Journal of Theoretical and Applied Information Technology
15th May 2023. Vol.101. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A SECURED BLOCKCHAIN BASED APPROACH FOR DECENTRALIZED AGRI-INSURANCE FOR FOOD CROPS SUPPLY CHAIN

DAYANA D.S.[1] AND KALPANA G[2]

[1]Department of Computer Science,

SRM Institute of Science and Technology, Chennai, India

[2]Department of Computer Science,

SRM Institute of Science and Technology, Chennai, India

ABSTRACT

Food crop agri-insurance is a critical tool for protecting farmers from the financial risks associated with crop failure or damage caused by natural disasters. By using trustworthy, secured transparent ledgers, smart contracts and decentralized platforms, the efficiency, security, and accessibility of food crop agri-insurance for farmers can be prominently enhanced. By tracking food crop provenance, blockchain aids in the establishment of reliable crop insurance and confidence between farmers and insurance company. Traditional crop insurance schemes are complicated and often unprofitable. Because of the lack of confidence in insurance companies and a concern over deferred and any non-payment of claims, farmers frequently express reluctance to have their crops insured. This paper provides an outline for the potential benefits of using blockchain technology in food crop agri-insurance and proposes the implementation that can automate the claim process, reduce the time and work needed to process claims and make the process faster and more efficient for farmers. It can also increase transparency and reduce the risk of fraud, which improves the overall security of the system. Moreover, the proposed system makes use of smart contracts which are feasible, effective, and inexpensive food crop insurance approach that guarantees farmers are protected and get prompt crop insurance benefits. Also, decentralization and security in blockchain technology ensure transparent transactions between stakeholders and safety in food crop agri-insurance. According to our data, the length of time required for block creation is directly correlated with the time of process.

Keywords: *Blockchain, Crop Insurance, Smart Contract, Distributed Ledger, Latency*

I. INTRODUCTION

Agri-Insurance for food crop is an important phase of the agriculture industry that provides farmers with protection against crop loss or damage due to factors such as weather events, and other unexpected events. Using blockchain technology, efficiency and security of food crop insurance can be improved. The decentralized, secured, and transparent ledgers of blockchain technology are used to store the information of all the agri-insurance components and automate the claim and payment process. Any company involved in farming or commercial operations associated with agriculture is considered to be in the agribusiness industry [1]. Farmers, shipping businesses, retailers and wholesalers' marketers, and grocery stores are few of the numerous entities involved in this highly spread and multi-stakeholder system [2]. All data in current agriculture is either stored on paper or privately owned databases and software from dependable third parties. Such a framework increases the cost for accessing the data and leaves it vulnerable to deception, corruption, or inaccuracy that can result in shortfalls of money and increase the likelihood of product counterfeiting. The current agricultural procedure is deficient in four areas:

1. product provenance,
2. product data security,
3. supply chain partnership trust,
4. client trust as well as confidence in the reliability of the product [3].

Because of limitations in connection, agriculture is considered as the lowest digitised sector that lost out on the benefits of the internet. With the usage of data and technology systems, some projects have been implemented in current years to solve the issues of traceability, safety of food, and fostering trust amongst supply chain participants.

Journal of Theoretical and Applied Information Technology
15th May 2023. Vol.101. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

1.1 Information and Communication Technology (ICT):

To increase sustainability and efficiency in the agri industry, it is becoming more and more important to use information as well as data. The efficacy and reliability of gathering, storing, analysing, and utilising information in farming has markedly expanded due to communication and information technology [4]. It makes it simple for farmers and other agricultural professionals to get current information, which helps them make better choices in their day-to-day operations. For instance, remote - sensing information on soil circumstances can help farmers handle their crops, cell phones lower the cost of information and therefore help farmers access markets as well as financial assist [5], and the advancement of the GPS makes it easier to map fields, guide machinery, and scout plants. It doesn't eliminate bias in the gathering and application of data. For instance, the organisation that a stakeholder represents has a significant impact on their preferences in a multi-criterion selection, and NGOs may focus excessively on the problems that have to be resolved owing to their interest.

1.2 Blockchain Technology:

Blockchain is a decentralized database architecture that upholds an ever-growing list of information records which are validated by all of the contributing nodes within the system [6, 7 & 8]. Blocks are used to hold data records, so each block is connected to another to form a chain. Because the data in a block cannot be changed, and because every node in a blockchain system has access to the full distributed database, there is no chance of one node gaining control over the data records. Each participant node stores a duplicate of the information recordings as well as transmits to all the other nodes throughout the network, boosting transparency and trust [8], as opposed to data being routed in via a central node. The following three lines explain how the blockchain technology functions: the block is formed and the payment is asked in the first phase. The freshly formed block would then be distributed to all network elements in the following phase. The network as a whole agrees on the intended transaction, and then gets confirmed in the following phase. The final stage is the addition of the block with a fresh block of information when the transaction has been validated. With its distinct features, blockchain is becoming more and more popular across a variety of industries, including agriculture. Figure 1 enumerates key characteristics of blockchain technologies.

