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An Unorthodox Way of Farming Without Intermediaries Through Blockchain

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***Abstract*— Blockchain technology has the scope of creating a decentralized environment where any third-party organization does not manipulate transactions, and the transaction is recorded in a public ledger permanently within the first-ever occurrence. The backbone of the developing countries' economy depends on farming. When farmers sell their crops, they don't get their desired money following their hard work due to the existence of a loop that always creates an artificial crisis, which causes rise to the price of the farming goods. As a result, the farmer doesn't get this extra money as a middle-man between the farmers and the consumers are taking this extra money out. Though modern farming involves science and technology, still it is centralized and not transparent to all. Based on blockchain technology, the study proposed a decentralized agricultural platform, named KHET to resolve the mentioned issue. This paper constitutes trust and decentralization between agricultural stakeholders such as farmers, supply companies, and markets.**

Keywords— Ethereum, smart contract, gas limit, decentralized, intermediaries.

I. INTRODUCTION

The farming sector plays a vital role in progressing the economic state of a country. GDP of a nation depends on many factors; amongst them farming is the important one. Especially for a country that depends on agriculture more and having low income according to their invested capital. Also, according to FAO, more than 60 percent of the world's population depends on agriculture for survival [1]. If we see the history of developed countries, e.g. (England, the USA, Japan, etc.), we can see agricultural development has helped them to a greater extent in the process of their industrialization and made their economy stronger [2]. In countries like Bangladesh, a farmer who grows cauliflower is forced to sell per piece cauliflower at BDT 1.00 ($0.012) in their village markets. But in cities, when a consumer goes to buy cauliflower, he/she is forced to buy one at least with BDT 30.00 ($0.36). When a consumer purchases their product from a retailer, there is no way they can understand that they are paying at least BDT 29.00 ($0.35) more. Another fact in developing countries is that farmers are poor, so they often take land in lease from rich people and work in their field. As a result, most of them might not have enough money to pay for the required fertilizer. So that the production of the crops in those fields decreases.

Based on the concept of blockchain and traditional agricultural system, the paper has proposed a blockchain-based agricultural platform, named KHET. The system will exploit the advantages of blockchain-like security, transparency, longevity, decentralized architecture and immutability to create trust among the stakeholders. The study implemented a concept on the open-source platform of Ethereum. Stakeholders like market and supply companies (e.g., seed and fertilizer companies) can take the advantages of transparency and invest heavily without worrying about losing money. On the other hand, poor farmers can enter this agricultural system without worrying about the overhead cost. Blockchain provides an environment in the farming system, which is decentralized and trustworthy for all stakeholders related to farming. From the proposed method of this paper, farmers are most likely to be benefited from this decentralized agricultural architecture.

Starting from taking land from the landlord to selling crops in the market it's a long and very complicated process. In that whole process, there are some significant issues. Firstly, when the farmer takes land from landlords sometimes, they don't have enough cash on hand. In that case, they have to take a loan from a bank, but in some scenarios, it's not always available. For sanctioning that loan, a farmer has to pass different terms and conditions of bank policies. Besides that, the farmer also has to pay interest on that loan. The second issue is to have sufficient cash for purchasing fertilizer and seeds in the middle of the season. If a farmer needs more money, then he has to go through the loan process again. The third and the most critical issue is third-party manipulation starting from taking land from the landlord to selling crops to the market. We often see farmers don't get the best price from the market for their goods because of this third-party involvement. So day by day farmers are losing interest in farming. As proof of our concept, we presented a prototype implementation based on open-source Ethereum Blockchain. By taking the advantages of a distributed peer-to-peer network, our KHET platform will hold, manage and control the money that will be transacted in a particular farming season. Here stakeholders are the peers of this network. This platform is the step towards the future of a more transparent and trustable agricultural system.

We introduced a peer-to-peer agricultural platform named KHET. So that there will be no intermediaries involvement between the farmers, landlord, and market. This platform will allow farmers, landlords, supply companies and markets to communicate between themselves and complete the whole process without taking a loan from the bank. Furthermore, this will also help those farmers to sell their products on best price by omitting third-parties. So the major contribution of the paper is:

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• We propose a decentralized farming approach that doesn't involve any middleman.

• We propose a new architecture where the poor farmer can enter without worrying about the initial overhead cost.

• Finally, we introduce a web-based application where our hypothesis will be implemented.

