

## Research on Blockchain-Based Rural Financial Smart Platform

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**Abstract:** With the increasingly expansive total demand of agricultural funding, imbalance between supply and demand of agricultural finance has made peasant households universally restrained by financing, so it is of great priority to perfect rural financial system. The thesis has applied blockchain technology and supply chain financial principle into agricultural production, so as to carry out a study on blockchain-based rural financial smart platform. By adopting distributed ledger, decentralization and asymmetric encryption as core to set up rural financial smart platform, the thesis has confirmed profit affiliating mechanism of all parties together with information digitization to put up with solutions to peasant household financing difficulties. Ultimately, a fairer and more transparent credit system will be built, so as to promote the sustainability of rural supply chain financial service, dedicate into exploring workable programs about releasing difficulties in agricultural finance, and then make contribution of wisdom to build a more beautiful rural area.

### 1. Introduction

Agriculture belongs to weak industry which is high in production cost, and low in input-output ratio and comparative profit. In recent years, the central government has intensified support on agriculture, continuously extended increment methods for peasant households, and vigorously promoted the development of modern agriculture. At the critical stage of agricultural development transformation, both production and sales of high-value farm products are relatively high in capital intensity, so external financing becomes necessary to attain more funding. Difficulty in agricultural financing becomes increasingly prominent and has hence posed constrained agricultural progress. High risk in agriculture is difficult to match with risk preference of financial institution, and has weakened the positivity of financial institution to provide financial support, so limited approach of attaining fund is available to related departments. Meanwhile, agricultural finance is backwards in digitization and information construction.

At present, digital economy maintains on push forward the change of human production and lifestyle. As a revolutionary technology, blockchain frequently invigorates in public, and is expected to lead a new round of technical reform and industrial reform. On May 20th, 2018, Information Center, Ministry of Industry and Information Technology has officially released White Paper on Chinese Blockchain Industry Development (2018) which is the first official white paper about blockchain industry in China. The application and promotion of big data and blockchain technology in finance has provided possibilities to solve problems in agricultural finance. After completing digitization in various parts of agriculture, decentralization, trustlessness, openness and tamper-resistance of blockchain are adopted to bring a brand new mode for developing rural finance and even agriculture.

### 2. Common reasons of difficulties in peasant household financing

In recent years, China has gradually increased financial support on agriculture, and its rural financial system has begun to take shape. With the emergence of upgrading tendency in farm product value chain, financing restraints brought by imbalance between agricultural finance supply and demand has been increasingly exposed. To transfer the right of fund use, financial institution

shall be based on the following premise: the borrower shall possess repayment ability, and an effective debt obligation fulfillment mechanism can be set up to control credit risk. Being located at the foremost end of industrial chain, there lack of symmetrical information and valid guarantee between peasant households and financial institution, so peasant households are confronting with severer credit constraint. Rural financial market is at preliminary stage of development, medium and small financial institutions progress in a slow way, for the total scale of stock market is relatively small and species in market are simplex, a variety of obstacles are existing ahead of financial institutions when serving for agriculture, rural areas, and rural residents.

First of all, peasant households widely and sporadically distribute, so it's difficult for financial institution like bank to investigate on peasant households' economic credit status and trace their borrowed money<sup>1</sup>. Secondly, transaction cost of financing and due high interests required by loans have posed economic pressure on peasant households<sup>2</sup>. Thirdly, being scattered and complicated, petty loans may increase the operation cost of financial institutions. Fourthly, restrained by systems, financial institutions including banks are rather prudent in approving loans. Fifthly, greatly affected by uncertainties, agriculture owns a higher failure rate than other industries, and the high risk of lending to peasant households is inconsistent with prudent operation principle held by financial institutions.

### **3. Advantages of rural financial smart platform**

#### **3.1. Adoption of supply chain finance**

Unpredictable elements like natural disaster and market fluctuation may directly impact on agricultural production, and most peasant households have no capital to realize scale advantage. Rural finance is limited in its service scope, only a small part of peasant households will be directly benefited, others can only sustain simple reproduction as their accumulate rate is low. Agricultural industrialization in some areas begins to take shape, and some influential enterprises have appeared. Relying on these enterprises, supply chain finance can be adopted to analyze internal transaction structure of agricultural industrial chain, so as to introduce fund into agricultural industrial chain and reach the goal of overcoming the exclusive risks in agriculture<sup>5</sup>. The platform applies the mode of finance, properly affiliates not binds with its core enterprises, upstream and downstream medium and small enterprises and peasant households, scientifically and rationally designs finance products, so as to satisfy various parts of financing requirements on agricultural supply chain.

