UnionChain — Agricultural Product Blockchain and Agricultural Brain: The DAO of the Future Society

Abstract—**UnionChain is an agricultural product blockchain project aiming at building a Decentralized Autonomous Organization (DAO) of the agricultural product industry chain with blockchain technology, artificial intelligence (AI), big data and cloud computing technology. The DAO is managed, owned and used by all organization members. Through the construction of a reasonable value distribution mechanism/economic model, people from the production, distribution, trade, consumption and ecology building sections of the industry will be rewarded and motivated. Thus a healthy value network will be realized.**

Union Chain is not an "enterprise" in the traditional sense. It has subverted Coase's Enterprise Boundary Theory by creating a tokenized community organization with Unionchain token (UNION) representing all rights and interests. The "working as mining" method pioneered by the UnionChain community is a re-construction of the stakeholder transaction structure by encouraging enterprises and individuals in the production, circulation, trading and consumption sections to upload their data to the blockchain to get rewards.

UnionChain provides a brand-new model of world operation. Smart contracts/Data enabled by every user combines to provide a multi-contract space parallel to the real business world.

UnionChain provides an "agricultural brain" solution that is different from the AI solutions developed by current Internet giants in that the data in this "agricultural brain" is not controlled by the giants but the owners. With its high transparency and efficiency, this decentralized solution will be adopted by the industry in an in-depth level and thus give impetus to the development of advanced technology.

I. DESIGN CONCEPT

A. Industry Pain Point

1) Food safety: Social concerns on food safety are mainly focused on nutrition safety and health safety. Food safety has become a national strategy of many countries. New technologies such as IoT traceability system are introduced. However, the supply chain of food is long and complicated with a wide coverage, which leads to many problems such as lack and imbalance of information, variable storage methods, high cost, excessive length of industry chain, bad management, speculation and fraud. Even the newly launched blockchain anti-counterfeiting & traceability system can only guarantee the safety of the process instead of the origin.

2) Low production efficiency: The production methods of agricultural products are mostly outdated with families as the main units of production and these units are scattered across the country. The mechanization, automation and informationization of production process is relatively low. The regionalized distribution, the large-scale plantation, the Make-to-Order production method and the industrialized development haven't been realized. The barriers between industry sections of plantation, processing, storage, logistics, distribution and retail has driven transactional costs higher. Successful enterprises in some sections of the industry can never expand to the whole industry chain because of enterprise boundaries.

3) The industry finance system is not inclusive enough: The agricultural finance basically relies on small-sized traditional financial organizations. These organizations are hard to permeate into the rural market and hinder the intensified scale effect and the efficiency of agricultural production.Agricultural enterprises and households have low loan values and scattered operations. Their operational data is difficult to access and credit level is hard to assess, which makes them hard to meet the criteria of loan lending of traditional financial organizations and enjoy financial service support in the upgrading of the industry.

B. Solution

UnionChain is born to sovle the three problems mentioned above. By combining blockchain technology with AI, big data and cloud computing, UnionChain is dedicated to business process refinement, production efficiency improvement and comprehensive industry finance.

UnionChain guarantees a trusted process through the applications of digital identity, digital data and digital voucher. After uploading to blockchain, the data can't be altered anymore. Proof of completion, proof of time, proof of inter-data relationship are provided. Right authentication is completed by the consensus reached by digital vouchers. Solutions of registration, distribution, transferring and monitoring are also available.

UnionChain introduced the technology of IoT by sensors. These sensors are able to collect data automatically, which saves manual labor. Data collected will be analyzed by the agricultural brain to support the authenticity of data origin.

UnionChain introduced the trusted node witness mechanism to confirm trusted nodes. Through a reward & punishment system, UnionChain is able to raise the cost of fraud and motivate the community in a positive direction and build a food safety ecosystem for all through autonomous operation, which supports the credibility of UnionChain. Following Fig. 1 gives end to end flow regarding agricultural product trace.

The DAO organization structure and the economic model that UnionChain employs will change the production relationship and reward all stakeholders according to labor by a benefit circulation and benefit reflection mechanism. This lowers the transaction cost, breaks down section barriers, improves transaction structure and redefines the make-buy economic model, thus improving the autonomous governance of the organization and improving industry efficiency.

