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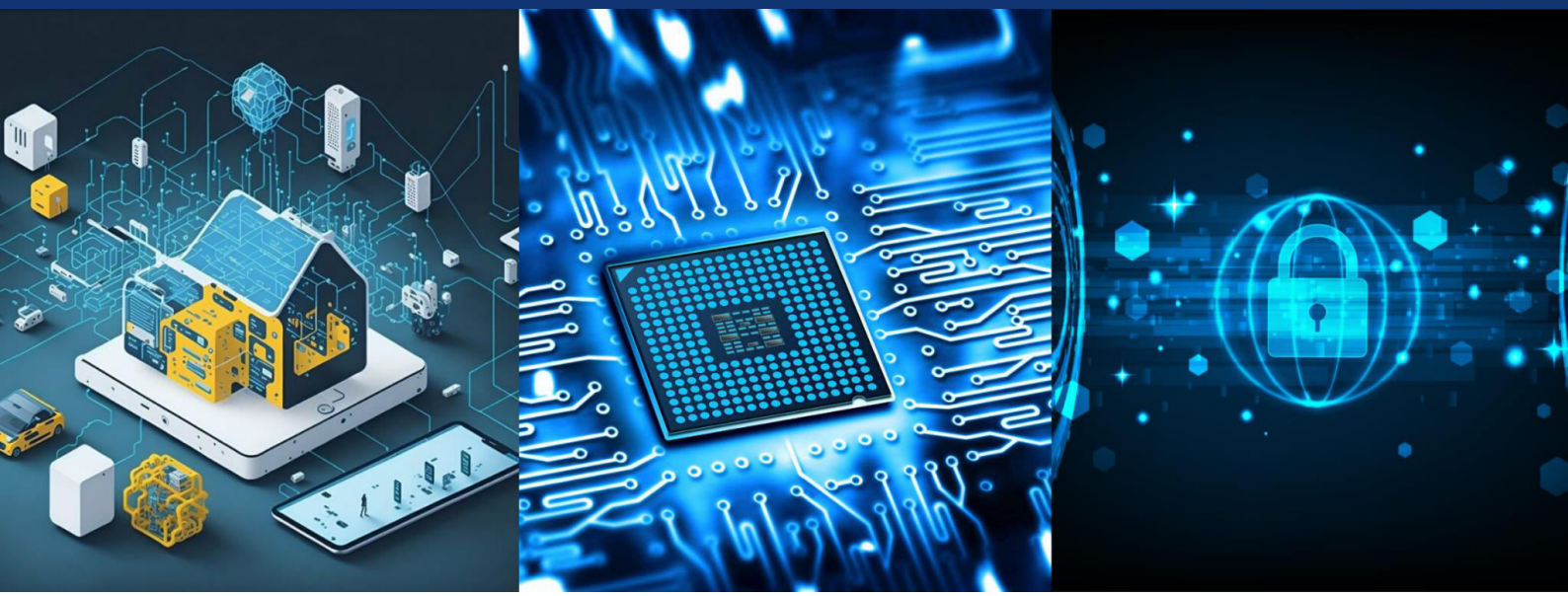