#### **3.2. Adoption of decentralization management theory**

Traditional financial platform is generally based on decentralization management theory, supported by financial institution and relies on core enterprises to endorse with all parties in credit. Credit enhancement of core enterprises heavily occupies the whole supply chain, imperceptibly undertakes huge risks and objectively adds the difficulty in realizing supply chain finance. Rural financial smart platform has adopted blockchain technology, ensured that no mutual trust is required among each nodes of distributed system, so as to attain point-to-point transaction, coordination and cooperation on the basis of decentralized credit. Meanwhile, by means of data encryption, timestamp, distributed consensus and economic incentive, problems like high cost, low efficiency and insecure data storage which universally exist in centralized institutions can be solved<sup>4</sup>.

#### **3.3. Construction of a stronger credit relation**

The platform has constructed a stronger credit relation based on blockchain technology and hence released the dilemma that core enterprises are not willing to burden credit endorsement. Under the traditional supply chain financial mode, core enterprises are required to have credit endorsement on the whole binding supply chain. In rural areas, no valid information screening system has been set up, most enterprises flinch in front of the binding mode of core enterprise + cooperative, objectively, the possibility of realizing supply chain finance has been decreased. Blockchain-based financial platform and distributed system with algorithm-formed decentralization

have broken the trust relation which is constructed by purely relying on centralized institution. As for data storage, blockchain has applied chained block structure with timestamp, its ultra-strong traceability has built trustable protection screen among all participants of agricultural supply chain, so as to solve the problem of trust loss among participants in agricultural production.

### 3.4. Strengthening on data reliability and security

Generally, financial platforms are highly open, so data is easy to be tampered. Cryptography in blockchain technology can ensure that all data cannot be tampered. Rural financial smart platform adopts hash function and asymmetric cryptography to construct a fairer and more transparent transaction platform. Hash function mainly focuses on compressing, by inputting binary number sequences of random lengths, hash algorithm can be used for outputting hash value of fixed length. It's difficult for encrypted hash function to calculate initial data from results; its particular value output can only be calculated in a forward direction through attempting each method one by one. In asymmetric cryptography, each pair of key includes public key and private key. Public key will be publicized, and private key is kept by owner. After encrypting all transmitted data, information sender will use private key to send information to receiver, and the receiver will applied known public key of sender to decrypt data, confirm the source of information and verify authenticity and objective existence of given information.

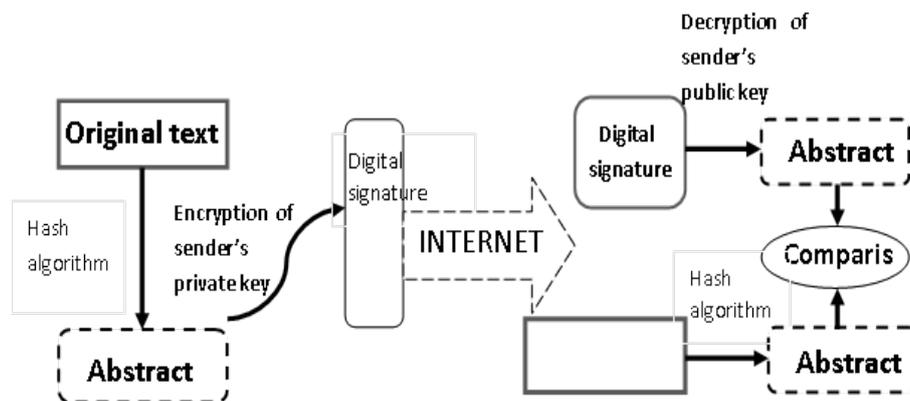


Figure 1 Block chain technology principle

Meanwhile, the financial transaction of whole supply chain is related to a great amount of manual inspection and paper-recording transactions with high risk, high cost and low efficiency. Blockchain technology has invisibly decreased error rate, and beneficial to improve financial transaction efficiency. Digitized smart contract can automatically conduct contract as scheduled time and condition are reached, so as to enhance binding force.