The token economy practice of UnionChain is naturally compatible with comprehensive finance.
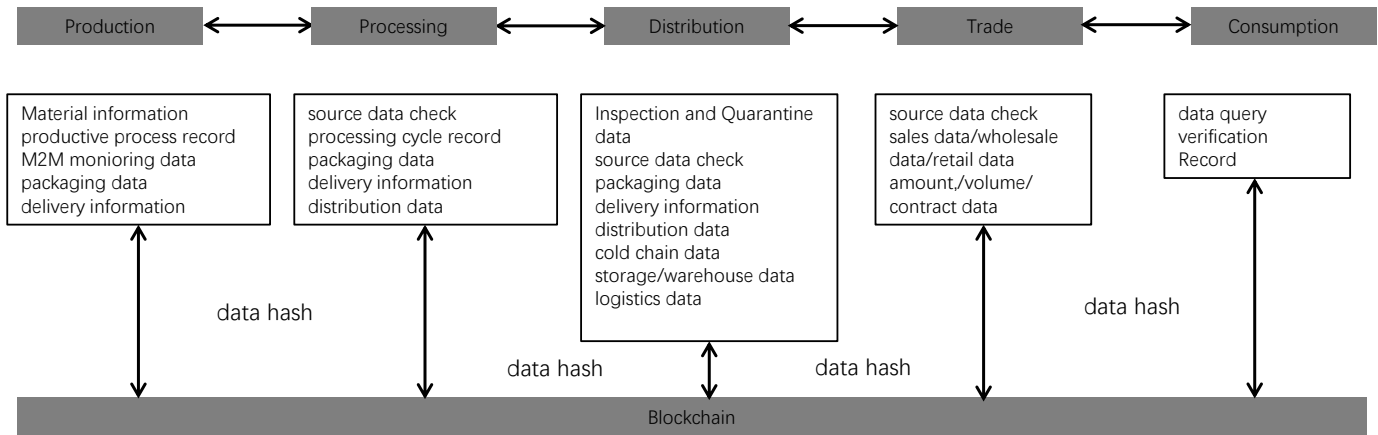
Fig. 1: End to end agricultural product trace.

1. The blockchain finance solution provided by UnionChain upgrades bank credit to business trust, which serves through the purchase, production, inventory and sales section and provides related investments. Through standardization and decentralization, the assets are divisible, transferrable and tradable with high liquidity and asset authentication. The four "streams" of logistics, business, information and capital are thus integrated. Following Fig. 2 gives an example for supply chain fintech based on account payable.
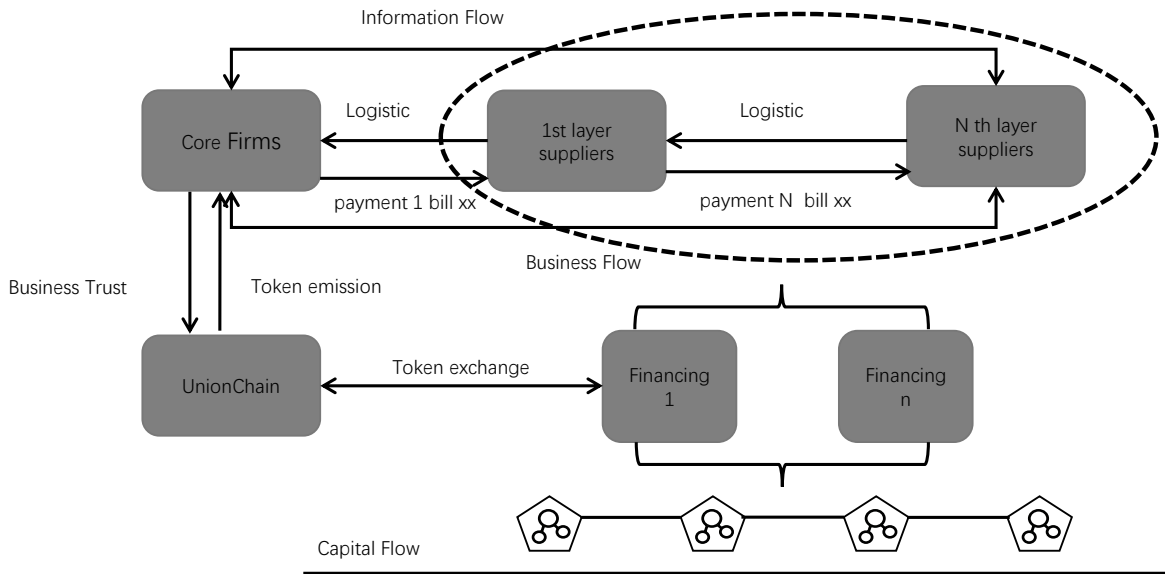

Fig. 2: An example for supply chain fintech based on account payable.