The structure of this paper is as follows. Section II will contain the literature review section provides a briefing about essential works related to our study, while the section III System Requirement and Design and the Background section IV hold the design preliminaries and background of our work. The most important part of this paper is the Prototype Implementation, which is described in section V. In that section, the KHET application is described in-depth while in the section VI Discussion section, some issues related to our solution are described in details. Finally, in the last section Conclusion and Future Work, we summarized our proposed hypothesis, and our plans related to this have been described.

II. Related Work

In the last few years, we have seen a lot of researches that have been done based on blockchain technology. Among those researches, most are done in financial and IoT sectors. Because of blockchains immutability and tamper-proof capability, a lot of researches have been done on sensitive areas like e-voting machine, tamper-proof review and many other fields where trust and security are significant issues [6] [23]. In recent times, IoT is considered a wide-spreading and connecting intelligent devices to the network. Continuously, these devices produce more realistic data. Authors in a paper applied blockchain so that IoT devices can efficiently transfer and utilize the massive amount of data [10] [20] [21] [22]. In recent times the Supply Chain Management system provides information and analysis to help their companies planning activities. Most of the time, these are irrelevant data that cause the disturbance in their planning algorithms. Moreover, double marginalization is a big problem in supply chain management. So, authors in a study applied blockchain to solve information asymmetry and double marginalization [12].

However, in the agricultural industry, blockchain is not explored yet. The authors in a study proposed a traceable agri-food industry using blockchain and some IoT devices [4]. Their goal was to make an auditable identifiable system to trace foods from the farm throughout the whole supply chain [11]. To store this data on the cloud environment, the decentralized cloud is an option to enhance privacy and availability [17] [18] [19].

In research [3], authors tried to consider agriculture as a chain and used the blockchain technology to ensure safety and efficiency at every stage of food production. Where they further discussed the need for a universal contract payment platform and how smart contract insurance against crop catastrophe can help sustainable agriculture. In another study authors researched (PPP) project 'Blockchain for Agri-food' [7]. Their aim for that research was to see how it can impact a specific sector of agriculture and application-based use cases of it.

In recent researches where Blockchains are used in the agricultural field, it's related to two types. One use where different IoT devices are used and then blockchain has used those devices [8], [14], [15], [[16]. Other scenarios are where blockchain is used to track every step of food from farms to consumers fork to ensure food safety [9,13]. But ours is the first work done in this domain where the whole agricultural system is encapsulated in a blockchain. We introduced a farming system where farmers can enter in cultivation without any overhead costs and deducting third-party manipulation from this sector.

III. System Requirement And Design

Farming is related to producer, land-owner, market, supply companies. In this paper, the system has been designed using blockchain. In our system nodes are supply companies, land-owners, markets, and farmers. We developed a smart-contract, if any node is agreed with the contract, then that node is connected to the chain. Our system agreement period is one year long, and if any node agrees with it, then this node will be provided with all supplies needed without any money. When the period of that agreement is over, each node is transected with the required payment (deducting the loan).

A. Farmer node:

- A farmer is a node when he/she uses correct evidence, full name, permanent address, national identity number, valid phone number, and verified by landlord nodes in the chain. This node can enter the landlord Ethereum wallet address and amount that would be paid after the agreement period.
- This node also can enter the fertilizer and seed companies Ethereum wallet address, and the amount of fertilizer and seed, are required for his/her farming so that the payment can be done gradually after the farmer sells her/his crops. A farmer will make a pre-contract with the Market at the same time when the farmer makes a contract with the landlord, fertilizer, and seed companies.
- Whenever a farmer needs any supply like fertilizers or seeds, a transaction is created within a block, in which block may contain farmers' Ethereum wallet address, supplier information, e.g.(fertilizer or seed company Ethereum wallet address, amount, date, etc.). Again farmer produces a crop, then markets collect those crops and provide money through cryptocurrency.

B. Market node:

A market node is like superstores e.g. (Walmart, Tesco, Metro, etc.). The market will collect crops from farmers. Then the value of their crops will be distributed to the supplier and landlords Ethereum wallet address; if that specific farmer has any loan, then the rest of the money is added to farmers' accounts. The farmer's account will get the rest of the money as the profit of their crops. So the whole distribution of funds will be based on the pre-contract made between farmer and landlord. Because of this mechanism, the third party can't participate in the manipulation of pricing in the market.

C. *Landlord node:*

Landlord leases their agricultural lands for a certain period, so when the market sells crops of farmers, the landlord may collect their money from the market directly.