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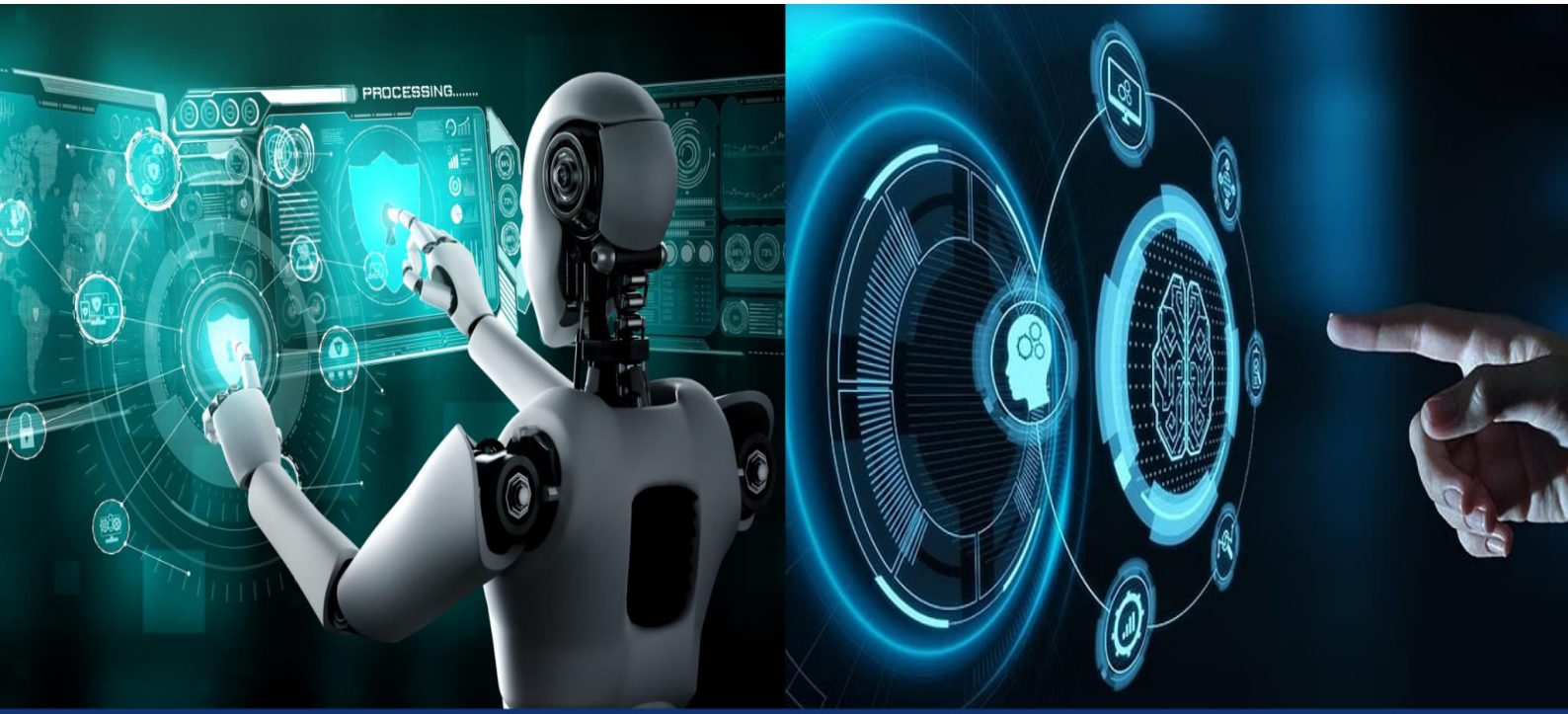

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Smart Contract Farming Platform Management (AGROBOND)

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ABSTRACT: The Smart Contract Farming System is a digitalized platform created to connect farmers and buyers more reliably and transparently. Its main goal is to reduce the gap between both buyers and farmers by using secure digitized agreements that clearly define terms and conditions, which helps to build trust and ensures that transactions are fair and well-structured. The platform is developed using Vite and React, through which users can easily register, explore crop listings, view contracts, and interact in real time. On the backend, Node.js and Express.js handle the core application logic, including API services, authentication, contract processing, and transaction management. All data is securely stored and managed using MongoDB, ensuring consistency and reliability. One of the key features of the system is the Price Prediction Module, which works before a contract is finalized. This module uses agricultural datasets collected from IEEE research publications. With the help of Python-based machine learning models, the system predicts crop prices by analyzing historical data, seasonal trends, and market needs and supply. It helps farmers and buyers in making informed decisions and agreeing on fair prices. Once the price is decided, digital contracts are created and accepted by both parties. This system also includes crops based on agricultural seasons such as Kharif, Rabi, and Zaid, which helps in better planning and avoids mismatches between supply and demand. In addition to contract management, the platform involves features like dispute resolution tools and analytical dashboards, which make the overall process more efficient and transparent. Payments are secured through trusted methods such as UPI and escrow systems, ensuring safe and reliable transactions. The feature that makes this application more effective is the Crop Insurance module, which allows farmers to enroll in government-supported insurance schemes. This protects them from unexpected risks like floods, droughts, or pest attacks. Overall, the system is designed to be scalable, efficient, and user-friendly. It strengthens farmers by giving them assured market access while helping buyers get a consistent and trustworthy supply of crops.