2. The consumption finance solution provided by Union-Chain is able to reach a good decision by building a risk management model on trusted data with sufficient data verification and logical inference. The decision is made by the autonomous smart contract without any third-party permission. The farmer purchases different data contracts according to his/her digital asset credibility for individualized consumption finance products. For example, farmers who worry about the harvest because of the bad weather can purchase a weather insurance smart contract on UnionChain. Following Fig. 3 shows an example on financial smart contract.

II. CORE TECHNOLOGY

In essence, agricultural product blockchain is a system built on the industry and the blockchain. It inherited many advantages and key features from blockchain, AI, big data, cloud computing and other existing software and hardware.

Similar to the "impossible trinity" of the freedom of capital flow, the stability of exchange rate and the independence of monetary policies, there is an "impossible trinity" in the blockchain industry too, that is the high efficiency on low energy, safety and decentralization.

The design of our agricultural blockchain follows the "impossible trinity" principle and guarantee the safety and efficiency by disposing trusted nodes through a certification & authorization charging mechanism.

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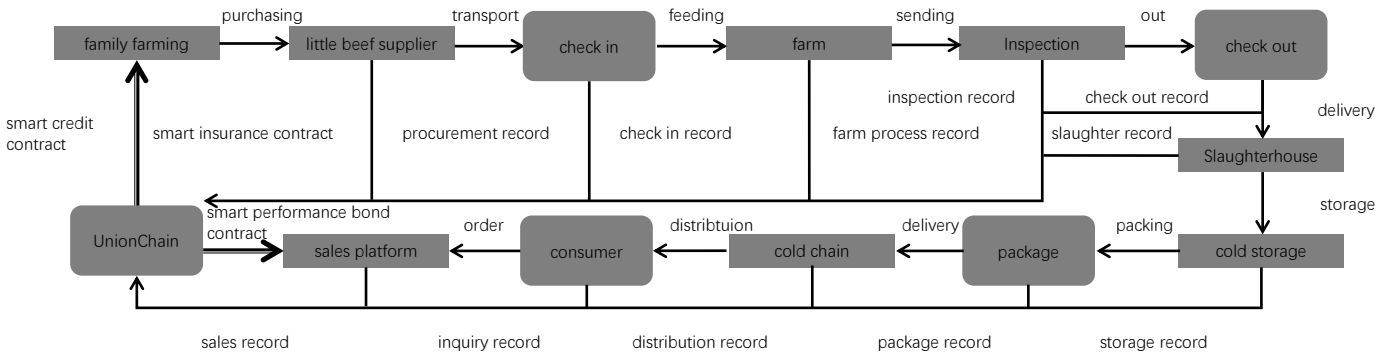
Fig. 3: An example on consumption finance solution based on beef supply chain.

Agricultural blockchain employs the operator and manager features of the operator network and manage the network by layers and regions to guarantee the functionality of nodes in this large network. Access layer, convergence layer and core layer are defined in the physical layering. Information is restrained to enhance efficiency in each layer. Some nodes are responsible for sending information to improve operation and management ability of the network. Visualized interface management ability is also included.

Agricultural blockchain inherited virtualization and parallel computing ability from enterprise network and cloud computing. By becoming a trusted node on the main chain, a corporate account will be able to dispose many nodes to end users within the enterprise network. The nodes in the enterprise network then form a new independent blockchain and has its own blockchain database. This corporate account can then choose to generate its own digital assets cUNIONs or use UNION directly. The information exchange between corporate accounts are comopleted by the trusted nodes on the main chain. The exchange of cUNIONs and UNION is also completed at the same time.

Agricultural blockchain adopts the modularization package design and the decoupling design of the four core blockchain functions: digital assets generation, block generation, nodes consensus, mining. Different function modules are independent with high cohesion and low coupling.

The nodes on the blockchain can be categorized into four sets based on their functions: router forwarding, block verifying, private key saving & transaction launching, account status saving & transaction history saving. The developer can combine different sets to launch a node he/she needs, add it into the network and serve different end user demands.

Agricultural blockchain introduced the concept of "governing". The definition of "governing" here is that people reach consensus on collective actions and execute their decision. The governance could be changed by changing the rules. Therefore, the governance is not only conducted by the coding. Above the coding, the trusted nodes that formed the main chain have the right to authorize block producing nodes to execute their power.

