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BLOCKCHAIN-POWERED CROP INDEX INSURANCE FOR IMPROVED TRANSPARENCY AND TRUST FOR INDIAN FARMERS

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Abstract **- Agriculture plays a vital role in India's economy, but farmers frequently face challenges such as unpredictable weather, pest attacks, and irregular rainfall that impact crop yields. Crop insurance serves as a safeguard, helping mitigate financial losses due to these natural calamities. However, traditional crop insurance models are often plagued by complex procedures, high costs, and a lack of trust, discouraging many farmers from adopting such protective measures. To address these issues, this project introduces an innovative blockchain-based crop insurance solution that leverages the advantages of blockchain technology to ensure transparency and security. By utilizing blockchain, every transaction and data exchange within the system is recorded on an immutable ledger, creating a transparent and trustworthy environment for all stakeholders. Smart contracts, embedded within a private blockchain, allow only authorized participants—including farmers, insurers, and weather data providers—to interact with the system. This reduces the risk of fraud and automates claim processing, ensuring faster settlements and increasing overall trust in the system. The core objective of this project is to develop an affordable, low-cost crop insurance model that guarantees timely insurance payouts for farmers who experience valid losses. The decentralized, distributed architecture of the system eliminates intermediaries, reducing costs and protecting smallholder farmers from exploitation. Through the integration of blockchain technology, the proposed solution aims to transform the crop insurance landscape by improving efficiency, accessibility, and trust for farmers.**

Keywords - National Agricultural Insurance Scheme (NAIS), Block Chain, Pradhan Mantri Fasal Bima Yojana (PMFBY), Internet of Things (IOT), Convolution Neural Network (CNN), Machine Learning (ML).

I. INTRODUCTION

Agricultural production and farm incomes in India are frequently affected by natural disasters such as drought, floods, cyclone, storm, landslide, earthquake etc. Susceptibility of agriculture to these disasters is compounded by the outbreak of epidemics and man-made disasters such as fire, sale of spurious seeds, fertilizers and pesticides, price crashes, etc. All these events severely affect farmers through loss in production and farm income, and are beyond the control of farmers. With growing commercialization of agriculture, the magnitude of loss due to unfavourable eventualities is increasing. In recent times, mechanisms like contract farming and futures trading have been established which are expected to provide some insurance against price fluctuations directly or indirectly. But, agricultural insurance is considered an important mechanism to effectively address the risks to output and income resulting from various natural and manmade events. Crop insurance is purchased by agricultural producers, including farmers, ranchers and others to protect against either the loss of their crops due to natural disasters, or the loss of revenue due to declines in the prices of agricultural commodities.

Agriculture insurance is insurance that insures crops of agricultural businesses and individual farmers. In other words, Crop-insurance protects farmers from identifiable and mostly predetermined risks that are not within their control such as:

Figure 1.Crop-insurance

- Drought
- Fire
- Hail
- Cold/Wet weather
- Flooding
- Market Price Shifting

A. National Agricultural Insurance Scheme (Nais)

The National Agricultural Insurance Scheme (NAIS), with the aim to increase coverage of farmers, crops and risk commitment, was introduced in the country from Rabi 1999-2000 replacing the erstwhile Comprehensive Crop Insurance Scheme (CCIS). The main objective of the Scheme was to protect the farmers against the crop losses suffered on account of natural calamities, such as, drought, flood, hailstorm, cyclone, pests and diseases. The Scheme was implemented by the Agriculture Insurance Company of India Ltd. (AIC).

II. LITERATURE REVIEW

The paper Blockchain Based Crop Insurance: A Decentralized Insurance System for Modernization of Indian Farmers (Jha et al., 2021) proposes a blockchain-based crop insurance solution using smart contracts on the

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Ethereum platform for Indian farmers. It describes how the system reduces administrative costs, automates claims, and removes intermediaries. (MDPI)

he article “How Blockchain Can Help Indian Farmers With Crop Insurance” (Outlook India) discusses how blockchain + IoT + smart contracts can increase transparency in crop-insurance by tracking weather data, making claim process automated and visible. (Outlook India)

The paper Impact of blockchain technology adoption in farms of FPO members (2023) examines actual adoption of blockchain by farmer producer organisations (FPOs) in Tamil Nadu, showing that for adopters farm incomes were significantly higher. It implies viability of blockchain in agriculture broadly. (Indian Agricultural Research Journals)

The study Adoption of Crop Insurance by Smallholder Farmers: Farm-Level Evidence from India (2024) analyses why smallholder farmers’ purchase of crop insurance is very low in India (~4.8% kharif, ~3.17% rabi) due to awareness, trust, product complexity. (NASS Publishing)

Another important work: Crop Insurance in India: Key Issues and Way Forward (ICRIER Working Paper) lists structural problems in Indian crop-insurance: delays, adverse selection, lack of transparency, high costs. (ICRIER)

III. METHODOLOGY

The proposed system uses blockchain technology combined with index-based crop insurance to ensure transparency, efficiency, and trust for farmers. The methodology begins with collecting data from multiple sources such as weather stations, satellite imagery, and agricultural records. This data is then preprocessed to remove inconsistencies and ensure accuracy.A permissioned blockchain network is established using a consensus mechanism like Proof of Authority (PoA), where authorized entities validate transactions. Smart contracts are deployed on the blockchain to automate insurance processes, including farmer registration, policy creation, and claim settlement.All transactions are securely recorded on the blockchain using cryptographic hashing, ensuring data integrity and preventing tampering. This methodology eliminates intermediaries, reduces delays, and provides a transparent and reliable crop insurance system.