KEYWORDS: sustainable agriculture; smart agriculture; smart contracts; agribusiness; NFT; future contract; blockchain

I. INTRODUCTION

Agriculture is always the backbone of human civilization, lifestyle, employment, and economic stability. Traditional farming was the primary source of living for many small farmers, where they cultivate crops mostly on a seasonal crop cycle, based on local knowledge and available resources. Farmers face extreme difficulty due to middlemen interference, unpredictable market prices, lack of trustworthy buyers, and limited access to modern inputs. On the other hand, buyers face challenges due to inconsistent sources. To address this gap, this paper proposes a transparent digital contract farming for guaranteed market access and a constant source. Ex-post facto research design using 60 farmers was collected through interviews and analyzed using statistical methods like t-test and averages [1].

Qualitative case study, political economy, and historical analysis were done to highlight the social impacts of contract farming [2]. A descriptive and comparative review of literature, policy analysis, and case references of Punjab, Haryana, and Andhra Pradesh was done, which emphasized the need for group contracts and producer organizations [3]. Conducted a survey of 247 farmers across 14 blocks in Kushinagar District by using random sampling and statistical analysis (SPSS) to assess adoption, awareness, and challenges of contract farming [4]. A study on India's contract farming model using descriptive and analytical methods was done by focusing on tripartite agreements (Farmer-Sponsor-APMC) [5]. A web–based platform using React.js, Firebase, Blockchain Smart Contract, and Tailwind CSS was developed for real-time contract tracking [6]. By eliminating hardware dependency and incorporating transparent contracts, the proposed solution provides a secure, scalable, and trustworthy approach to small farmers and buyers in need.

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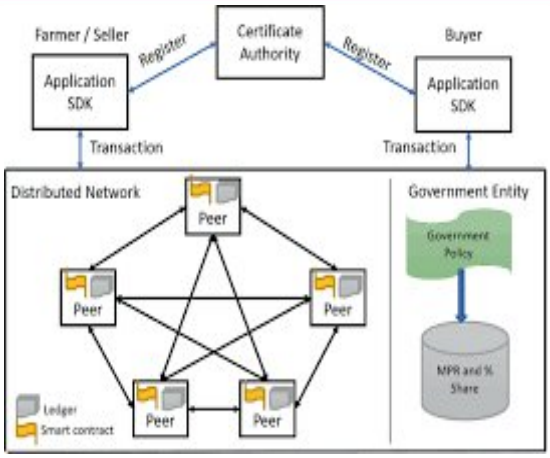

Fig 1: Improving Farmer Income Using Blockchain Smart Contract

To make agricultural applications more efficient and reliable, we can divide blockchain applications into four categories. &e first is the provenance of traceability and food authenticity. &e second category is smart agricultural data management. &e third category is trading finance in supply chain management. &e last is the category of other information management systems [3]. In agriculture, collecting data is frequently prohibitively expensive. &e blockchain provides a dependable source of truth about the state of crops, inventories, and contracts. Food provenance is tracked using blockchain technology, which aids in the creation of trustworthy food supply chains and develops trust between producers and consumers. It also enables timely payments among stakeholders generated by data changes when used conjointly with smart contracts [4]. Many characteristics of the blockchain make it unique and promising for future industrial applications. For example, blockchain is decentralized, transparent, immutable, irreversible, autonomous, open-source, ownership, provenance (authenticity and origin), and task automation.

