

# Blockchain in Food and Agriculture Supply Chain: Use-Case of Blockchain in Indonesia

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## ABSTRACT

Agriculture is one of the most important and largest sectors in Indonesia and creates jobs for at least 38.7 million workers. Although the number of workers in agriculture is relatively high and the sector contributes 14% to Indonesian GDP, many challenges still remain hampering growth. One of the key issues is the limited data availability in the agriculture sector causing imperfect and incomplete information on agriculture products. Data can provide the information about the quality of the product to the consumer to create transparency between producer and consumer. In order to facilitate data access, a big data base is needed in which all stakeholders can access the near-time data. A technology that can help to support this database is called blockchain. Blockchain is an immutable, transparent, public and append-only ledger. It is a peer-to-peer network that can maintain updates and verifies those updates to the ledger in a way that it is impossible to alter the data. This paper discusses HARA, a use-case of blockchain implementation in the food and agriculture sector.

## KEYWORDS

Agriculture, Blockchain, Indonesia, Rice, Supply Chain

## INTRODUCTION

Agriculture is one of the most important and largest sectors in Indonesia. According to the data from Indonesia's Central Bureau of Statistics (Badan Pusat Statistik, or BPS), the number of the working population in the agriculture sector in February 2018 was 38.7 million people (Badan Pusat Statistik. n.d.). This number is around 30.45% of the total working population in Indonesia. Although the number of the working population in agriculture is relatively high, many challenges exist in the sector hampering growth. One of the key issues is the limited data availability in the agriculture sector, causing imperfect and incomplete information on agriculture products.

Data is the basic need in all sectors, especially for the economy. The existence of data can provide information on product quality to the consumer, creating transparency between producer and consumer. The availability of data in agriculture can reduce losses of a food company because they can have a better understanding about the source of the product, improve communication in the supply chain and improve its operations. On the other hand, via data on for instance farmers profile and cultivation, smallholder farmers can be connected to the supply chain and gain access to services, such as working capital loans, crop insurance and quality inputs, to increase their productivity and income.

To facilitate data access, there needs to be a big data base in which stakeholders can access near-time data. Technology that can help to support this is called 'blockchain'. Blockchain is an immutable, transparent, public and append-only ledger. It is a peer-to-peer network that can maintain updates and verify those updates to the ledger in a way that it is impossible to make the data fraudulent (Blockchain for better decisions, n.d.). Blockchain has been used in various sectors ranging from health and copyright protection to supply chains. One of the companies in the photography field, Kodak, has developed a blockchain called the KodakOne platform, a digital ledger of image rights that photographers can use to license their work and instantly receive payment for any online usage. Besides photography, blockchain is now also implemented in the food and agriculture sector.

With blockchain, everyone can access near-time data in the agriculture sector. Farmers can input their agricultural production data to get appropriate agriculture loans as well as better insights in market prices. Food companies that need agricultural products can get better insights in the source and quality of the products. The track record of the farmers is stored on the blockchain and helps farmers to connect with buyers. With blockchain, the food chain supply will be more transparent, effective and efficient. Furthermore, a company can easier maintain their quality of food products because they have more reliable information about the source.

It is believed that blockchain will be very useful to all agriculture stakeholders. However, to provide data integration and exchange, a platform is needed as an intermediary. HARA aims to bridge this by providing a blockchain-based data exchange to make the agriculture data accessible for all stakeholders. HARA is an agri-technology start-up from Indonesia who started in 2015.

The platform connects smallholder farmers with other stakeholders, like financial institutions, input producers and offtakers based on the exchange of valuable data. HARA crowdsources the data collection through “agripreneurs” young village leaders who will be incentivized for data collection through mobile phone. In addition, these agripreneurs help to provide and monitor products and services to the farmers, such as inputs and finance. HARA is currently running several pilot projects with banks for the disbursement of microloans. In their operations in East Java, already 2,000 farmers received microloans through HARA operations with a repayment rate of 97%.

The current database of HARA with farmer relate data, production data, and location specific data, will eventually be an input to build additional services such as traceability.

## **Agriculture and Food Sector: Brief Overview**

As one of the largest sectors in Indonesia, agriculture has an important role in the economy. Agriculture employs 38.7 million people in Indonesia and almost 200 million people in the world. The area of agricultural land in Indonesia is 8.19 million hectares (Ha) (Figure 1). Based on the data from the Ministry of Agriculture, those areas consist of 4.78 million hectares (Ha) of irrigated rice fields and 3.4 million of non-irrigated rice fields. According to the Ministry of Agriculture, during the period 2010–2014, the average agriculture contribution to the GDP reached 10.26% with growth of circa 3.9%.

