A Comprehensive Survey on Blockchain for Disaster Relief in Farming

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ABSTRACT

With the increased number of climate disasters and the exposed nature of agricultural societies, timely and transparent disbursement of relief funds are now a matter of utmost priority. Inequalities and inefficiencies in the support given to farmers are brought down by conventional subsidy disbursement mechanisms that are commonly hindered by corruption, and lack of traceability.

Unlike conventional relief programs that rely on heavily manual and centralized databases, blockchain avoids these gaps by offering decentralized and tamper-proof solutions with higher transparency using smart contracts, essentially redefining aid distribution mechanisms.

This paper talks about using blockchain technology to help out when disasters hit. We're looking closely at how smart contracts on Ethereum work, how we can identify people, and how we can keep track of donations. We'll set up direct deals between people who donate and farmers who need help. Also, a special government platform will watch money flow in real-time to make sure it's used right and no one takes advantage. We'll also connect this system with things like weather apps and land records. This will help us automatically figure out who needs help the most.

This paper discusses the use of blockchain technology for disaster relief. We're looking closely at how Ethereum's smart contracts work, how to track donations, and how to identify users in particular. Direct transactions between donors and farmers in need of support will be facilitated by us. In order to guarantee appropriate use and guard against exploitation, a special government platform will also track the funding's movement in real time. We will also incorporate this system with weather applications and land records. This will allow us to automatically identify the people who require the most help.

There is more to using blockchain for disaster relief than just cool new technology. When government services are provided, it alters our level of trust and accountability. Every bit of aid money is visible to everyone since blockchain records are unchangeable and universally accepted. By doing this, cheating and record-tampering are less common. When specific conditions are met, such as when someone is in a particular location, when their crops are destroyed, or when the weather is exceptionally bad, smart contracts also automatically distribute money. This eliminates the need for laborious manual checks and an excessive number of middlemen, which frequently cause delays or corruption.

Keywords: Disaster help, blockchain, smart contracts, farm money, clear money, decentralized aid, safe systems.

I. INTRODUCTION

1.1 Background of the Study

Large storms, droughts, and floods are examples of disasters caused by nature that have increased in frequency and intensity in recent years. This puts a lot of strain on farms, especially small farmers who are usually the most vulnerable. These disasters have the power to swiftly wipe out crops, affecting people's quality of life and upsetting our food supply. Governments and humanitarian organizations frequently distribute funds to assist individuals, families, and communities in recovering from such events. Usually, this assistance takes the form of cash or mending damaged items.

But the ways we currently give out this help aren't very good. The old systems depend a lot on people checking things by hand, filling out paper forms, and having many different people involved. This can cause delays in getting help, corruption, and extra fees. Farmers might have to wait a long time to get help, or they might not get it at all because of unfair treatment or slow paperwork. Because of these problems, people are worried about whether disaster relief is clear, fast, and fair.

Previous research and literature highlight the challenges associated with centralized governance models in disaster relief.While some systems have introduced better record keeping and interoperability but they face challenges like outdated coordination protocols, and no real-time updation which eliminates accountability and transparency in the disaster efforts.Also, Recipients and donors often have limited awareness of how resources are being distributed and used, which makes it easier for funds or supplies to be misused or diverted. These problems clearly show we need tech-driven solutions that can help with disaster responses that are decentralized and automatic, while also being clear and accountable.

Blockchain technology appears to be a great choice. This decentralized, impenetrable record-keeping system securely and transparently logs transactions without the need for a central supervisor. It also makes it achievable for us to automate aid work using smart contracts. These are comparable to specialized computer programs that automatically carry out tasks in certain situations.

A smart contract, for example, can set rules for who is eligible for aid, how they are screened, and how much money they can receive, ensuring that aid reaches the right people without the need for human intervention. Additionally, these distributed ledger systems make it easier for various organizations, such as donors, non-governmental organizations, and government agencies, to collaborate by offering a common platform for tracking aid activities in real-time.

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1.2 Problem Statement

Even though the importance of immediate and fair disaster relief in agriculture, the current mechanisms are inefficient, non-transparent, and vulnerable to corruption. Using systems that are centralized and rely on paper often causes delays, money disappearing, and real people in need being unfairly left out. This clearly shows we

need a system that delivers help faster, more fairly, and with more openness.