Peer-to-peer transactions can be performed transparently as well as instead of the involvement of an intermediary in the Agri industry. As a result of technology's elimination of the requirement for a centralized power, trust is now granted to encryption and peer-to-peer design rather than authority [9, 10]. Accordingly, it helps to build consumer and farmer trust that can reduce the transaction cost in the agricultural food crop industry.

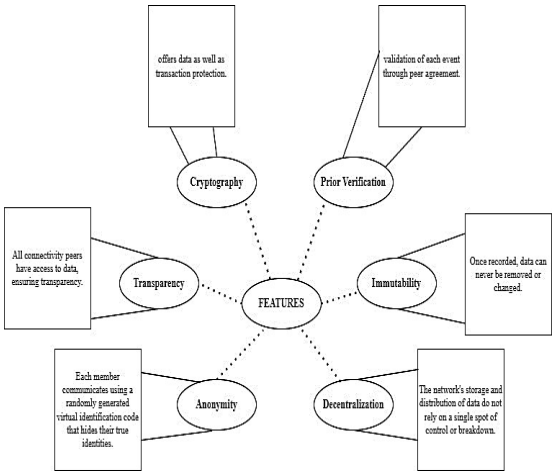

Figure 1. Features of blockchain Technology.

1.3 Agri-Insurance:

Severe weather threatens agricultural productivity, jeopardising global food security. Grain and cattle output are both impacted, and an upcoming climate shift is forecasted to cause unpredictable weather [11]. Agri insurance programmes are a recognised plan for dropping risks related to the weather. Whenever the food crop phase begins, farmers are paid an insurance amount, and in case of crop damage or loss, they obtain insurance money. Farmers are allowed to manage a user's financial vulnerability to weather abnormalities, i.e., financial losses brought on by weather severity, because the insurer is taking on all of the insured danger in this way. In addition, the insurer could use a reinsurance business to substantially hedge the larger systemic portion of the danger in the event of weather hazards that adversely affect all-covered farm well.

Agri-insurances vary in terms of how liabilities are determined and, as a result, how compensation is initiated. Indemnity insurances are those that compensate farmers according to a damage estimate made by a professional on the farm. While indemnity-based insurance can accurately pay losses, these are vulnerable to issues brought on by

asymmetric knowledge concerns. More precisely, the distribution of data between farmers and insurers regarding the risk involved in farm output as well as production practices is uneven. Farmers are anticipated to be more knowledgeable about the two factors that encourage moral danger and unfavourable selection. According to the unfavourable selection, farmers who are exposed to even more danger are often more likely to buy insurance than farmers who are exposed to less risk.

Moral hazard suggests that when farmers are insured, they switch to riskier producing methods. If the insurer lacks sufficient knowledge about the two circumstances, these instances result in market breakdown of the insurance plan. As a result, indemnity-based insurances are vulnerable to expensive damage assessment and must take precautions to prevent issues brought on by asymmetric data, such as limits. Additionally, productions that are not quantifiable, such as grazed pastures, cannot be covered even though they cause financial harm [12]. In this study, a blockchain network-based crop insurance option is proposed since it offers a new architecture for securely storing, validating, and transferring data. The proposed system is designed with Blockchain, which is founded based on the idea of smart contracts, offer a tamper-proof environment, which means that a transaction may only be carried out after receiving validated data [13].

Smart contracts used in food crop agri-insurance automate the claim procedure and trigger payments based on predetermined conditions. This reduces the time and work required to process claims and complete the procedure faster and more efficiently for the farmers. Moreover, blockchain is a decentralized database with secured ledgers that allows transparent tracking of food crops from the source, reduces the risk of fraud and increases the ease of access to insurance for farmers. The system proposed in this work will be an economical and efficient food crop insurance option for farmers which eliminates the requirement for a centralised entity for transactions, which eliminate middlemen and scams.

Blockchain technology in agricultural food crop insurance reduces costs, increases efficiency, and improves transparency and trust between insurers and farmers. Food crop agri-insurance creates a shared database that is accessible to all parties involved in the insurance process, including farmers, insurance companies, and government regulators. Moreover, agricultural food crop insurance creates smart contracts. By using smart contracts, insurance companies can automate the claims process, reducing the time and cost of processing claims, and increasing transparency.

The key aspects of the paper include:

- An application framework is implemented using blockchain technology for the food crop agri-insurance supply chain, which guarantees decentralization, traceability and transparency among entities which increases the overall security of the system.
- Implementation of food crops agri-insurance has the facility to claim weather-based crop insurance in case of any natural calamities.
- Smart contracts programmed in the proposed system automatically trigger the claim and payment process when the pre-determined conditions are reached, such as crop damage in the course of natural disasters.