The food and agriculture sector is crucial, especially for countries located around the equator. For instance, more than 70% of the total land area in Bangladesh and Uganda is comprised of agricultural land (Table 1). Mexico pays big attention to the agriculture sector with more than 1 million square kilometers of agriculture land. Peru is an exception with the proportion of agricultural land at 19% of total land area. A number of countries contribute their land to agriculture with more than 30% of total land area (World Bank, n.d.).

## **Agricultural Food Chain in Indonesia**

### ***The Framework***

According to agro-economic studies, the agricultural food chain is the combination of agents and activities that, with regards to a product or a group of products of agricultural origin, include the production of their raw material, their transfer in time and space, and their transformation if needed, making it possible to adjust to the consumer’s taste and needs (Pancino, 2009). Understanding the framework of the agricultural food chain in Indonesia is necessary to understand the activities and challenges, and to find possible solutions. This paper will focus on the rice sector, which is the main staple crop of Indonesia (Figure 2).

The agricultural food chain starts from the input supply. It consists of all the materials needed to produce the rice, such as seeds, fertilizer, irrigation and labor to prepare the land. The production cycle for rice takes about 3-4 months. Farmers either own or rent the land. After harvesting, the farmer either sells their yield through the

Figure 1. Area of agricultural land in Indonesia (Source: Badan Pusat Statistik (BPS))