### 4. Design plan of rural financial smart platform

Blockchain-based rural financial platform relies on supply chain binding and information digitization. Peasant households will firstly join in cooperative, and then regional core enterprises are bound with cooperatives to form an entire structure of functional chain. Especially, this binding process needs no credit endorsement from core enterprises and aims at breaking information barriers in agricultural finance. Chained structure can effectively accelerate the speed of information spreading between supplier and demander, adopt professional social labor division to decrease circulation cost, promote operational efficiency and economic benefit of all participants on the chain, so as to form entire competitiveness advantage of supply chain and advance the development of agricultural industrialization. Each peasant household on supply chain is viewed as a data node on blockchain, by digitally processing all information, regulation and standard, a decentralized and huge information database will gradually be formed. All information has been verified, screened and protected by asymmetrical key, each piece of individual information will form a sharing information network through integration. At least 51% hash rate of the whole network is required to

tamper data, and cost of counterfeiting information significant varies from related total loan. All parties on the platform precede open and transparent information communication and financial transaction under stated regulations.

#### 4.1. Platform Internal affiliating mechanism

In the existing market environment, information asymmetry has obstructed a valid link between peasant households and enterprises; it's difficult for both parties to seek for profit maximization. Family-based operating unit is not good for realizing scale development; the participation of peasant households into agricultural cooperative organization has become an irresistible tendency of transiting from traditional agriculture to modern agriculture<sup>5</sup>. On rural financial smart platform, capital chain operation needs multi-party cooperation, every business entity owns its interest demand, only by well understanding their demands can agriculture be promoted to a higher level. First of all, vertical departments in enterprise select proper cooperatives, and inspect, screen and bind with their fixed assets, organization structure and leader qualification. Secondly, financial institution will assess the transaction credit of bound supply chain, and evaluate enterprise, enterprise, and cooperative and peasant households in supply chain. Lastly, a paper contract will be signed between enterprise, cooperative, peasant household and debtor, creditor, professional cooperative is the main loan entity<sup>6</sup>, when signing a contract, loan allocation mechanism and benefit allocation mechanism should be specified, and farm product's purchasing price shall be confirmed. By digitizing related information and recording it into system, blockchain-based financial platform can realize all financial transactions<sup>7</sup>. The loan party opens a public account to receive loan release whose proportion is confirmed by financial institution according to cooperative's comprehensive evaluation. All members in cooperative will apply for withdrawing loan step by step based on weight range of acquired loan, and then pay for the rational expenditure generated in production. After a certain period, the platform internal information screening mechanism will work to screen peasant households with no credit out, and list quality peasant households as alternative object for credit extension<sup>8</sup>. As agricultural production begins, agricultural enterprise is responsible for selling cooperative's indispensable production materials on credit, providing production information and technological guidance and recording information on platform. Data about raw materials, production process and technical standard will be recorded on blockchain and distributed based on time node to realize verifiable and traceable. Cooperative will deliver harvested farm products to enterprises for profit, preferentially pay back loan to financial institution, and calculate profit with peasant households.

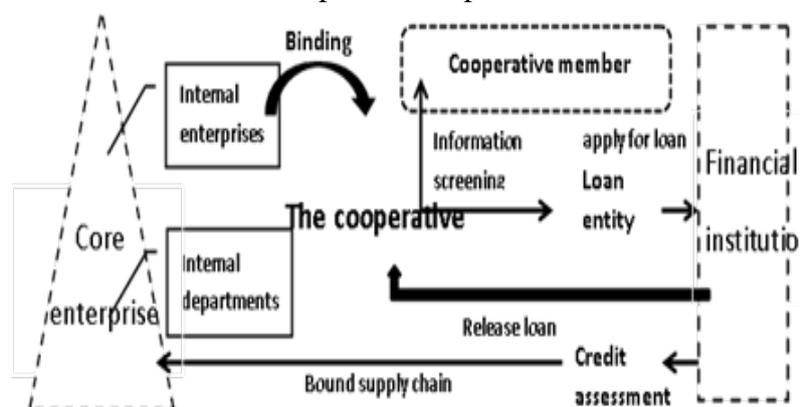


Figure 2 benefit affiliating mechanism

#### 4.2. Program of constructing platform database

Basis of confirming cooperative's loan limit. Core enterprise selects proper cooperative for binding into a new supply chain which may be viewed as an important foundation for financial institution rating, so the selection of cooperative is of great importance. By combing with

investigation conditions, the thesis takes cooperative scale, leader qualification, cooperative-enterprise distance as key indicators on assessing agricultural production cooperative, through entropy weight method, each cooperative can be scored in a comprehensive way to determine related credit amount. The credit rating index system of cooperative is as follows:

Table 1 Cooperative's credit rating index system

Index	Content	Attribute
Cooperative scale	Cooperative scale= cooperative's land holding quantity/ all cooperatives' land holding quantity	Positive
Leader qualification	Leader qualification=Quantity of enterprises which have once cooperated with cooperative leaders/ Quantity of enterprises which have once cooperated with all cooperative leaders	Positive
Cooperative-enterprise distance	Distance between cooperative and enterprise=distance between cooperative and enterprise/ distance between enterprise and the farthest cooperative	Negative

Basis of whole supply chain evaluation. After completing a valid binding between enterprise and cooperative, both parties need to confirm the amount range of recycled farm products, stipulated farm products' protective price, and then calculate the total price of farm products purchased by core enterprises: total price of farm products purchased by agricultural enterprises=quantity of raw materials purchased by agricultural enterprise\*purchasing price of raw materials.

Farm products which are beyond the scope of recycling will be uniformly sold by cooperatives under the leadership of enterprises, so the wholesale price of rest farm products=quantity of rest farm products\*wholesale price in market

Financial institution needs to assess bound whole supply chain and transaction credit, and confirm ultimate earnings of cooperatives: total earnings of agricultural production cooperative=total prices of farm products purchased by agricultural enterprise + total wholesale price of rest farm products

Surplus fund of supply chain=total earnings of agricultural production cooperative-loan capital and interest

When surplus fund of supply chain conforms to cash flow standard, financial institution will continue on transaction credit appraisal on this supply chain, choose qualified supply chain for loan and sign four-party agreements.

Calculation basis of peasant households' interests increment and loan limit. Agricultural professional cooperative will allocate earnings according to contribution made by each peasant household. Contribution made by each peasant household is mainly determined by owned cultivated land area. Generally, cooperative members are divided into two categories: 1. Pooling of land as shares. When peasants join in agricultural production cooperative, their lands are converted into shares based on certain land quantity and quality, delivered to cooperative for unified management and production management. Cooperative will calculate reward according to member's number of share. The second category: peasants directly produce and operate their own lands; cooperative assigns production input materials, and uniformly purchases farm products. Members of the second category are related to loan, and loan limit is based on estimated value of harvested farm products/

### 4.3. Construction of rural financial smart platform

After confirming supply chain benefit affiliating mechanism and completing early-stage preparations, construction of rural financial smart platform will be preceded. Blockchain-based rural financial smart platform consists of data layer, network layer, consensus layer, activation layer and smart contract layer. Data layer lies at the bottom with data block and technologies like data encryption algorithm and timestamp. Network layer is divided into three parts, namely distributed networking mechanism, data spreading mechanism and data verification mechanism. DPOS

consensus mechanism is contained in consensus layer. Activation layer mainly consists of distribution mechanism and allocation mechanism of economic activation, which is aimed at activating nodes for autonomous mining. Contract layer adopts programming technology more to encapsulate various scripts, algorithms and smart contracts. Financial institution can set different smart contracts by concentrating on diversified supply chains, all transaction information of platform are recorded on nodes, released loans can be traced by financial institutions, so as to save a large amount of time and manpower. As shown in the following figure:

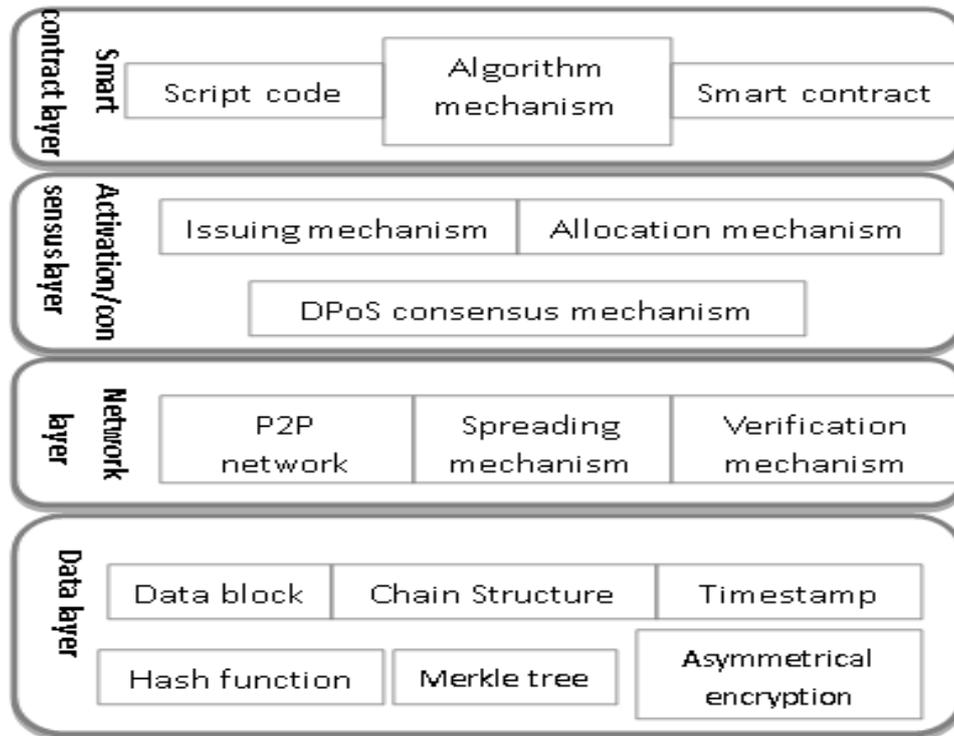


Figure 3 Platform infrastructure model

## 5. Further explanation on platform blockchain technology

### 5.1. Data layer realization

In a certain period, data layer may receive different transaction data and codes. Through adopting specific hash algorithm and Merkle tree data structure, each distributed data encapsulates data and code in a data block with timestamp and then links to the existing longest main blockchain, so a latest block is formed<sup>9</sup>. Data block consists of head and body, by applying hash algorithm, initial data will be coded into specific character string and then recorded in blockchain, a longest main chain from genesis block to current block can be attained by a chained structure formed by the current block's parent block hash value and the front block hash value, hence, data traceability and positioning function can be realized for further carrying out block addition. Nodes with ledger right will be stamped with timestamp in data block head, for the sake of avoiding data tamper, each block will then form a time network according to time sequence.

Hash algorithm penetrates the whole process of platform operation, double SHA256 hash function can be used to convert initial data of random length into binary numeral of 256 bits (32 bytes) after twice hash algorithms and then for uniform storage and identification<sup>9</sup>. Meanwhile, SHA256 algorithm is highly collided, so probability of hash collision is relatively low. Merkle tree is applied to realize rapid conclusion of transaction and verification of block data integrity, and two Merkle trees will be created as transaction tree and receipt feedback tree. Merkle tree groups data transaction for hash algorithm, by inserting a new hash value into Merkle tree for upward recursion, only a root hash value is eventually left and denoted as Merkle root. Each hash root always contains

two neighboring data blocks or their hash values<sup>9</sup>. Merkle tree supports SPV, so as no complete blockchain network node is operating, transaction data can be verified<sup>10</sup>. Asymmetrical encryption often adopts public key and private key (two asymmetrical codes) for encryption and decryption, the mechanism operation is shown in figure 4.

When other users have received information b from M1, firstly, they will find its public key in M1 address, uses M1's public key to decrypt information b, and then connect information a with M3's public key. Through comparing between hash algorithm and decryption result, information will be deemed as coming from M1 if they are identical, so as to realize platform's encryption on information.