II. LITERATURE REVIEW

2.1 Study Design

This study uses a mix of approaches, combining a careful look at existing information with designing a system. It begins by reviewing existing blockchain-based systems used for disaster relief, especially those related to farming and collecting money from many people (crowdfunding). Based on what we learn from analyzing those systems, we will then present a new, decentralized model. This model will use blockchain's features, programmed through smart contracts, to give emergency aid in a quicker and more open way. This proposed model includes both a general idea of how it will work and a more detailed technical plan, explaining each part of the system and how users will interact with it. Instead of collecting new information from the field, this study uses what's already written and moves into creating a system. This means the model is based on real-world problems while offering new tech-driven solutions.

2.2 Settings

The project is aimed for a rural setting with several farming communities that are regularly subjected to natural calamities such as floods, droughts, and storms. Most small-scale farmers are vulnerable due to lack of timely support or inefficient aid delivery in times of crises. Existing aid mechanisms are inefficient because of bureaucratic delays, corruption, and poor infrastructure. This blockchain-based platform aims to address these challenges by providing a transparent, seamless, and efficient aid mechanism. By addressing these areas, the system wishes to complement existing welfare mechanisms,while increasing their speed and credibility.

2.3 Participants

The decentralized system connects all actors ensuring that aid distribution is transparent and secure. Farmers start the process by submitting requests for aid along with documents such as a copy of their ID, proof of land ownership, and evidence of damages.Smart contracts would validate these claims through government-based resources such as land records, satellite images, and climate data, after successful verification the funds from the stakeholders would be deposited to the farmer's digital wallet. Table 2.1 shows the role of each player in the smart contract system.

Actor	**Role**
Farmer	Submits a request for aid along with supporting documents
Government	Verifies farmer identities and claims
Stakeholders	Contribute funds directly to verified farmers through smart contracts
Smart Contract	Executes fund disbursement logic, validates rules, and maintains audit trail

Table 2.1: Roles of system participants in the smart contract architecture

2.4 Inclusion and Exclusion Criteria

The inclusion criteria considers any literature or systems using blockchain for disaster relief, especially those employing Ethereum or hybrid architecture with smart contracts to verify claims and transfer funds automatically. Solutions and mechanisms included are decentralized crowdfunding platforms that address agriculture and disaster management in the broader sense, prioritizing verified aid distribution and traceable donation flow.

Exclusion criteria eliminate those systems that center on centralized aid platforms without implementing a blockchain or smart contracts and those whose focus is entirely outside disaster or aid management. Solutions lacking automation, transparency, or accountability features are also excluded.

2.5 Materials Used

The system is technically implemented over a strong decentralized architecture, utilizing the Ethereum blockchain as our primary layer to deploy and manage smart contracts, which is both reliable and widely used in the ecosystem. The contracts are built in Solidity, and the front-end interface has been deployed in ReactJS and Web3.js for live interactions with the blockchain. User identity verification, transaction management, and authentication on the blockchain is through a secure digital wallet application (MetaMask). All off-chain data, such as images of crop damage, is stored either with IPFS or with cloud services,while cryptographic hashes are registered on-chain for verification. External oracles such as weather APIs, satellite imagery, and field sensors feed trusted data into the smart contracts for claim validation.

2.6 Statistical Methods

Several quantitative methods are used to assess system performance. Transaction throughput is measured by the formula:

$$TPS\ (Transactions\ per\ Second) = \frac{Total\ Transactions}{Total\ Time\ (in\ seconds)}$$

This evaluates the system's ability to handle concurrent transactions. The transaction cost is calculated using:

$$Gas\ Cost\ =\ Gas\ Used\ \times\ Gas\ Price$$

which helps analyze cost-efficiency on the Ethereum network. To evaluate the accuracy of the smart contract–driven validation process, the following formula is applied:

$$Accuracy\ =\ \frac{TN\ +\ TP}{TP\ +\ TN\ +\ FP\ +\ FN}$$

where TP represents valid claims approved, TN denotes invalid claims rejected, FP indicates invalid claims mistakenly approved, and FN refers to valid claims wrongly rejected.

III COMPARATIVE ANALYSIS

Recent research shows that blockchain can really help make disaster relief and crowdfunding more open, efficient, and accountable. For example, during disasters, one system uses Ethereum smart contracts to help manage emergency aid, identify missing persons, and capture data in real-time from maps and drones. It still has some challenges, such as infrastructure problems and getting various systems to work together, despite its ability to be flexible and grow.