D. *Supply company node:*

Supply companies sell seed, fertilizer, and other materials to the farmer. As they are offering farmers those materials, and they are not taking the goods price immediately. So they can sell products with extra profit so that, when the market pays the cost of goods after the end of the season, the supply company will be benefitted a little more.

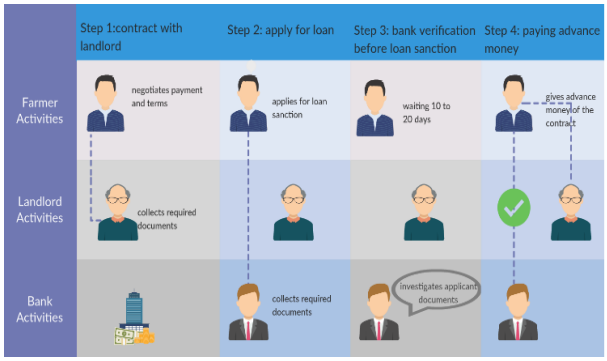

Fig. 1. Traditional land lease process.

IV. Background

As discussed in the introduction part, there are some issues in the traditional agricultural filed. If we look at the conventional agriculture system in Fig. 1, we can see what farmers have to go through before starting their harvesting season. At first, he/she has to apply for a loan to have landed from the landlord and to buy fertilizer and seeds. So, after 10 to 20 days when all verifications are done, the bank sanctions a loan for that farmer. But this valuable time, taken for approving the loan, hampers the farmers season a lot.

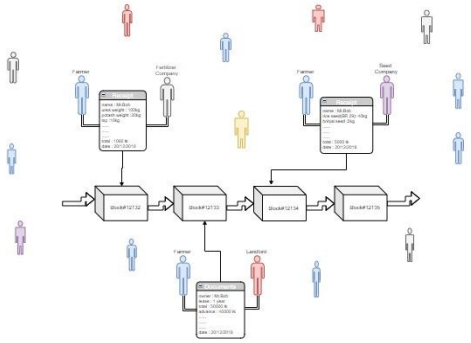

Fig. 2. *The recording process is decentralized farming.*

Moreover, though the farmer gets money from the bank, they have to pay a little more as the interest for that loan, if we look at the full timestamp of harvesting, then we can see farmers need that loan for a short time it's about 4 to 6 months. So if we can make a deal between landlord, suppliers company, and farmer so that farmers will pay the money to the landlord after farmer gets money of their goods, then the farmers don't have to take a loan from the bank. So for that in Fig-2, a community has been created among farmers, landlords, and suppliers company so that they may have intercommunication between them and can pay the money to the landlord and this supplier company after selling the goods on the market. Besides that, we can see in some cases landlords rent their land in a particular condition like farmers have to pay a specific portion of their good's price. So that can also be easily implemented by using our KHET community chain. In that community chain, there are also markets, seed companies, and Fertilizer Company. Farmers also need money for buying fertilizer from Fertilizer Company and seeds from the seed company. We are including Fertilizer and seed companies in that chain. So that farmers do not have to pay that fertilizer money in cash. It will work as a business investment for those companies. Those companies will give fertilizer to the farmers for the full timestamp; in return, the investment company will have some extra profit by selling fertilizer at a little more price than the usual price. Besides that, the farmer will be linked with market nodes, as soon as a farmer starts sowing seeds in their land. So, the market will negotiate the base price of crops directly with farmers so that there will be no third parties to manipulate the price. Farmers will get money from the market through their Ethereum account. Before a particular farmer gets their money, every stakeholder related to that farmer will be paid first. That's how the whole system will be run. For all those transactions of payment, we will use either as currency and use Ethereum blockchain for holding our smart contract.

V. Prototype Implementation

In our implementation, the government will deploy the smart contract. So, our contract will recognize the government as the owner. Here the owner has the capability of choosing fertilizer companies, seed companies, and markets for a season, shown in Fig-3(b). The owner will determine the price rate of fertilizers and seeds, and this price would be maintained for the whole season. Other than this, the owner has no manipulation power.