On the blockchain, all transactions are securely recorded. &e controller may use this technology with smart contracts and the Internet of &ings to control the supply chain management, store farm data, and manage identity, among other things. On the blockchain, personal data are masked and need permission control to access them. Information gets stored over multiple computers (distributed ledger) rather than on a single server; this system makes it harder for hackers to alter data. By maintaining a track audit, blockchain can instantaneously trace commodities or goods, assisting in delivering proof and revealing weaknesses in any supply chain. Furthermore, smart contracts will automate transactions and enhance efficiency. Smart contracts eliminate the dependence on human intervention and ignore the reliance on third parties.

II. RELATED WORK

Recent research shows that fairer agreements significantly increase the number of contracts made between farmer and buyer. Statistical methods like the t-test and averages are applied by collecting data to identify the benefits that contract farming has [1]. Case studies and historical analysis are done to exploit risks and unequal power between farmers and firms [2]. Policy analysis, descriptive and comparative review of literature was done to highlight the merits of fair agreements [3]. Random sampling and statistical analysis (SPSS) were applied to the survey of 247 farmers to address risks of contract farming [4]. Improved farmer income, ensured price stability, promoted private, and introduced safeguards for fair trade [5]. Enabled digital contracts between farmers and buyers, reduced negotiation time through a web-based platform [6]. However, many existing solutions lack trustworthy agreements, unstable market prices, and less reliable sources for buyers. The proposed system addresses these limitations by providing Python-based price prediction, secure digital contracts, and a crop insurance module to help farmers and buyers in case of any loss.

lecting the environmental data. Smart contracts will play the role of data science analyzer, which means dealing with data for actionable insights, while blockchain records and validates data. &is scheme uses algorithms created to govern interactions with various data segments. &e next step of this system is to create a blockchain system automated by smart contracts and make the correct predictions after analyzing the collected data. &is project will guarantee the

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enhancement of farm production. &e application platform will allow all the participants on the network (providers, farmers, customers, and distributors) to visualize data and trace product growth. Blockchain validates data using a decentralized consensus algorithm and encryption, making it nearly hard to alter owing to the massive amount of computer power needed. As previously stated, blockchain's validated data are organized, comprehensive, and immutable. Smart contracts are composed of codes that analyze collected data and display to members if the sensor results are on the optimum values. &ese contracts help track the product supply chain by keeping eyes on product identification and detecting the member that holds the product. Furthermore, the block cannot store the data until it is verified and validated by control members, so the case in which an entity can be malicious is significantly minimized compared to other centralized systems. In general, the truth is that blockchain systems and smart contracts can perform middleman duties independently. Concerning the prospective research gap and research challenge, we noticed that many researchers built a scheme that consists of a single blockchain that stores data about farms, entities, products, financial business, deals, and trades all in one distributed ledger. We reckon that the data in our system need to be more structured. &e research challenge is placing data related to individuals into "the user blockchain," data describing products into "the product info blockchain," and data related to deals between entities into "the transaction blockchain."

The transaction information blockchain is the last one on the list. It holds a wealth of information, including user personal information, intermediate information, transactions, logistics, and agricultural product data. Smart contracts are used in this paradigm. &ose automated contracts use the highest level of data encryption currently available in the security industry. As a result, it will confirm the quality of the decision and guarantee clarity and effective communication between entities [25]. Many sides will attempt to check the average transaction fees because the whole system comprises a multi-blockchain system. But let us see the other meaning of the blockchain model. &e suggested architecture concurrently distributes secure data to all network participants. It is regarded as significant advantage that can increase the efficacy agricultural system. &e block will be full of transactions containing recorded data, and we will get multiple verified transactions at once. Combining numerous transactions into a single block each period is cost and space-efficient. So, batching allows for reducing per-transaction fees by aggregating various transactions into one. Following this protocol benefits you and keeps the fees low across the board for everyone. We can use cryptocurrencies for frequent transfers across platforms if we want to add crypto money to our model.