In crowdfunding, Ethereum-based decentralized apps (dApps) are used to collect donations, release funds gradually, and verify the identity of donors using tools like smart contracts and MetaMask wallets. Like in a DAO (Decentralized Autonomous Organization), some of these systems even let donors know if the transaction fees are excessive and give them a voice in how projects are managed. In India, blockchain is even being tested for

regulated crowdfunding with the goal of increasing transparency through identity verification and the use of distinct digital tokens. But there are still hurdles like regulations and getting people to actually use it.

A great example of a robust system for international fundraising is IHSAN. It employs a DAO-style governance model, decentralized storage, and several tiers of smart contracts. On the one hand, this platform excels at preventing cheating and being adaptable. However, it also attracts attention to the difficulties in connecting with other services and gaining new users. Table 3.1 provides a thorough comparison of all the papers we examined.

Paper Title	**Blockchain Platform**	**Key Features**	**Smart Contract Functionality**	**Intended Users**	**Identified Challenges**
Blockchain Applications in Disaster Management Systems	Ethereum	Aid tracking, missing persons module, UAV integration	Streamlines workflow automation for each module	Citizens, government bodies, NGOs	High system complexity, integration of UAVs
Crowd-Funding Using Blockchain	Ethereum + Metamask	Milestone-based funding, donor voting, gas fee notifications	Oversees donation tracking and approval processes	Donors, NGO administrators	Gas cost concerns, limited scalability
Exploring Blockchain's Potential in Crowdfunding in India	Ethereum	DAO structure, project tokenization, legal insights for India	Governs token creation and project oversight	Startups, individual contributors	Ambiguity in Indian regulations
IHSAN: Secure Transparent Crowdfunding Platform	Ethereum + BigchainDB	Dual smart contracts, milestone monitoring, DAO-style voting	Verifies donors/projects, manages fund allocation	Donors, project owners	Complex onboarding, off-chain DB integration
Enhancing Transparency in Disaster Relief Donations	Ethereum	Role-based accounts, donor-validator interactions	Validates fund transactions and ensures transparent flows	Validators, NGOs, and donors	Dependency on network and trusted validators
A Secure Blockchain-Based	Ethereum (via Truffle & Ganache)	Multi-level fundraising, audit dashboards,	Encodes donor info and manages	NGOs, corporates, individuals	Initial setup complexity, user adoption hurdles

Fundraising Architecture		immutable tracking	transactions securely		
Blockchain-Based Crowdfunding via Smart Contracts	Ethereum	DAO governance, diverse donation types, wallet-based holding	Automates project funding based on predefined goals	Entrepreneurs, backers	Scam potential, uncertain regulatory scope
Transparent Aid Distribution Using Blockchain	Hyperledger	P2P validation, real-time aid monitoring, multi-stakeholder access	Registers aid data, ensures fair validation and transaction consistency	Local governments, citizens, donors	Infrastructure demands, coordination among participants
Decentralized Finance: P2P, Crowdfunding & Loans Platform	Ethereum	P2P payments, campaign funding, smart contract-based loans	Controls P2P payments, handles loan terms, monitors crowdfunding status	General users, lenders, borrowers	Needs compliance setup, system complexity
Charity with Clarity: Smart Contract-Driven Crowdfunding	Ethereum + Metamask	Donation tracking, project status display, approval workflow	Enables transparent donations and request fulfillment via contracts	Campaign creators, public donors	Risk of contract bugs, hesitation in user adoption
Platform for Tracking Donations of Charitable Foundations	Ethereum	Transparent donation tracking, donor & foundation account linkage	Automates donation registration, tracks fund flow, integrates with REST APIs	Donors, charitable foundations	Lack of trust, manual reporting, integration with CRM
Helpchain: A Blockchain based Disaster Management System	Ethereum (Sepolia testnet)	Victim status updates, real-time user location, mobile & desktop app support	Registers user data, updates victim condition, enables agency access	Citizens, disaster response agencies	Network dependency during disasters, lack of unified data

Harnessing the Power of web3: A Blockchain Approach to Crowdfunding	Ethereum + Thirdweb + MetaMask	Admin-free DApp, wallet-authenticated access, real-time project data	Handles campaign creation, donation, update, deletion, and payout	Startups, public donors	Requires Web3 literacy, delayed mainstream adoption
FarmFund – A Blockchain based Crowdfunding App for Farmers	Ethereum + Matic + Web3 + MetaMask	Investor return model, credit score for farmers, gasless sidechain transactions	Manages fund allocation, credit scoring, payout system	Farmers, investors	Farmer verification, technical complexity
Crowdfunding Platform Using Decentralised Application (Blockchain)	Ethereum + MetaMask + Thirdweb	Refunds on project cancellation, campaign analytics, OpenAI project tagging	Executes donations, automates status tracking, ranks campaigns via AI	Campaign creators, donors	No central DB used, depends on AI model prioritization