The remaining sections are structured in this way: Section 2 presents related work of blockchain technology in food crop agri-insurance. Section 3 demonstrates the architecture and workflow of the model. Section 4, deals with implementation results and discussion of blockchain-based food crop agri-insurance. Section 5 describes the conclusion.

2. RELATED WORK

Globally, a lot of research has been conducted to address the issues that farmers are facing and to advance the agricultural industry. A blockchain-based agricultural insurance architecture built on the NEO blockchain has been proposed by the authors [14]. The framework, which is built on an Oracle database, has the flaw of only accounting for losses suffered by farmers due to drought and neglecting to account for harsh weather. The authors of [15] have created a transparent, decentralised peer-to-peer grain insurance solution that is open to all stakeholders. This approach promotes trust in a climate where it is lacking in order to assist the farmers in achieving self-sufficiency.

In [16], the authors created a system called "Etheric" to demonstrate how decentralised smart contractual systems, principal-agent models, and restricted optimization affect both demand as well as supply. The researchers of [17] propose an insurance scheme for smart communities based on blockchain (BIS). The smart city administrators, insurance providers, customers, users, detectors, and other gadgets make up this system. Individuals in this framework are identified by their modifiable public keys, which also contribute to some kind of anonymity. In [18], the problem of manipulated claims and fake claims was overcome by creating an

insurance model with a consensus mechanism that assures the system's authenticity. The confidence and decentralisation amongst agricultural stakeholders, including farmers, supply firms, and markets, are represented in this study. The authors of [19] have created a solution for node identification in the IoT paradigm utilising the blockchain. The aforementioned method is capable of preserving the security features of the stored information.

For improved efficiency, the researchers of [20] propose a model based on intelligent IoT as well as data analysis for cellular networks and apps. Similar can be applied to create effective blockchain-based applications. The applicability of blockchain software for enhancing food tracking systems has been reviewed by experts in [21]. This review's objective was to emphasize the advantages and constraints of blockchain software in the food industry, in addition to examining its characteristics. The solution to create certain commercial web apps using intelligence was offered in [22]. The developers of [23] have offered a blockchain-based architecture for the auto insurer industry that can automate the settlement of claims and also regulate insurance coverage for autos. The authors of [24] have proposed a blockchain-based architecture to address the problems caused by environmental disasters like lightning, floods, etc. in the agri sector.

3. SYSTEM ARCHITECTURE

The main concept behind the proposed solution is to execute contracts over a decentralised platform, record the outcomes, and use smart contracts to replace conventional insurance operations. Insurance businesses will benefit from a blockchain-based approach that makes it simple to process requests and detect cheating. If accepted by the insurer, the intelligence contracts will launch an additional review of claims. The complexity and weaknesses of the current insurance schemes can be simply misused. The thieves can use this as a chance to file duplicated or numerous claims with different insurers. Blockchain techniques can make it possible for insurers to work together securely to combat cheating. Records are kept on a global ledger that is secure encryption, and any suspicious attack will disrupt and also stop the operation, avoiding fraud. The key advantage of adopting smart agreements is that it makes the process of submitting claims easier and eliminates the requirement to examine them repeatedly.

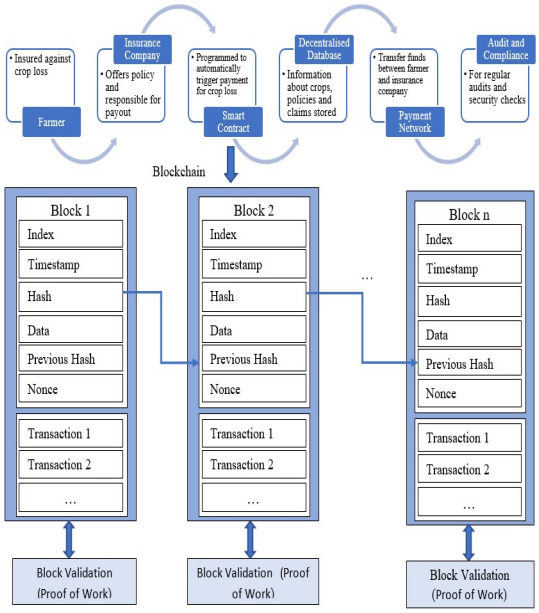

Figure 2. Architecture of Food Crops Agri-Insurance System

Figure 2 illustrates the architecture of blockchain based food-crop agri-insurance and components involved in the system.