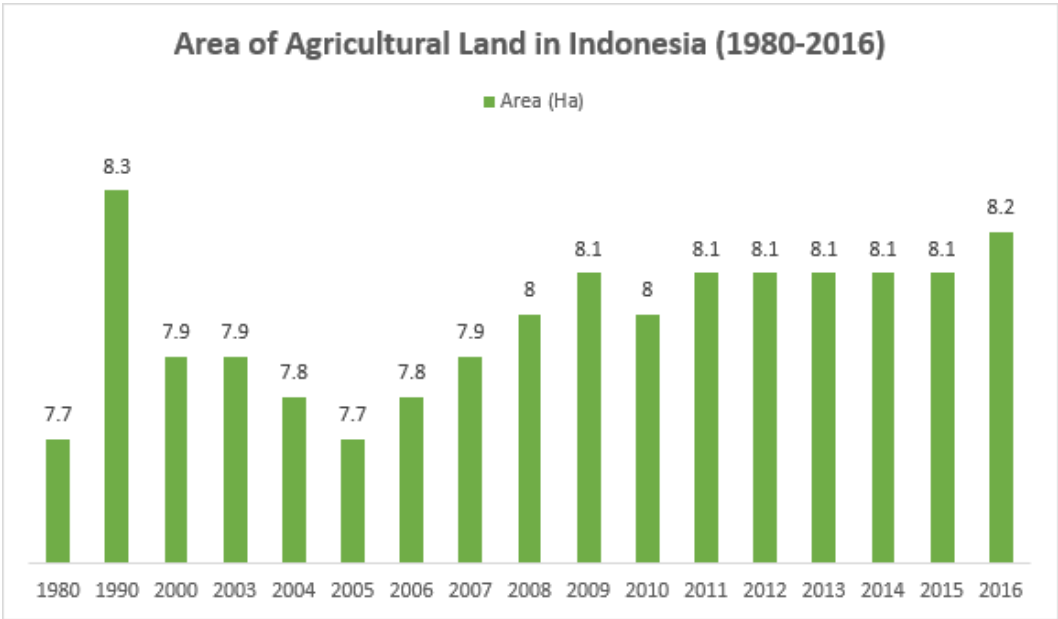


Table 1. Agricultural land in eight countries

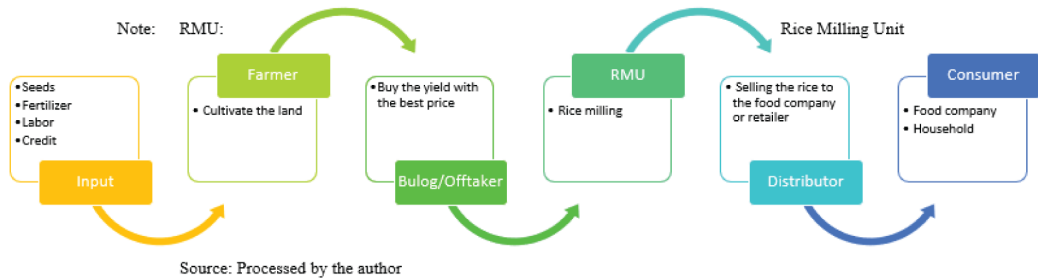
Target Market	Total Population	Production Value (Current US\$)	Total Workers in Agriculture	Total Land Area (Sq. km)	Agricultural Land (% of Land Area) 2015
Bangladesh	162,951,560	\$ 62,644,488,070	40,445,519	130,170	70.6%
Indonesia	261,115,460	\$153,225,975,712	46,178,507	1,811,570	31.5%
Kenya	48,461,570	\$ 15,365,895,535	27,333,732	569,140	48.5%
Mexico	127,540,420	\$ 85,286,916,154	6,767,994	1,943,950	54.9%
Peru	31,773,840	\$ 20,849,232,121	4,291,679	1,280,000	19.0%
Thailand	68,863,510	\$ 75,068,128,347	16,310,773	510,890	43.3%
Uganda	41,487,960	\$ 10,700,763,022	12,164,802	200,520	71.9%
Vietnam	92,701,100	\$ 75,887,835,992	41,204,574	310,070	37.8%

Source: World Bank

middle-men or through the government agency, called the *Badan Urusan Logistik* (BULOG).

Some farmers will sell their yield to the middle-man before it is processed in the Rice Milling Unit (RMU). They must sell, because they cannot afford to transport their yield to the RMU. These farmers are forced to sell their yield to the middle-man at the lowest price, because they need the liquidity. In Indonesia, the government aims to support farmers to give a minimum price for the yield through BULOG. This governmental institution buys the farmer’s yield directly to give a minimum price for

Figure 2. Agricultural food chain – rice (Note: RMU: Rice Milling Unit)



the yield. After selling their yield to the middle-man or government, the yield will be processed in the RMU. The rice will then be sold to the distributor, either a food company or retailer. Then, the distributor will sell the rice to the consumer, such as a food company or individual household.

### *The Problem*

Stakeholders in the total agriculture supply chain face efficiency problems due to a lack of access to reliable information to improve its efficiency, communication and coordination among the players. This applies to all parties, from the producer all the way down to the consumer.

For instance, smallholder farmers (often rice farmers), face myriad of difficulties in accessing the services and resources they need to increase productivity and income. First, the lack of personal identification (ID), land and cultivation data make it hard for the farmer to get access to formal financial services. Farmers need working capital to purchase quality inputs and cultivating equipment, with a time gap until harvesting session when they can sell their crops.

From a financial institutions' perspective, with only limited information available on farmers and cultivation data and the high costs of serving people in rural areas, makes it costly for financial institutions to disburse the small loans to the farmers. Also, the lack of cultivation and ecological data makes it unable to predict their financial risk.

Third, the productivity of farmers in Indonesia is low, especially compared to other countries in the region such as Thailand and Vietnam (FAO, 2018). Indonesia is the third largest rice producing country in the world and follows a policy to be self-sufficient with regard to rice production. Self-sufficiency is rarely achieved (only 2 times in the last 25 years) and on average 1.1 million tons of rice needs to be imported each year. Stagnating rice production is mostly caused by farmers using non-optimal farming techniques, coupled with increasing rice consumption due to the large and growing population. Also, rice production is mostly carried out by smallholder farmers who have limited land, access to capital and resources.

From an input producer perspective, they have limited insights into the production process of the farmers. Without having visibility of the on the ground sales and the

production cycles, it is hard to predict the demand for inputs in the field to forecast the sales.

The buyers of the agriculture produce (off-takers) have limited visibility in the production cycle of the smallholder farmers, the origin of the product, and the quality of the produce. It is impossible to guarantee the quality of the agriculture produce and traceability, without knowing the production process and products being used.

Consumers want to have more information about the food they consume. Consumers want to know what the food contains and its nutrition value. Increasing consumer awareness of health risk and health benefits makes the consumer more selective of the food they want to consume. The food company should share this detailed information about the content of the product to persuade the consumer that their product is safe to consume.