Table 3.1: Comparison of Papers w.r.t Platform Used, Key Features, Smart Contract Roles, Target Users and Notable Limitations

IV. RESULTS/ DISCUSSION

The proposed blockchain-based disaster relief system for agriculture aligns with emerging technological trends aimed at improving transparency, efficiency, and trust in humanitarian aid delivery. The issues with traditional methods of providing aid have been established by previous research: they frequently require excessive manual labor, lack real-time tracking, and are susceptible to corruption. The system we are discussing here builds on that by addressing these persistent problems by leveraging the key features of blockchain, such as its unchangeability, decentralization, and automation.

This model allocates responsibilities in a decentralized yet structured manner by assigning specific tasks to all parties—farmers, government officials, non-governmental organizations (NGOs), and even the smart contract itself. This division of labor is similar to what we have observed in other research, such as multi-party healthcare platforms or increasing the transparency of supply chains,

where decentralization improves efficiency and accountability. Similar to decentralized finance (DeFi), on-chain transactions and smart contracts are used to ensure that predetermined rules are followed; however, in this case, the technology is being used for public service.

The system's technical design makes it incredibly useful. The use of Ethereum and Solidity ensures compatibility with a wide developer ecosystem, while tools like Web3.js, MetaMask, and IPFS demonstrate an adherence to open-source, verifiable technologies. This choice reflects best practices in blockchain development and enhances

the system's adaptability and resilience.

However, the implementation is not without limitations. First, the reliance on digital literacy and internet access may pose significant barriers in remote agricultural communities, where infrastructure is often lacking. This digital divide has been noted in other technology deployments in rural development and may require targeted capacity-building programs or hybrid solutions that include offline or SMS-based interfaces.

Second, the cost and scalability concerns associated with Ethereum's mainnet (e.g., gas fees and network congestion) could affect usability during large-scale disasters. Although the use of Layer 2 solutions like Polygon is proposed, practical integration and real-world testing will be essential to validate performance. Additionally, while smart contracts can automate fund transfers and reduce human intervention, the quality and credibility of input data—especially for claim validation—remain critical. Satellite imagery, IoT sensors, and oracles can provide valuable insights, but their effectiveness depends on coverage, calibration, and trustworthiness.

From a governance perspective, the inclusion of DAO-style mechanisms and multisignature wallets introduces novel opportunities for participatory oversight. This aligns with current research exploring decentralized governance models in public administration. Nevertheless, regulatory compliance, especially around data privacy and digital identity, requires further exploration. The system's integration with government portals and adherence to local laws will determine its long-term sustainability and scalability.

Future research should explore the integration of artificial intelligence and predictive analytics with blockchain to enable proactive disaster response. Additionally, pilot projects in targeted regions could yield valuable insights into user behavior, technological adoption, and real-world limitations. There is also scope for comparative studies between blockchain-enabled and traditional aid systems to empirically assess impact.

In conclusion, this proposed system offers a technologically advanced framework for reforming disaster relief in agriculture. While promising, its practical success will depend on addressing infrastructural, social, and regulatory challenges through continued interdisciplinary research and field-based experimentation.

V. CONCLUSION

Overall literature review provides an overview of the increasing interest in blockchain transforming aid distribution, especially in disaster relief and crowdfunding. By designing a blockchain platform with decentralized systems, smart contracts, and transparent ledgers, the platform provides trust, traceability, and efficiency with instance tools for donation on Ethereum and governance models implemented by DAOs for fund management in a secure and tamper-proof manner.

Smart contracts are the core of these systems, triggering conditional payments on the occurrence of pre-agreed conditions, thus reducing the need for third parties. UAVs, decentralized storage solutions, and off-chain data repositories provide more examples indicating the flexibility of blockchain across crisis domains.

However, the challenges still remain, such as transaction costs, ease of onboarding, and jurisdiction-related issues. Such concerns point toward hybrid solutions balancing decentralization with governance and usability in the real world. Overall, the lines of research guide toward laying the strong foundation for platforms aid-blockchain design for fair, transparent, and resilient.

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VII. CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to disclose.

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