3.1 Components of blockchain-based agri-insurance for food crops:

i) **Farmer/Insured party:** Farmers are the entity who is insured against crop loss or damage. Farmers provide information about their crops, farming operations and decide insurance premiums.

ii) **Insurance Company:** Insurance Company offers insurance policies to farmers and is responsible for paying out claims in the event of crop loss or damage.

iii) **Smart Contract:** Smart contracts are self-executing contract codes that are stored on the blockchain. They are programmed to trigger claim and payment processes automatically in case of crop loss or damage. The code gets executed when the precise conditions reached that have been agreed upon between the farmer and the insurance company.

iv) **Decentralized Database:** The decentralized database is where information about the crop, entities involved in agri-insurance, insurance policies, and claims are stored on the blockchain. This information is transparent and secure, and can be easily accessed by all entities involved in the insurance process.

v) **Payment Network:** The payment network is used to securely transfer funds between the farmer and the insurance company.
vi) **Audit and Compliance:** This component is responsible for checking whether all the transactions on the blockchain are executed with their terms and conditions and the system remains secure.

3.2 Safety and quality of agri-food crop using the Blockchain:

Conventional supply chain planning and communication are one directional, providing for just downstream and upstream interactions. These methods are inefficient as well as unproductive because they prevent supply chain participants from becoming able to track a food's origin in the event of contaminated foods or other problems. The decentralised, irreversible blockchain nature allows it to link all of the supply chain's components and save sufficient data from agricultural production to the buyer's plate. Since all parties involved had access to the product's data, there was greater transparency and mutual trust between them. Every step of the distribution chain, including the farmer, food inspector, distributor, retailer, and the weather company records the digital information. Storing data on a network of blockchain is unchangeable and available to all stakeholders, allowing for the tracking of products. Blockchain-based real-time food tracking systems offer a platform enabling data sharing that enables transparency, openness, neutrality, reliability, and security in the agricultural supply chain by giving all participants in the chain exposure to all relevant data. A product's appearance, weather, moisture, light gas content, number of pesticides, artificial colorants, food additives, and other details that are crucial to tracking the product's quality and safety are all recorded using blockchain technology.

Traditional food crop agri-insurance lacks transparency and trust between farmers, insurance providers, and other stakeholders in the agricultural supply chain. Also,the farmers are not given access to the information they need to make informed decisions about their insurance coverage, and insurance providers may not have accurate information about the risks faced by farmers.

But blockchain technology has the potential to address these problems by providing a secure, transparent, and immutable record of agricultural transactions and data. By using blockchain technology, agricultural insurance providers can create a decentralized, trusted system that allows farmers, insurers, and other stakeholders to share information and collaborate more effectively.

The proposed system creates a secure, tamper-proof record of farmers' crop yields, weather data, and other critical information that can be used to calculate insurance payouts more accurately. Additionally, blockchain-based smart contracts can automate the claims process, reducing the administrative burden on insurers and speed up the time it takes for farmers to receive payouts.

Without blockchain technology, traditional agricultural insurance programs could be slow, inefficient, and prone to errors and fraud. By leveraging blockchain technology, agricultural insurance providers can create a more secure, transparent, and efficient system that benefits farmers and insurers.

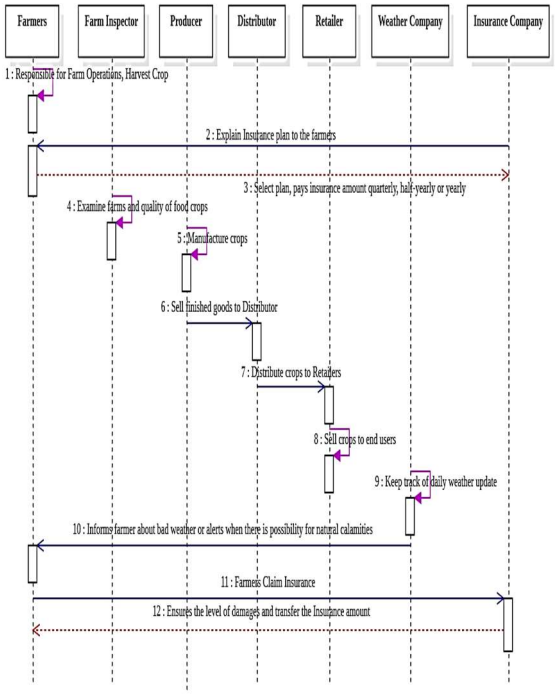

Figure 3. Communication between the entities involved in the food crop agri-insurance

Figure 3 describes the communication between the entities involved in food crop agri-insurance. The following list includes the entities participating in the food crop insurance scheme:

i) **Farmers:** Farmers carry out the tasks of selecting, sieving, cleaning, grading, and filtering while maintaining the crop type, humidity and temperature throughout the procedure. They also select the plan for insurance. Pays the due of the insurance in yearly, half-yearly or quarterly basis.

ii) **Farm Inspector:** Farm examiners have the authority to examine food farms and share information on the crop family, the seed variety, and the fertilisers employed in crop production.

iii) **Distributor:** Distributors are companies that ship crops around the world. The distributor must enter the following information: amount, destination location, shipment name, shipment number, projected time, date and Distributor Identification.

iv) **Retailer:** Wholesalers update quantities, shipment names, shipment numbers, carrier data, storehouse name and address, and the retailer's address after receiving crops from food suppliers.

v) **Weather Company:** They keep track of the daily weather update and warn the farmer when the weather is bad or alert when there is a possibility for natural calamities.

vi) **Insurance Company:** The insurance company explains the plan to the farmers. The farmers select the plan that suits them best. The insurer ensures the level of the damage or the quality of the product claiming the insurance amount that is being ensured.