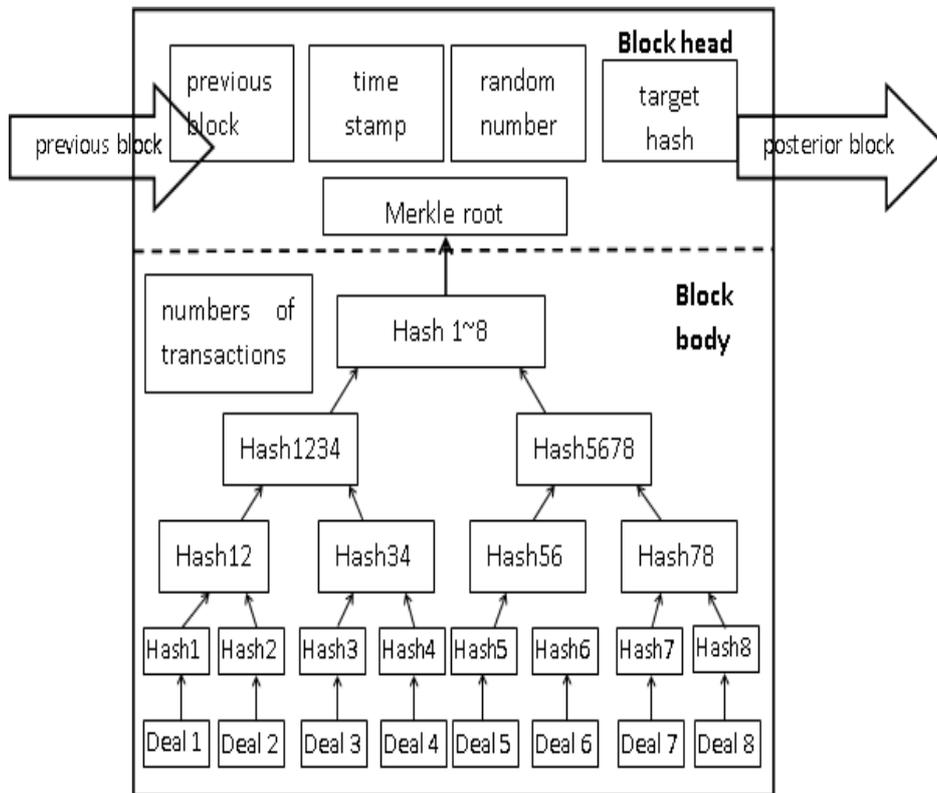


Figure 4 Block structure

## 5.2. Application of network layer

Financial smart platform applies P2P network, and network nodes interlink in flat topological structure<sup>11</sup> to realize decentralization. Each node undertakes functions of network route, verification of block data, spreading of block data and discovery of new nodes<sup>9</sup>. Data spreading on platform has referred to Ethereum, and possesses two branches- active delivery and data request. As long as transaction data is received, the node will broadcast to other nodes of the network, all nodes will store attained transaction data in one block, and any node which have not received the information can request data from neighboring nodes. When nodes receive transaction information from neighboring nodes, data verification mechanism takes effect to verified data validity. After verification, data will be orderly forwarded to neighboring nodes, any invalid information will be terminated in delivery and any invalid information spreading is forbidden. All platform data synchronously scatter in all nodes, and then the advantages of decentralized system are manifested. Only by finding an operating node, the lost main chain data can be recovered, so as to avoid the disruption of data loss on records of other block data.

## 5.3. Setting of consensus layer and activation layer

The platform has selected DPoS consensus mechanism which bestows each node with self-determined option, through implementing scientific democracy, negative effects brought by centralization can be offset. The principle is to make each shareholder to vote 101 super nodes with

completely equal right. In accordance with set schedule, transactions will be packaged and settled in turn. As nodes are unable to produce new blocks, nodes will be removed, and then network will select new super node to take place. In addition, activation mechanism is an important method to encourage network mining on financial platform. In order to stimulate miners to mine, the platform will issue virtual currency to successful miners. Activation mechanism can ensure total hash rate based on sufficient value, maintain decentralized operation of financial platform and improve platform security.

#### 5.4. Creation of smart contract layer

Contract layer is necessary for the whole financial platform to realize a successfully operation, smart contract is achieved by program code, owns programmed regulation and logical, and relies on virtual machine on financial platform to carry out. Contract signing doesn't rely on any central organizations, and platform can objectively represent all parties to implement contract. All contract parties like financial institution, agricultural enterprise, cooperative and peasant household have reached an agreement on contract content, contract breach condition, contract breach responsibility and external inspection data source; any complicated clauses can be added through codes. On the basis of guaranteeing the accuracy of program code, a smart contract is formed. Operation mechanism of smart contract is shown in figure 5.