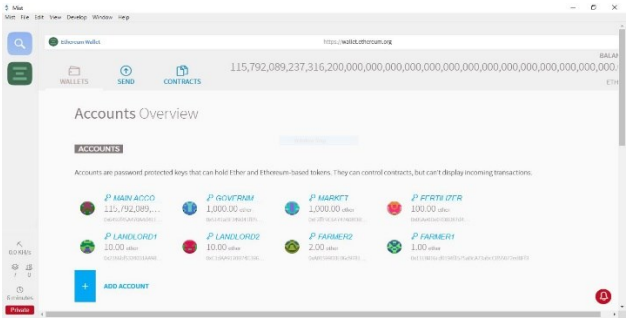

Fig- 3(a) Users of our system

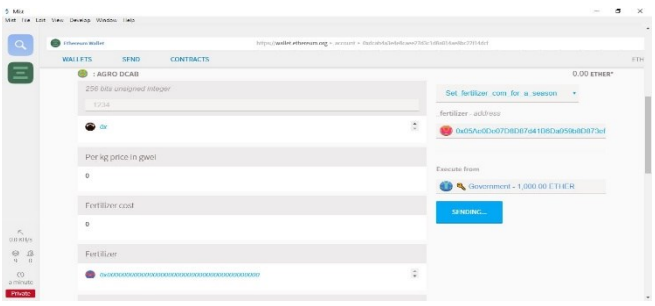

Fig-3(b) Government is entering fertilizer account

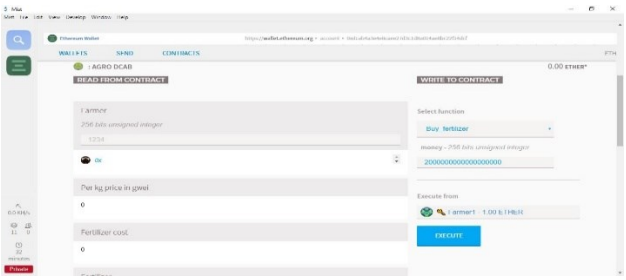

Fig-3(c) Buying fertilizer from the selected fertilizer company

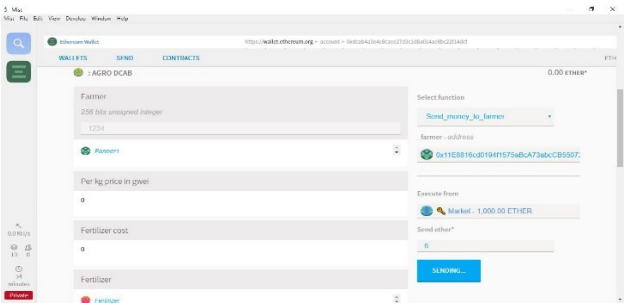

Fig- 3(d) Market is paying farmer after selling their crops

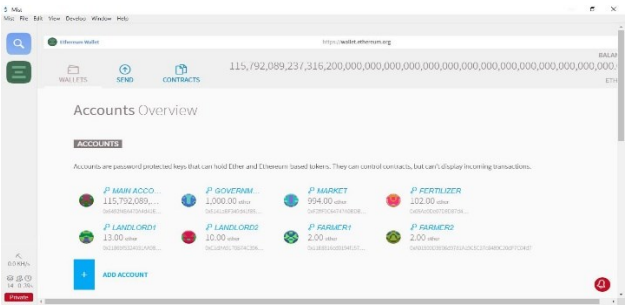

Fig- 3(e) After paying all parties

Fig. 3. Different features in KHET application

At the beginning of the season, the government will open the opportunity of selecting fertilizer companies, seed companies, and markets. Where interested parties will participate in Fig-3(a). By electronic tendering systems, these fertilizer companies, seed companies, and exchanges will be selected [5]. Then their Ethereum address will be added into our KHET platform so that farmers can know whom they will be contracted with. Those farmers and landlords who are interested in involving in a particular seasons agriculture will sign up by this website based application and Make themselves available for the platform. When they sign up, their unique id will be provided by the KHET platform, and their public address will be the Ethereum wallet address.

So when all market, fertilizer company, farmer, landlord, seed company is in the blockchain, the season starts at a particular time. As the blockchain has a public ledger, farmers become capable of checking out those landlords who have lands for rent. If both farmer and landlord accept the conditions, then in the public ledger that area will be allocated to that farmer for that particular season. In this way, the farmer and landlord will have a deal with each other.

So when the land renting process is done from the KHET platform market, seed and fertilizer company knows which are the farmers for that season and how much land they got for cultivation. So they know their customers. And farmers also know their predefined fertilizer and seed companies and market. Here every action is treated as a transaction, so each time an transaction occurs, a new block is created. Because of the blocks being transparent, fertilizer and seed companies know the amount of fertilizer and seeds are going to be needed. Besides fertilizer and seed companies will have a rough estimate of what amounts of production would be required. When companies give fertilizers and seeds to a farmer, this will be added to the ledger as a new transaction between that farmer and those companies so that a new block will be created and distributed in Fig-3(c). The value of the fertilizers and seeds will be kept as a due which must be paid by the farmers after harvesting.