A. Core Technology Structure

Core technology structure of Agricultural blockchain like a TCP/IP four-layer of the Internet. the four-layer logical model as showed below:

Application layer	Smart farm, smart production, smart wholesale, smart logistics, smart retail
Contract layer	Trust contract, supply chain financial contract, consumption finance contract, traceability contract, dispute resolving contract
Dialogue layer	Support no status, event-driven and Turing-complete automation scripts. The smart contract and the base ledger are in different layers and are interactive and separated in logic and data. The tokens are modularized.
Network layer	Peer-to-peer network, supports mesh, end-channel-cloud structure, elastic computing and distributed storage InterPlanetary File System.

Agricultural blockchain components:

B. Smart Wallet:

Users can store their encrypted digital assets in the smart wallet, which has mobile versions that supports Android and IOS plus desktop and web versions that support Windows, Mac OS and Linux. There are several transaction pairs in the smart wallet to support decentralized transactions. The project team will develop a hardware wallet in the near future that will innovatively combine private key insulation, BLE technology and trusted mobile phones to provide the safest method to store encrypted currencies. We will also cooperate with several popular wallets to realize the maximum usage of our hardware wallet.

C. Information System:

All agricultural data will be on the blockchain to realize end-to-end management. Each section of agricultural production, trade, transportation and consumption is traceable. Logistics, business flow, information flow and capital flow can all be stored, connected and used. A re-development of business can be done by adding blockchain function without changing the current cloud structure system to realize the co-existence, switching and transferring between new businesses and current businesses. The system supports visualized smart contract templates. It can generate different smart contracts for administrators with different authorities, which lowers the threshold for smart contract generation and increases system flexibility. Apart from the smart contract template,

the system also supports an API to make developments more convenient and automated system operation and maintenance to enhance efficiency and save human resources. The roles in the information system are: producer, custom, wholesale platform, new-retail platform, logistics, merchant, consumer, government, system integrator, operator and agency.

D. Hardware:

In the blockchain world, hardware is just as important as software. Apart from the hardware wallet, we will also develop a series of trusted devices to integrate blockchain function to NB-IoT module, WiFi module, Bluetooth module, Zigbee module, RFID module and NFC module. Blockchain mobile phones, blockchain wearable cameras will also be launched. The blockchain mobile phone will serve the functions of mobile end on hardware wallet, software wallet, QR code and code scanning. The blockchain camera are for real-time monitoring and will upload photos and videos onto the blockchain automatically which can prevent human error and fake data. We will closely check the progress of TIP, Terragraph, project fi and pCell and examine the possibility of them on the blockchain mobile phone. Phoneblock and 3D cameras features is under discussion also.

E. Agricultural Brain

Agricultural blockchain provides an agricultural brain solution through the combination of blockchain, cloud computing, big data and AI. There are 5 layers of models in the brain solution, with each being a closed-loop system that includes both hardware and software.

Scene Layer	Composed of devices at the scene, which include: QR code, RFID, nfc, bar code, camera, temperature and humidity, infrared, optical fibers and other sensors, robots, robotic arms, lathes. These devices will automatically collect texts, photos, videos, sounds and other data and upload them onto the blockchain.
Control Layer	Controlling the devices at the scene and achieve automation by PLC/DCS, SCADA, IPC through HMI.
Communication Layer	Including wired networks such as industrial Ethernet, field bus, switchboard, WiFi, Zigbee, microwave, FTTx and wireless networks such as LTE.
Management Layer	This layer is the node of section activities and data exchange. It has three functions: perception, dispatching and planning and is compatible with the MES layer in the industry sector. It realizes nimble and flexible movements based on indicators, data and constrained conditions with various configuration.
Corporate Layer	Including product development, product design, routine management and product life cycle management. Compatible with CAD, CAE, CAM and other CAx, CRM, ERP, PLM systems. It can realize C2B2M according to demands in a flexible manner.

Combining temperature and humidity sensors, optical fiber sensors and other sensors with computer visual deep-learning technology and acoustic features to create digital profiles for behavior characteristics analysis, life cycle management, agriculture intelligent analysis and full-chain tracing to achieve the end-to-end monitoring of agricultural product growth. Data of pests, humidity, climate, soil, immunity, variety, days of age, weight, feeding, movement frequency, movement track…cover every section of agricultural product industry from land cultivating, seeding, fertilizing, pest-killing, harvesting, storing, breeding, cultivating, transporting to final sales, which improve agricultural production efficiency and guarantee food safety from the farm to the table.