On a national level, in Indonesia still, many people are living below the poverty line and cannot afford their daily food intake. According to the data, there are still 19.4 million people who cannot meet their daily food needs (Ika, 2018). It certainly constrains the achievement of the second SDGs “zero hunger”. To achieve zero hunger, the United Nations is trying to achieve food security, improve nutrition, and promote sustainable agriculture. However, due to the geography of Indonesia and the fact that the agriculture landscape is largely dominated by smallholder farmers, makes it harder to achieve this SDG. Nevertheless, it shows the huge need for improvement in productivity and infrastructure to strengthen the agricultural sector.

## **Blockchain Overview and the Urgent Need for Blockchain in the Food Supply Chain**

Consumers can perceive risk when they realize there is hidden information in a product supply chain. This perceived risk can influence customers’ purchase decisions and attitudes (Antony et al., 2006; Featherman & Pavlou, 2003; Kim et al., 2008; Mitchell, 1999; Sweeney et al., 1999). The lack of information about the product increases consumers’ perceived risk of negative outcomes that may come from purchasing and using that product (Montecchi et al., 2018). Therefore, the availability of information is important for consumers in the food supply chain.

To increase the transparency of information in the food supply chain, a big database is needed that can be accessed by everyone in real time. One technology that can be used is blockchain. Blockchain is a technology that allows users to transfer value or assets between each other without the need for a trusted intermediary (Weston & Nolet, 2018). In the blockchain, the exchange will be recorded in a ledger that is shared by all users of the blockchain. This ledger will provide a transparent view into the details as well as descriptive information such as quality or location.

One popular blockchain technology are the smart contracts. Popularized by Ethereum, the idea is that blockchain can do more than simply record information; it can execute process, agreement or tasks automatically if and when conditions are met. Recently, blockchain has promising usage in cases such as tracking goods throughout supply chains. Real-time product tracking to improve food safety and shelf

life dramatically reduces food loss, reduces adulteration and sheds light on supply and demand imbalances that could be enabled by The Internet of Things (IoT) in combination with blockchain.

In the agricultural industry, blockchain has big potential especially in three key areas: provenance and radical transparency; better finance for the developing world; and real-time management of supply chain transactions.

### **Provenance and Radical Transparency in the Food Supply Chain**

Recently, the demand for clean food from the consumer including organic food is high, but the information is still limited. Producers and manufacturers often struggle to provide transparent information and verify the accuracy of data from farm to table. To solve this problem, blockchain could be one of the ways to answer this challenge and trace the information back to the producer.

Like all advanced technology in this era, blockchain is very useful for business and consumers especially in the agriculture industry. The ability to make the supply chain entirely transparent and rich with immutable provenance data is the true value of blockchain. In addition, blockchain could trace information about the food and participants along the supply chain. With blockchain, it is very difficult to tamper with the supply chain information. Blockchain could enable farmers, manufacturers, and retailers to justify premiums for certain products and give consumer confidence about where the food comes from and how it was produced.

### **Inclusive Financing in the Developing World**

A lack of identification, collateral, and credit histories, and the high cost of serving people from the rural areas are just a few problems that excludes rural communities from access to finance. In Indonesia, only 49% of the population uses formal banking for their savings (Global Findex, 2017), which explains why the majority of rural Indonesia still lives in poverty. The inability to access formal financial services affects the efficient functioning of agriculture value chains, smallholder farmers face liquidity constraints which makes it hard to invest in better agriculture inputs and farmers are often forced to sell the crops at a lower price. The use of blockchain can help to provide a digital identify for farmers and improve access to finance in the developing world. A digital identity will also help to provide land certification for farmers. Technological developments like mobile banking, financing opportunities such as micro-financing creates even greater reach to those in the rural areas. There are several use-cases of the implementation of blockchain for financial inclusion, like agri-ledger from the UK, BitPesain East Africa and Rebit in the Philippines.

### ***Near-Time Management of Supply Chain Transactions***

One of the biggest challenges in Indonesia's agricultural sector is the lack of available agriculture data. Data related to farmer's information, cultivation, and location are crucial to improve the supply chain. This data on agricultural output is needed by all stakeholders in the sector.

The use of blockchain in agriculture can facilitate all stakeholders in accessing near-time data. This can also accelerate the supply chain to move faster and more efficiently. This will help every agriculture stakeholder to make their operations more efficient.

### ***HARA as the Equality Solution to Improve Supply Chain and Food Product***

As stated above, there is clear need in the food and agriculture sector for data. This will help to make the supply chain more transparent and will impact our food quality. To meet the need for this data, a platform is needed to mediate between the data exchange among its stakeholders. HARA is where equality is present as a solution which is believed to improve supply chain and food quality.