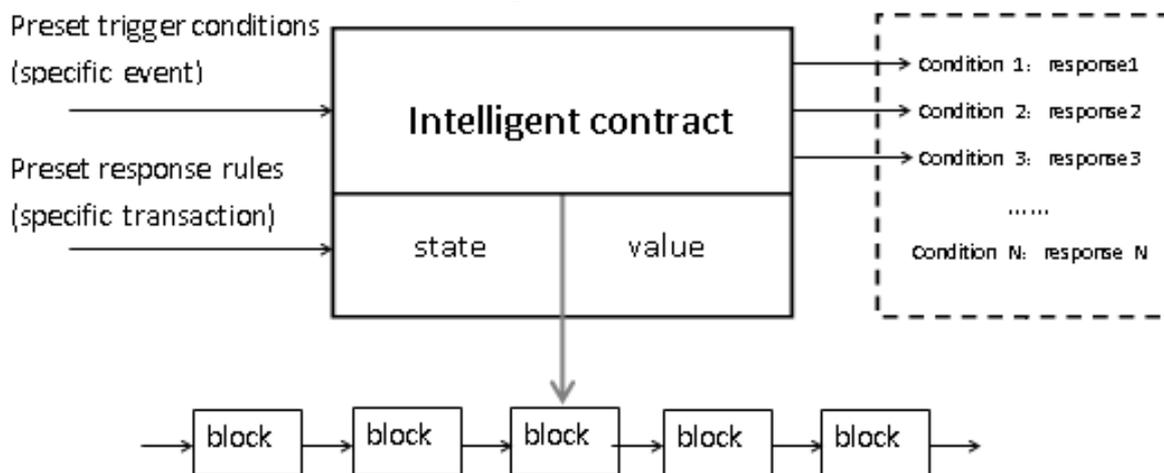


Figure 5 Operation mechanism of smart contract

In general, internal data on financial platform bear program codes of smart contract, and contracts will be recorded in specific blocks through P2P network spreading. Smart contract has encapsulated some predefined statuses and conversion regulations, triggered scenes of contract execution and response in specific situation. Blockchain can realize real-time monitoring on smart contract status, and activate and execute contract through verifying external data source and confirming the satisfaction of specific triggering condition<sup>9</sup>, as a result, all parties' appeal of fund on the supply chain can be met.

#### 6. Disadvantages and suggestions about platform

First, rural financial smart platform is constructed on vast data information, blockchain has innovated method of information recording, but unable to solve problems in data resources. As a result, establishment and completion of agricultural big data system need to be accelerated.

Second, based on different types of cooperative, various credit assessment index systems will be generated. As for processing cooperative, annual power consumption is a key index. Platform's credit assessment index system on cooperative is not limited to cooperative scale, leadership qualification and distance between cooperative and enterprise.

Third, Operation of rural financial smart platform requires financial institutions like banks to provide basic credit information, after a period of operation; platform can rely on algorithm to

gradually set up integral credit information. Meanwhile, peasant households' inflexible constraints should be envisaged, and peasant household performance fulfillment mechanism.

Forth, rural financial smart platform is in need of support from government to be set up, by properly deregulating control over non-governmental finance to a certain extent, some shortcomings of bank-centered indirect financing mode can be remedied.

Fifth, Owing to professional restraints, the thesis has only generally studied the technological aspect of rural financial smart platform, related opinions may not be perfect, but the application of blockchain in agricultural field leads the future development. It is expected that the thesis can raise some opinions and thoughts to enlighten future researches.

## 7. Conclusion

In conclusion, rural financial development is positively related to agricultural economic growth, so increasing construction and perfection of agricultural financial system will definitely transform agriculture to a higher level. Solution to agricultural finance shall be based on core enterprise and cooperative, and the construction of rural financial smart platform has somewhat broken financial restraints on peasant household medium and small-sized enterprise. The rapid development of internet and its profound coupling and strong feedback on physical world have fundamentally changed modern society in production, living and administration decision<sup>9</sup>. Platform construction has to consistently confirmed benefit affiliating mechanism between core enterprises and medium and small-sized enterprises or peasant households, so as to gradually form a fair and transparent credit system. By applying advantages of blockchain technology, informatization, digitization and traceability of agricultural finance can be attained, so supply chain can be opened up step by step, industrialization scale can be expanded, agricultural development can be promoted to serve for building beautiful village.

Financing difficulty cannot solved immediately, government needs to continue on improving external environment, invigorating agricultural finance, sparing no efforts on promoting stability among each financing entity, and then stimulating agricultural development to form a virtuous cycle.

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