A. Proposed Method

To design a Blockchain-based crop index insurance system that ensures transparency, automation, and trust between farmers, insurers, and government agencies. Integrate (IoT), weather data, blockchain, and smart contracts.Automate insurance payouts based on predefined index triggers (e.g., rainfall or NDVI).Eliminate manual claim verification and delays.

B. Algorithm Used

The integration of blockchain consensus algorithms, smart contracts, index-based insurance models, data analysis techniques, cryptographic hashing, and oracle mechanisms ensures a transparent, efficient, and reliable crop insurance system. These algorithms collectively eliminate intermediaries, reduce fraud, and provide timely compensation to farmers, thereby enhancing trust in agricultural insurance systems.

C. Dataset

The dataset used in the proposed system integrates weather, crop, satellite, geographic, and insurance data to ensure accurate and reliable insurance processing. Proper preprocessing and secure storage of data enable efficient decision-making, transparent operations, and timely claim settlements for farmers. The effectiveness of the proposed blockchain-powered crop index insurance system depends on the quality and reliability of the dataset used. The dataset consists of agricultural, weather, and environmental data collected from multiple trusted sources. These datasets are used to calculate index values, assess risk, and trigger insurance payouts through smart contracts.

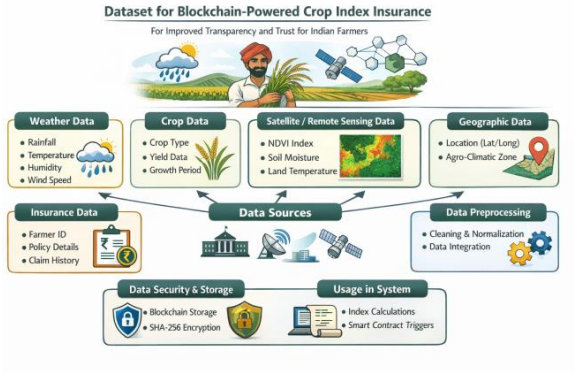

Figure 2.Dataset

D. Preprocessing

Data preprocessing plays a vital role in the proposed system by transforming raw agricultural and weather data into a clean and structured format. Techniques such as data cleaning, normalization, feature selection, and time-series processing ensure accurate predictions and fair insurance payouts. Proper preprocessing enhances the reliability, transparency, and efficiency of the blockchain-powered crop insurance system. Data preprocessing is a crucial step in the proposed system, as the collected raw data from multiple sources (weather stations, satellite imagery, and agricultural records) may contain inconsistencies, missing values, and noise. Proper preprocessing ensures that the data is clean, reliable, and suitable for analysis, prediction, and smart contract execution.

IV. IMPLEMENTATION

The implementation of the blockchain-powered crop index insurance system involves integrating blockchain technology, smart contracts, and data-driven processes. Initially, a permissioned blockchain network is set up

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using a consensus mechanism such as Proof of Authority (PoA), where authorized participants like insurance providers and government agencies manage the network.Farmers are registered in the system, and their insurance policies are created and stored on the blockchain through smart contracts. These smart contracts define the rules for claim settlement based on predefined environmental conditions.Real-time data such as rainfall, temperature, and vegetation indices are collected from external sources using oracle mechanisms. This data is continuously fed into the blockchain system, where the smart contracts evaluate it against threshold values.

When the specified conditions are met, the smart contract automatically triggers the claim payout to the farmer without manual intervention. All transactions, including policy creation and claim settlement, are securely recorded on the blockchain using cryptographic hashing techniques. Thus, the implementation ensures automation, transparency, data security, and efficient claim processing in the crop insurance system.

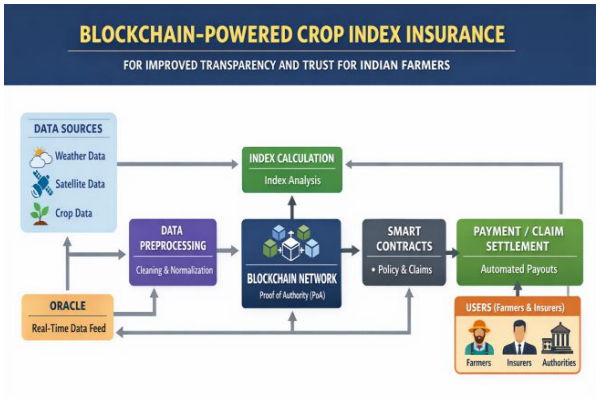

Figure 3.Block diagram

V. CONCLUSION

In conclusion, the introduction of a private blockchain-based crop insurance system represents a transformative leap towards addressing challenges in the traditional crop insurance landscape. By leveraging blockchain's transparency, security, and efficiency, the proposed system aims to create a trustworthy ecosystem connecting farmers, insurers, and weather data providers. The implementation of smart contracts streamlines processes, automates payouts, and reduces the risk of fraud. This initiative strives to overcome the drawbacks of the existing systems, offering smallholder farmers an affordable, low-cost index crop insurance solution with prompt payouts. Through decentralization, elimination of intermediaries, and enhanced transparency, the project seeks to empower farmers, mitigate risks, and contribute to the overall efficiency and reliability of crop insurance in the agricultural sector.

6. FUTURE ENHANCEMENT

The proposed blockchain-powered crop index insurance system can be further enhanced by integrating advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), and mobile applications. AI and ML models can improve weather prediction, crop yield estimation, and risk analysis, leading to more accurate insurance pricing and claim decisions.

IoT sensors can be deployed in farms to collect real-time data such as soil moisture, temperature, and crop health, increasing the reliability of index-based calculations. A mobile application can be developed to provide farmers with easy access to policy details, real-time updates, and claim status.

Additionally, integration with digital payment systems and government platforms can ensure faster payouts and better policy management. Future systems may also support multi-blockchain interoperability and enhanced security mechanisms to improve scalability and data protection.

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