To provide high-quality service for the farmers, the insurer collects their personal details, information about crops, and locations of the field. Farmers who already have coverage should ensure that they submit their contracts for improved service.

The Distinctive ID (DID) of the plan, the start date of the plan, and the end date of the plan, the insured money, and the geographical dimensions of the field as the vertex of a polygon are all updated when upgrading the insurance plan.

The farmers verify the extracted information, and it ought to be recorded mostly on blockchain like a service housed on a cloud service like Azure, Amazon, Google, and so forth, as a smart agreement with such an insurance plan document.

The geo-coordinates were indeed checked to see if they are located in the area that has been designated by the insurance companies as the position of an instinctual calamity like a dry spell or heavy rainfall once the specifications are modified and the agreement is created.

Whereas if the insurance plan is valid, that is, if it is between the beginning date and also the expiration date. Users can analyse the weather for said land locations with the aid of ML algorithms. Since local weather bureaus typically give weather analyses and forecasts, it is of fundamental use in our system.

Algorithm 1 Smart Contract for Food Crop Agri-Insurance

Input: CID→ Crop ID

FA → Farm Area
EY → Expected Yield
PA → Premium Amount
IS → Insurance Status
MV1, MV2 → Mapping Variables
I → Insurer

1 Define a structure FoodCrop to store crop information {CropID, area, Expected Yield, Premium Amount, Insurance Status}
2 Define MV1 ← Crop Information
MV2 ← Insurance amount to Farmers
3 Define I ← Address of Insurer
4 Define PA ← Premium Amount charged by Insurer
5 Define Constructor function to set insurer and premium amount variables
6 Execute InsureCrop(CID, FA, EY)
If Farmer paid PremiumAmount then
Update crop info. to MV1 and MV2
Else
Crop premium amount not paid
7 In case of natural calamities
If Crop Insured and Insurance Amount paid then
Withdraw payout from Insurer
Else
Crop Not Insured / Premium amount not paid

Algorithm 1 describes the smart contract algorithm, which is a vital part of food crop agri-insurance using blockchain technology to insure the food crops and claim insurance in case of natural calamities. This algorithm is used to execute the claim process automatically and ensure that payments are made by agreeing to the terms of the insurance policy. The agri-insurance process is transparent, secure, and efficient, which reduces the time and effort required to process the claims and makes it easier for farmers to access the insurance coverage they request.

Figure 4 illustrates the sequence diagram which demonstrates the communication between farmer and insurer. The farmer and the insurance company agree on the terms of the insurance policy, including the amount of coverage, premium, and conditions for payment. These terms are then programmed into a smart contract and stored on the blockchain. The farmer provides information about their crops and farming operations, which is used to assess risk and determine the premium. During crop loss or damage, the insurance company provides information about the smart contract, which automatically triggers a

payment to the farmer. The payment is automatically transferred to the farmer's account, without the need for manual intervention. This procedure is secure, transparent, and efficient, since all the entities involved have access to the same information and the payment process is automated.

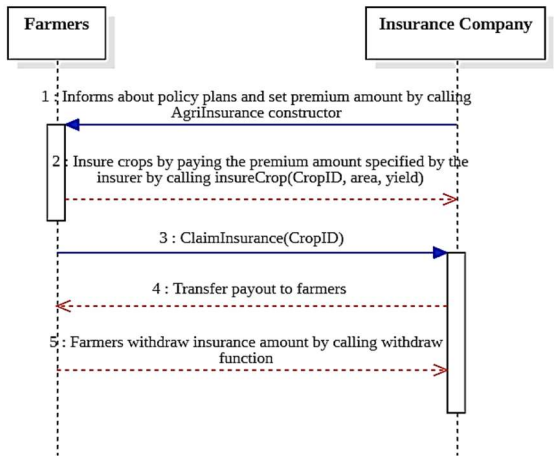

Figure 4. Communication between Farmer and Insurer

Taking into consideration the following to comprehend how algorithms function. Let "Q" stand for the highest payment the insurance will accept from the vendor. In other terms, the merchant cannot profit by charging a larger premium than Q. Let "L" represent the advantages of the payment that the insurance company will profit from the lowest. As an outcome, A € (L, Q) can be viewed as a compilation of alternative premium values that might result in an insurer's favourable value V(a € A) -> Z^+. Assume that Z reflects the overall total of farmers and (X) the overall number of insurers (X ≥ Z). If we assume that farmers as well as insurers both gain equally, we can take into account the following: If the insurance makes an offer of "B" that is consistently random by A and, technically, P(B = a_1) = P(B = a_2) for all a_1, a_2, and a_1, but not a_2, the insurer's expected efficiency is calculated as