III. METHODS

The suggested architecture also maintains confidence between entities. Before acquiring a product, it guarantees that the consumer is adequately informed about the reputation of other sides (the seller). Furthermore, the early warning feature is added to reduce the usage of chemicals and establish the safety of agricultural produce. &oughbitcoin popularized blockchain transactions, putting it in a real-world use case still has various difficulties and many goals to achieve. Nevertheless, blockchain is still in its early phases and contains serious flaws. Also, the applications are a considerable challenge to optimize the solutions and the entire food supply chain. We all agree that the procedures are automated and dependable after these analyses. Smart contracts periodically self-check data, keep track of all the details, and help save data to the blockchain. When it comes to the blockchain, the date, time, and product identifier allow all participants to track products and assure that they have access to information about the source of the products. &e integrity is not threatened because the only participants authorized were those who could execute operations. Furthermore, using smart contracts eliminates the need for an intermediary party, and no one can alter the data inside the blockchain after it is verified.

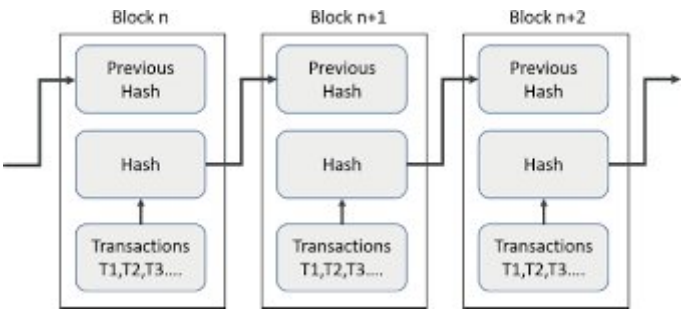

Fig 2: Supply Chain Model for Improving Farmer Income Using Blockchain Smart Contract

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So, it will be impossible to change the data if someone does something wrong or by mistake. Also, data collection relies on IoT devices; if they get broken, data collection is impossible. Furthermore, IoT devices are sometimes subject to security vulnerabilities. Possibly, some participants cannot comprehend the system or blockchain technology. They may have limited knowledge or a lack of understanding of some functionalities. Perhaps we cannot persuade some participants to give information. But, in general, the system offers a radical change in all aspects of an existing business. &e comparison system (see Table 1) provides all the details we have discussed. It is conceivable that the proof-ofwork consensus mechanism is the algorithm that operates when the system employs the Ethereum platform. However, we have found that many studies neglect to include this point.

A performance report for this scenario would reveal that the throughput is three records per moment. For more explanation, the user information blockchain can save the first recording data, the agri-product information blockchain can keep the second recording data, and the transaction information blockchain can save the third recording data. &is thinking is our maximum throughput, but the goal now is to increase it by updating the programming level of smart contracts by incorporating new methods and functions that reduce execution time and work to prevent bottlenecks in the blockchain network.

IV. RESULT ANALYSIS

Security Analysis. Now we will go on to the security analysis part, where we will list all of the model's components and discuss how they can provide security services and how they operate together to secure our data and deliver accurate information to all network members. Smart contracts, apps, and the blockchain environment are vulnerable to attacks if the model gets weakly built. Let us start with the blockchain-based system, a public ledger of data kept on all nodes, with all participants receiving the same version of information and updates in real time as data changes. Furthermore, users authenticate using public-key cryptography, and validators check the data for accuracy before storing them in blocks; thus, all data transactions ought to have acceptance from all nodes in the network. Finally, once transactions get preserved in blocks, no one or entity may edit or alter the block's content.