Super robotic warehouses, smart delivery robots and drones are employed to improve efficiency. The three scenes of people, vehicle and goods generate real-time data for the agricultural brain, who conducts the most efficient people-vehicle-goods match-up of international, domestic and local town deliveries with the support from logistics centers of the highway system, the railway system, airports, port cities and online smart logistic platforms. The delivery power map shows the distribution of drivers; the goods flow map shows where the goods come from and where they are going as well as the distance in between; regional and municipal goods distribution status and industry distribution status can also be obtained. We will be able to conduct forecasts on product sales and move the products near consumers in advance by big data analysis. we can carry out risk management, industry trends analysis, etc. by doing these, repetition and invalid actions can be removed, no-load runs can be prevented and thus reduce carbon emission and guarantee the orderly operation and efficiency of the economy.

A series of agricultural product indicators will be publicized through the agricultural brain.

The agricultural brain successfully displays the advantages of the three integrations and prevents their disadvantages:

Horizontal integration	the automation of nodes of different sections on the same layer. The seamless cooperation between trusted nodes of up and down stream enterprises is realized. Applications such as traceability, anti-counterfeiting, supply chain finance, consumption finance, agricultural insurance and big data marketing are developed.
Vertical integration	including the four layers of operation, executive, control and equipment. This mainly solves the problems of intra-enterprise integration and network-equipment connection on information isolated islands. Within the integration system, information in different sections are seamlessly connected to control all actions from material preparation to product retail, which keeps the transaction cost at its lowest level. The DAO model also prevents the prevailing problem of low responding speed of a large, complicated organizations.
Life cycle integration	end-to-end product management from the value dimension. It stretches from the front-end sections such as product design, production plan, product engineering, production implement and services to back-end sections such as product life cycle transaction, transportation and consumption.

F. Special Features of Agricultural Blockchain

Here are the highlights of our agricultural blockchain:

- Supporting large consumer pool
  We connect the end consumers and deal with millions of users and their data. We have the ability to support a large consumer pool.
- Excellent user experience
  Our blockchain is efficient: high TPS, low latency, parallel management of internal storage via various technologies, optimization of distributed management, quick response.
- Extensibility
  It has the flexibility to upgrade and support new applications. It supports software, algorithm and smart contract upgrade. Blockchain nodes can be extended smoothly to construct a large mesh network.
- The ability to operate and manage
  The system supports OAM tool and has a visualized interface. Operation and analysis are made easier and multi-authority and multi-region management are possible.
- Safe and reliable
  The node network and the software and hardware system are highly reliable and safe from large scale attacks with the ability of quick bug fixes.
- Sound compatibility
  Modular design. API ports are provided to connect software and hardware. Plug-ins are supported.

III. ECONOMIC MODEL

A. Introduction to Unionchain Digital Assets

Unionchain token digital assets is abbreviated as UNION. As the basic digital assets of the system with a total quantity of 1 Billion. The total quantity of UNION is fixed and there will be no additional issuing. UNION serves the function of value storing. It can be used in the following circumstances:

1) Equities of community.
2) Mortgage for being a witness.
3) Mortgage for being a platform.
4) Community incentives by future mining.

B. Unionchain token Liquidity Control

Unionchain abides by the Metcalf's Law and adapts to market liquidity by a specific algorithm. Set liquidity threshold as $E(t_n)$. When market liquidity $S(t_n) > E(t_n)$, lock up liquidity by filter to block abnormal address. When market liquidity $S(t_n) < E(t_n)$, conduct open market operation and release liquidity. t_n Set time interval as $T, t_0, t_1, \ldots, t_i, t_i + 1 = t_i + T$, the market liquidity formula is as follow:

$$E(t_n) = \lambda S(t_{n-1}) f\left(k \frac{E_T(t_n) - S(t_{n-1})}{\lambda S(t_{n-1})}\right)$$

$\lambda = \left(1 + \frac{L}{100}\right)^{1/N} - 1$, $S(t_i)$ refers to the liquidity of system S at time t_i. N refers to liquidity management frequency within a year. L refers to the increase rate of liquidity within a year. $f(x)$ is a Sigmoid function. k is the coefficient. $E_T(t_n)$ refers to the liquidity needed to be released. It is expressed as follow:

$$E_T(t_n) = \begin{cases} E_T(t_{n-1}) + K\Delta A(t_n), & \Delta A(t_n) > 0 \\ 0 & \text{otherwise} \end{cases}$$

K is the coefficient, $A(t_i)$ refers to node activity at time ti. $\Delta A(t_n) = A(t_n) - A\max(t_{n-1})$ is the increase of network activity, $A(t_n) = \sum_{i,j} l_{ij}(t_n)$, $A_{\max}(t_{n-1}) = \max(A(t_i), t_i \in [t_0, t_{n-1}])$.