After the landlord and companies give resources to the farmers, the market will associate with farmers. By this time market will know which farmer has sowed which crops and exactly how much each farmer has loaned for their crops. Here, both markets and farmers will have enough information to predict the cost per kilograms of their harvest. At this time, the market will come to the farmer with a pre-contract where farmers have to accept a price after negotiation. This is the price that a farmer ought to sell his/her crops once it is harvested. From the KHET platform market will know about the debt and with whom they have contracted. Here, the market will decide when the harvest will be collected. Whenever yield is obtained, markets have to pay that farmer according to the price of which they have agreed on the pre-contract. This money will be sent to that farmer's Ethereum wallet account in Fig-3(d). This smart contract is implemented in such a way that whenever the market pays a particular farmer, this money is firstly paid equally to fertilizer and seed companies automatically. Then after entirely spending fertilizer and seed company, the landlord's required payment will be transferred to his/her Ethereum wallet account, but the landlord only can withdraw that money after the contract between that farmer and landlord expires. At all times before the agreement between landlord and farmer expires our smart contract will hold the money for the landlord. After the debt of a farmer is fully paid rest of the money is transferred to the farmer Ethereum account in Fig-3(e). The farmer is allowed to withdraw money from their account as much they want.

After the ending of the season, every stakeholder will be removed from our smart contract. With the new season again with electronic tendering new markets, fertilizer, and seed companies will be selected.

VI. Discussion

As we stated above, a farmer is bonded with a contract at the beginning of the season. As the blockchain is immutable so, if a natural disaster occurs in the middle of the season and slowly damages the crops, then the plants will not be able to gather enough money after selling to pay associate parties investments. Then our proposed farming architecture will fail.

Throughout the year in the tropical areas, often there are three harvests. If a natural disaster occurs and one harvest damages, there will be no problem because the rest two will be enough to pay the investors and give the farmer a handsome amount of money. But in the worst case, when two or more harvests are being damaged, investors will fail to collect their

investments. In those cases, an insurance company can be an option. We have a plan of implementing Insurance Company as a node like suppliers companies and act as a rescuer at desperate times. We can also relate insurance companies with the landlord in such a way that insurance companies will insurance for land crops. So if any hazard occurs and damages the crops, the insurance company will pay for them. In these cases, a landlord who has done insurance for their lands can generally charge little more than other landlords. But in general, in emergency times like this government usually, sanction a massive amount of money to support farmers. In these circumstances, in our implemented model government can quickly check every farmer's debt and pay them directly through their Ethereum wallet.

A scenario can happen where a problem may arise if a farmer becomes unreachable after collecting the fertilizer for their crop. In these cases, we can modify the contract in a way that if a farmer disappears after taking the fertilizer in that case landlord of that missing farmer has to pay the debt. As a result, the landlord will be more careful about selecting a person whom he/she will give his land.

In our system, we proposed that anyone can enter in the farming community chain without having any money in their Ethereum wallet account. But we know that every transaction in the Ethereum blockchain needs to pay the gas price to execute the transaction successfully. It would cause no inconvenience for the farmers from the second season because we assumed that the farmer would have some ether left from the sales of the first season harvest. It would be the problem for the farmers who are entering our KHET platform for the first time and the farmers who joined in the first season. A possible solution to that can be the government will introduce a little amount of money in their farmer's Ethereum wallet, who are participating for the first time in advance. The government will collect this money automatically whenever a farmer has successfully paid their debt. Another way can be that farmer has to insert some money when they are entering into the community chain.

VII. Conclusion And Future Work

Our platform (KHET) introduces blockchain technology and fully decentralized peer-to-peer communication between different stakeholders in traditional agriculture. In this system, all nodes are interconnected via Ethereum blockchain. This platform mainly focuses on making conventional farming smarter, removing third-party influence between farmers and the market. Our main goal was to solve those issues and make the whole system more reliable for all. This system works in such a way so that it's a win-win situation for all (farmer, landlord, markets, fertilizer, and seed companies). In the future, we plan to make this application more user-friendly. And as we stated before, we built our platform on Ethereum blockchain, so we have to follow their protocols strictly. To overcome this limitation, building our blockchain can be an excellent option. For that further future study is needed.

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