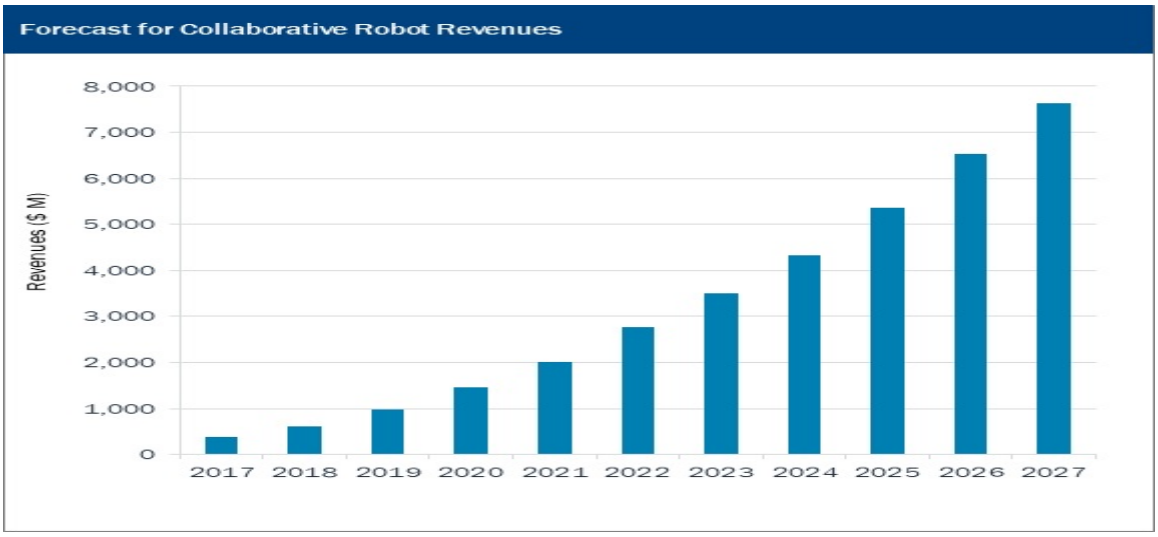

Fig 3: Collaborative Robot Market to Grow by 60% in 2028

The level of security in the blockchain scheme is intriguing, but let us now discuss smart contract security, which is more than simply a software program that gets run automatically. It is a part of the system. In our example, it can receive, transmit, and store data about the environment, such as temperature, humidity, light, and soil pH. It can also track down the merchandise and determine which company owns it. We must not forget that smart contracts specify the extent of an agreement between business parties by defining criteria that function as a trigger event in the contractual terms. &e code gets performed, and the results get displayed on all of the network's nodes. Smart contracts get written conditionally, using if-then expressions, and thus neglect many of the problems caused by regular agreements, such as

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fraud. &e use of blockchain to establish these types of arrangements eliminates the need for an intermediary. As a result, the total expenditures of the company get reduced. To prevent losses, professionals make timely code optimizations, conduct frequent code audits, and monitor the aberrant behavior of implemented deals.

V. CONCLUSION

This research presents an intelligent, secure, transparent, reliable, and digital platform that enables farmers to connect with buyers to make successful contracts. By integrating the Python-based Price Prediction module, farmers face less trouble with price issues. The main feature, "Insurance module," highlights and protects farmers and buyers from unpredictable natural losses. This framework promotes sustainability, trustworthiness, and resource efficiency while being beneficial to both farmers and buyers. The work aims to provide a possible technique to build practical blockchain-based applications and change the agriculture industry, even though the evolution of blockchain and agriculture research studies is still in its infancy. &is model is considered a prototype for reducing financial loss and agricultural pollution. &e system defines the three primary entities in the agriculture domain: data, process, and stakeholders. Adding a cryptocurrency process for the interaction between the entities and registering/tracking the seller's land will be a big step for this blockchain system model.

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