$l_{ij}(t_n)$ is constructed by w_{ij}, w_{ij} refers to the total transactions from address i to address j within the time interval of T. It indicates weight.

$$l_{ij}(t_n) = \begin{cases} 1 & wji(tn) - wij(tn) > 0, \\ 0 & \text{otherwise} \end{cases}$$

$$w_{ij}(t_n) = \sum_{\substack{k \mid i \to j, \\ t_k \in [t_{n-1}, t_n]}} a_k$$

ak refers to the amount of the kth transaction.

C. Circulation and Reflection Mechanism

The UNION issued are purchased by end consumers and will be distributed proportionally to nodes'(users') contribution(influence) to the network. The defining factors of contribution(influence) include: data generation, data transaction, data consumption and UNION holding time(stake+activity). The transaction structure of stakeholders is optimized through this benefit circulation and benefit reflection mechanism.

D. Trust and Anchoring

Company Unionchain digital assets are abbreviated as cUNIONs. It is the currency issued internally by core enterprises of the DAO and is linked with the credibility of these enterprises. It is pegged with asset pledge and serves as a trust. Through building a blockchain + supply chain financial service system in the three stages of "purchase, operate and sell", agricultural blockchain securitizes the pre-payment, inventory and accounts receivable. The cUNIONs digital assets have applied new meanings to Fintech and Techfin such as agricultural product weather insurance contract. The total quantity of cUNIONs will be decided by the core companies according to different scenes.

Unionchain supports Market Pegged Assets solution. UNION as the basic assets can be used to support the mortgaging and cashing of cUNIONs through smart contract.

E. Unionchain token Digital Assets Distribution Plan

Community rewards: "working as mining" model is employed to gradually reward community organizations and individuals on their contributions in operation, management, innovation and marketing.

Founding team & founding investors: rewarding individuals contributed in the initial business model design, technology development, application scene realization, core resources lead-in, initial capital lead-in.

Public sale: fund-raising from cornerstone investors to invest in constant technological innovation, market development, operation and services, organization cooperation, business realization, co-construction of industry, etc.

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Strategic partners: linking the upstream and the downstream organizations and individuals of the industry with digital assets as the bond.

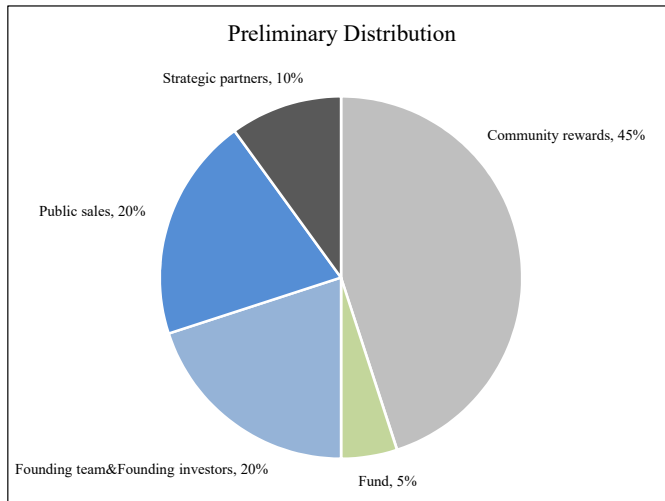Fund: Operation, public market operation and financial management of Unionchain fund.

Fig. 4: Unionchain token Digital Assets Distribution Plan.

F. Unionchain Profit Model and Reward Plan

Unionchain is a network of value and has ability to gain profitability. All main businesses and extended businesses are sources of profit:

Unionchain provides enterprises and individuals with food safety traceability SaaS services.

Unionchain provides agricultural brain services.

Unionchain provides blockchain hardware sales.

Unionchain commissions proportionally from DAO incentives.

Unionchain provides fin-tech and tech-fin services such as supply chain finance and consumption finance.

Unionchain community rewards are released to community members through UNION digital assets under the "working is mining" model.

G. Unoinchain Digital Assets Mangement

Unionchain provides customization of cUNIONs to core companies and supports the exchange between cUNIONs and UNION. cUNIONs is circulated internally through credibility and mortgage.

Unionchain supports Market Pegged Assets. UNION as the basic assets can be cashed with cUNIONs via smart contracts.

Unionchain builds a liquidity management function, which can absorb or release liquidity according to supply and demand with management tools.

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