$$T[V] = \frac{B^*(Q-B)}{Q^*(X-Z)} \quad (1)$$

In this case, the premium payment calculated by multiplying the possibility that farmers will make an insurance pay-out is the insurer's projected utility. The insurance company's finest offer as

$$B^* = \frac{Q}{(X-Z+1)} \quad (2)$$

The software will make it possible to interchange any farmer's product with a monetary value through the blockchain platform. Smart agreements will control this deal. A neighbouring node validation will conduct a settlement on a payment that adds a new frame [23]. Through a confirmation mechanism, each smart agreement determines the possible execution possibilities. A group of endorsers connected to a particular smart contract carry out this logic. From sign up, policy filing, premium paying, claim processing, etc and reimbursements, our system produces straightforward transactions. The blockchain technology is used to manage and retain transaction outcomes. This eliminates any possibility of fraudulent transactions and holds the insurance company responsible. Farmers must first enrol in order to use the grain insurance service. Farmers can select the appropriate insurance provider from a variety available. The farm worker will include both general information (name, contact information, etc.) and specialised information, like the crops that are grown on the land, the address of the lands, and the size of the crop's cultivation area. The climate monitoring facilities give weather information so that farmers may predict the climate and prepare their crops accordingly. Occasionally, farmers can access the forecasts directly via a variety of sources, including the media and weather applications. Following thorough research, farmers select the best insurance companies, select the premium and term options.

Through a hash ID or perhaps the landowner's Ethereum blockchain location, which he submitted during the enrolment procedure, each of these details is connected to the customer. Through this hash id, all information on the blockchain platform is recorded and made available to those other nodes involved in the payment. To protect the interests of the farmers, several verification measures are put in place, such as key losses. Although every farmer does have a distinct hash ID, as was noted above, subsequent payment on a distributed ledger platform will have the hash ID that was previously used, which could aid in recovering the missing items if it happens. A payment is recorded upon the blockchain platform each moment it is completed. A new node is created as well as appended to the blockchain database whenever the latest transaction occurs.

JavaScript is used to create a blockchain network by using the blockchain framework, Ethereum. Web3.js is used to interact with Ethereum network and a generic blockchain application is built for food crop insurance. Smart contract is coded using Solidity and deployed on the Ethereum network using Remix IDE.

4. RESULTS AND DISCUSSION

Journal of Theoretical and Applied Information Technology
15th May 2023. Vol.101. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Through the creation of a virtual assessment environment that is as comparable to the real scenario as possible, we have carried out some simulations to assess the system's efficacy. The following changes were made in order to achieve the best outcomes because the controllers have an impact on every system's result after it has been run. When the accounts were enhanced, the throughput increased to 223. When the CPU load was 75%, RAM consumption reached 81%.

Figure 5. Food Crop Agri-Insurance Form

Figure 6. Farmer Insurance Application Details

Figure 5 demonstrates the insurance form for farmers to apply in the event of crop loss or damage due to natural calamities such as heavy rainfall, flood, cyclone etc. Figure 6 describes farmers' insurance application details. If the details given by the farmer is valid, insurance will be approved by the authorities and the farmer receives the insurance amount.

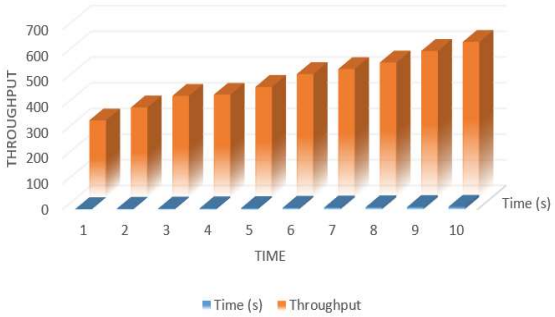

Figure 7. Block Time's Effect.

The block timings are one of the elements that influence how well the system performs. For testing reasons, two clients and 2 controllers were employed, and cloud standard settings were utilized. Here, we discovered that as the frame size is increased, the result decreases. According to Figure 7, the length of time required for block generation is inversely proportional to its time of process. The block durations are fixed at 1s since maximising throughput is the main objective.

