug and Sense kit, a robust waterproof enclosure with specific external sockets, and incorporated GPS. Data transmission was performed with the LoRaWAN

Gateway protocol, which performs best compared to other technologies.

Imagery data acquisition– An eBee X senseFly drone together with a Parrot Sequoia+ camera to capture ground and air images.

Imagery data processing – Preliminary processing of the images directly in the field via Pix4D to improve the overall processing time.

Cloud infrastructure– Data coming from both land and air are stored, processed, and analyzed using multiple machine learning and computer vision algorithms. They are managed through web and smartphone applications. Cloud platforms are the best choices for such storage due to the additional tools they provide.

The proposed system aimed to provide multiple area solutions, extended area coverage, and macroscopic and microscopic data, portability, and adaptability.

VIII. AI IN AGRICULTURE

Agriculture has a significant role in the sustained viability of any economy. It is significant for long-term economic growth and structural transformation, and it has evolved in terms of the processing, production, and conveyance of crops and domesticated animals. Currently, the agricultural sector is being influenced by new innovative IoT technologies, wireless communications, machine learning, and AI. Thanks to these technologies, the collection and analysis of data such as temperature, weather, soil properties, and historical crop performance provide predictive information that helps solve agricultural problems such as crop diseases, pesticide control, weed management, lack of irrigation, and water management [9]. At the same time, intelligent robots that operate in dynamic and unstructured situations and interact with humans have sparked increased interest and expanded applications in all fields, including agriculture.

Significant advances have occurred in the field of agriculture from 1980 to the present day. For example, Jha et al. [11] listed more than 50 technological advances in subfields of agriculture, including the use of artificial neural networks and expert systems, machine learning and fuzzy logic systems, automation, and IoT techniques to solve agricultural problems. Artificial neural networks that predict and forecast based on parallel reasoning were incorporated into the agricultural sector by Robinson and Mort [11], who proposed one of the first models to be fed with raw meteorological data like humidity, temperature, precipitation, and wind direction to predict the occurrence of frost.

Gliever et al. [2] used an artificial neural network successfully to differentiate weeds from cotton plants and soil in images collected from commercial cotton fields with 92% overall accuracy. Maier and Dandy [3] presented a literature review of the use of artificial neural networks for forecasting water resource variables and they outlined the steps that should be followed, the options available, and the issues that should be considered in the development of models that use artificial neural networks for the prediction of water resource variables. Song and He [4] used an artificial neural network and expert system to help farmers detect crop nutritional disorders in time. That combination led to diagnostic efficiency of 92% for nutritional disorders in crops. Prakash et al. [5] developed an expert system with a graphical interface based on fuzzy logic. It stored knowledge provided by agricultural experts, implemented reasoning algorithms to simulate human thinking, and provided a decision-making framework to help farmers improve their soybean planting and harvesting decisions in circumstances where the help of an agricultural expert is needed but not immediately accessible.

Sannakki et al. [5] applied an image processing-based approach for the automatic grading of leaf diseases by utilizing fuzzy logic. The proposed system was divided into five steps including image acquisition, image preprocessing, color image segmentation, calculation of the image total leaf area and image total disease area, and disease grading by fuzzy logic. The system gave accurate results. Tilva et al. developed a fuzzy inference system to forecast plant diseases on the basis of weather data. The framework was created to prevent diseases in plants using an "IF, THEN" condition that indicated diseases happening because of a particular range of temperature and humidity. Shahzadi et al. developed a specialist expert system based on the IoT that gathers and sends real-time data to a server to make appropriate decisions to enhance productivity and limit losses due to diseases and insects/pests.

Embedded intelligence aims to discover individual behaviors by mining their digital traces during interactions with the IoT. Yong et al. applied wireless sensor networks and embedded intelligence in the domain of agriculture and presented a technology roadmap that explained the challenges and opportunities in agricultural areas in general and offered examples of IoT applications for smart irrigation. Patil and Thorat used the IoT and machine learning to predict grape disease before it occurred. That involved developing a monitoring system for leaf temperature and a humidity sensor to identify grape disease risks in the early stages using a hidden Markov model that provides SMS alerts to farmers and experts.

IX. COMPARISON OF METHODOLOGIES

Machine learning, expert systems, and image processing methodologies are commonly used to solve various problems in the agricultural sector. Table 6 provides information about several recent applications of AI techniques for smart farming systems. For example, Shakeel et al. proposed a deep learning-based classification algorithm for cow behavior recognition. Durai et al. developed a system using the random forest classifier and deep learning algorithm to classify crops. They reported very promising results with accuracy of 95.45%. Decision tree, K-nearest neighbor, and random forest algorithms were used in mushroom classification by Rahman et al. with accuracy of 100%. Other relevant algorithms used in recent works are given in Table 8. It shows that Junior et al. have the best accuracy in the spectral, hierarchical, and DBSCAN clustering applications using decision tree and K-nearest neighbor algorithm compared with other machine learning algorithms. Sharma et al. provided a review of precision agriculture using machine learning algorithms to demonstrate that data-driven solutions in smart farms improve the productivity and quality of the products. In prediction of the crop growth K-neighbor's classifier, Logistic Regression, Ensemble classifiers algorithms give very promising results. Linear regression algorithm is commonly used predict the production value for climate data such as rainfall, temperature and humidity. Deep learning algorithms are very successful for weed detection, image classification, image segmentation and object tracking in agricultural data. Neural network, k-nearest neighbors and Naïve Bayes classifier algorithms are used in insect recognition and classification. Experimental results show that accuracy is more than 90%.

X. CONCLUSION

It is well understood from the literature review that the application of blockchain, AI, and IoT in agriculture is still in the developing stage. The existing work mainly comprises evocative and prescriptive studies with very few definite systems being designed and implemented, even at the prototype level. There is a requirement of implementing a large number of real-time use cases to analyze the suggested results that many existing works claim including improved performance, intelligent decision support, security, and privacy of different acting entities throughout the supply chain, enhanced food safety, and environment-friendly techniques. Besides, there is a need to develop optimization tools to implement the existing solutions of these technologies in agriculture applications and can assist in addressing various implementation challenges.

Smart farming is a concept that involves handling and controlling farms using new technologies such as the IoT, robotics, drones, and AI to increase the quantity and quality of products while reducing the human labor required for production. These benefits will have positive effects on the profitability and the growth of the economy as population sizes are dramatically increasing worldwide. Therefore, researchers and scientists are moving toward the utilization of recently introduced IoT technologies in smart farming to help farmers use AI technology in the development of improved seeds, crop protection, and fertilizers. AI in agriculture is emerging in the three major areas of soil and crop monitoring, predictive analytics, and agricultural robotics. In this regard, farmers are rapidly beginning to use sensors and soil sampling to gather data to be used by farm management systems for further investigation and analysis.

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