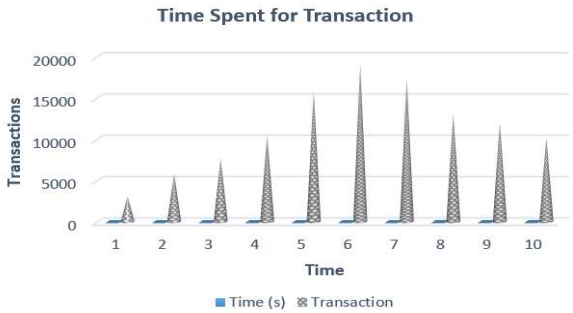

Figure 8. Time spent on each transaction

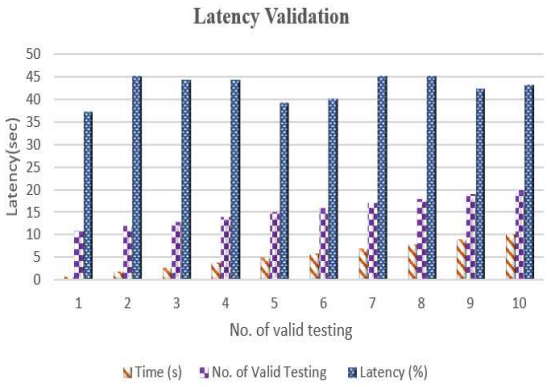

Figure 9. Latency Validation.

Figure 8 displays the time spent on each transaction. Figure 9 demonstrates the dramatic increase in memory that is required to keep the system functional. By calculating the amount of time needed to complete a valid payment, the device's

end-to-end delay was also evaluated. The throughput of the infrastructure along with the amount of time needed by each node in a system to conduct a transaction were taken into consideration while calculating the delay for the initial 20 valid events, also known as trials.

Blockchain-based food crop agri-insurance is a novel solution that aims to provide transparency, efficiency, and security in the agricultural insurance process. The initial goal of this solution is to provide farmers with a reliable and transparent system that enables them to easily access insurance services and receive compensation for crop losses.

One of the main benefits of blockchain technology is its ability to provide a secure and transparent record of transactions. This makes it easier for farmers to access insurance services and receive compensation in a timely and efficient manner. Moreover, blockchain technology can reduce fraud and improve accountability in the insurance process, thereby increasing trust between farmers and insurance providers.

In comparison to current state-of-the-art solutions, such as traditional crop insurance programs, blockchain-based agri-insurance has several advantages. Blockchain technology offers a more transparent and secure system that can reduce fraud and improve accountability. Additionally, blockchain-based systems can provide farmers with more efficient and timely access to insurance services, which can be crucial in the event of crop loss.

5. CONCLUSION

One of the key industries driving every country's economic expansion is the agricultural industry. The majority of developing nations rely on agriculture either directly or informally, and a sizable portion of the population works in this industry. Smart contracts can automatically execute the agri-insurance claim process and make the procedure quick and more effective for farmers. The decentralized and secured nature of blockchain technology can also reduce the risk of fraud and increase transparency and security of the system. Additionally, by using a decentralized platform, insurance companies can reach a wider range of clients and offer agri-insurance to farmers who may have previously been excluded. Nevertheless, this industry is among the most impacted and farmers incur significant damage in the course of any environmental disaster, including storms, flood, drought, earthquakes, etc. Governments periodically launch various crop insurance plans, but the key issue is that all the farmers not actually gaining from them. In this work, we suggested and implemented a decentralised agri-insurance system based on cutting-edge blockchain technology. The method that has been devised will make the agri-insurance system transparent and eliminate the need for intermediaries.

REFERENCES

[1] V. S. Yadav and A.R. Singh, “A systematic literature review of blockchain technology in agriculture.”, In Proceedings of the International Conference on Industrial Engineering and Operations Management, pp. 973-981, July 2019.

[2] Kamilaris, A. Fonts and F.X. Prenafeta-Boldύ, “The rise of blockchain technology in agriculture and food supply chains”. Trends in Food Science & Technology, 91, pp. 640-652, 2019.

[3] G.A. Motta, B. Tekinerdogan and I.N. Athanasiadis, “Blockchain applications in the agri-food domain: the first wave.” Frontiers in Blockchain, vol. 3, p. 6, Feb 2020.

[4] Walter, A., Finger, R., Huber, R., and Buchmann, N. (2017). Opinion: smart farming is key to developing sustainable agriculture. Proc. Natl. Acad. Sci. U. S. A. 114, 6148–6150. doi: 10.1073/pnas.1707462114.

[5] Kaske, D., Mvena, Z., and Sife, A. (2018). Mobile phone usage for accessing agricultural information in Southern Ethiopia. J. Agric. Food Inf. 19, 284–298. doi: 10.1080/10496505.2017.1371023

[6] K. Demestichas, N. Peppes, T. Alexakis and E. Adamopoulou, “Blockchain in agriculture traceability systems: a review”, Applied Sciences, vol. 10, p.4113, 2020.

[7] J. Xu, S. Guo, D. Xie and Y. Yan, “Blockchain: A new safeguard for agri-foods”. Artificial Intelligence in Agriculture, vol. 4, pp.153-161, 2020.

[8] D. Gunasekera and E. Valenzuela, “Adoption of blockchain technology in the Australian grains trade: An assessment of potential economic effects”. Economic Papers: A journal of applied economics and policy, vol. 39, pp. 152-161, 2020.

[9] M. Torky and A.E. Hassanein, “Integrating blockchain and the internet of things in precision agriculture: Analysis, opportunities, and challenges”, Computers and Electronics in Agriculture, p. 105476, 2020.

[10] N. Srivastava, "What Is Blockchain Technology, And How Does It Work?",[Online].Available: https://www.blockchain-council.org/blockchain/what-is-blockchaintechnology-and-how-does-it-work/. [Accessed 18 06 2021].
[11] Finger, R., Dalhaus, T., Allendorf, J. S., and Hirsch, S. (2018). Determinants of downside risk exposure of dairy farms. Eur. Rev. Agric. Econ. 45, 641–674. doi: 10.1093/erae/jby012.
[12] Vroege, W., Dalhaus, T., and Finger, R. (2019). Index insurances for grasslands – a review for Europe and North-America. Agric. Syst. 168, 101–111. doi: 10.1016/ j.agsy.2018.10.009.
[13] Rahim, S.R.M.; Mohamad, Z.Z.; Abu Bakar, J.; Mohsin, F.H.; Isa, N.M. Artificial Intelligence, Smart Contract and Islamic Finance. Asian Soc. Sci. 2018, 14, 145, doi:10.5539/ass.v14n2p145.
[14] Nguyen, T.; Das, A.; Tran, L.; Tq, N.; Ak, D.; Lt, T. NEO Smart Contract for Drought-Based Insurance. In Proceedings of the 2019 IEEE Canadian Conference of Electrical and Computer Engineering (CCECE), Edmonton, AB, Canada, 5–8 May 2019; pp. 1–4.
[15] Iyer, V.; Shah, K.; Rane, S.; Shankarmani, R. Decentralised Peer-to-Peer Crop Insurance. In Proceedings of the Proceedings of the 3rd ACM International Symposium on Blockchain and Secure Critical Infrastructure; Virtual Event, Hong Kong, China, 7– 11 June 2021; pp. 3–12.
[16] Kevorchian, C.; Gavrilescu, C.; Hurduzeu, G. A Peer-to-Peer (p2p) Agricultural Insurance Approach Based on Smart Contracts in Blockchain Ethereum. In Agricultural Economics and Rural Development; New Series, Year XVII; 2020; pp. 29–45. Available online: ftp://www.ipe.ro/RePEc/iag/iag_pdf/AERD2001_29-45.pdf (accessed on 20 July 2021).
[17] Sharifinejad, M.; Dorri, A.; Rezazadeh, J. BIS-A Blockchain-based Solution for the Insurance Industry in Smart Cities. arXiv 2020, arXiv:2001.05273.
[18] Gera, J.; Palakayala, A.R.; Rejeti, V.K.K.; Anusha, T. Blockchain Technology for Fraudulent Practices in Insurance Claim Process. In Proceedings of the 2020 5th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 10-12 June 2020; pp. 1068–1075.
[19] Khalaf, O.I.; Abdulsahib, G.M. Optimized dynamic storage of data (ODSD) in IoT based on blockchain for wireless sensor networks. Peer-to-Peer Netw. Appl. 2021, 1–16, doi:10.1007/s12083-021-01115-4.
[20] Ogudo, K.A.; Nestor, D.M.J.; Khalaf, O.I.; Kasmaei, H.D. A Device Performance and Data Analytics Concept for Smartphones' IoT Services and Machine-Type Communication in Cellular Networks. Symmetry 2019, 11, 593, doi:10.3390/sym11040593.
[21] Feng, H.; Wang, X.; Duan, Y.; Zhang, J.; Zhang, X. Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges. J. Clean. Prod. 2020, 260, 121031, doi:10.1016/j.jclepro.2020.121031.
[22] Khalaf, O.I.; Sokiyna, M.; Alotaibi, Y.; Alsufyani, A.; Alghamdi, S. Web Attack Detection Using the Input Validation Method: DPDA Theory. Comput. Mater. Contin. 2021, 68, 3167–3184, doi:10.32604/cmc.2021.016099.
[23] Nizamuddin, N.; Abugabah, A. Blockchain for automotive: An insight towards the IPFS blockchain-based auto insurance sector. Int. J. Electr. Comput. Eng. 2021, 11, 2443–2456, doi:10.11591/ijece.v11i3.
[24] Paul, S.; Joy, J.I.; Sarker, S.; Shakib, A.-A.-H.; Ahmed, S.; Das, A.K. An Unorthodox Way of Farming without Intermediaries through Blockchain. In Proceedings of the 2019 International Conference on Sustainable Technologies for Industry 4.0 (STI); Dhaka, Bangladesh, 24–25 December 2019; pp. 1–6.