### **How HARA Creates Job: Improving the Lives of Farmers and Villagers**

Improving the quality of life of farmers and people in the villages is one way to improve the quality of agricultural products. HARA believes that improving the quality of life of farmers and villagers can be done by creating jobs to generate an additional income. To meet the data needs of agricultural stakeholders, HARA empowers young village leaders and farmers to work together while helping them to increase their income and quality of life.

To create these jobs, HARA utilizes a technology accessible to most, the mobile phone. Farmers and villagers who want to cooperate with HARA only need a mobile phone and can then work immediately. HARA offers jobs as field agents called agripreneurs, who have the initial role as data collectors to map out the agricultural potential in their village. For example, they will check the familial relations and IDs of local farmers, examine the yields of their crops, and track the market prices (HARA, 2018).

A field agent will be able to then move on to become a HARA Farm Manager. The farm manager has several roles including as an agent between farmers and services, and as an agronomist, and could play the role of a sales agent. As an agent between farmers and services, the Farm Manager could act as an agent for a loan program for a bank, or for an insurance program. As an agronomist, the Farm Manager plays the role of expert on crops and soils, who translates the data insights from HARA to the farmers to improve their business practices. As a sales agent, the Farm Manager will help the farmers to buy farm inputs, sell their yield, and monitor the loan disbursement and payments.

The remuneration of the Farm Manager will be dependent on the roles they assume and on the size of the community they serve (Figure 3). The Farm Manager would assume a small margin of the sale as a salary. The calculation of this salary is based on the function of the number of farmers, times the potential harvest, times the net margin per kilogram of the harvest.



Figure 3. Farm manager as sales agent (Source: HARA Token)

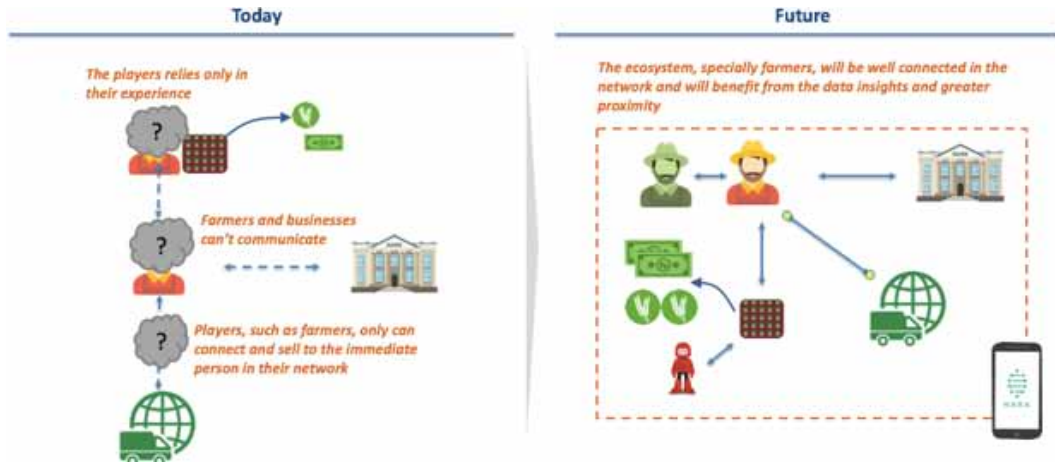


## HARA: Change the Way Farmers and Other Players Are Connected to the Ecosystem

HARA realizes that one of the weaknesses of the food and agriculture sector in Indonesia is the lack of communication between farmers and other stakeholders. This has led to asymmetric information between stakeholders. Stakeholders usually take action in this sector based on their respective experiences. Businesses usually buy farm produce based on information from their acquaintances without knowing the conditions of other crops. Farmers usually sell their crops at low prices to middle-men without knowing the price of the actual agricultural products on the market. This condition causes stakeholders in the ecosystem not to be interconnected.

HARA will completely change the way farmers and other stakeholders are connected to the ecosystem (Figure 4). In realizing this, there is a need for perfect information among stakeholders. The effort that will be carried out by HARA is to provide data on crop yields in the agricultural sector. Data can be a good language of communication between stakeholders so that they can be connected to each other. Through the availability of data, the farmer can notify the conditions of his farms to the businesses. Businesses can find out the actual conditions of agricultural products between one piece of land and another so that they can find out the best farm produce. In addition, farmers can also know the actual price of agricultural products. This makes information in the ecosystem more transparent and accessible to all stakeholders.

Figure 4. Present vs. Future communication in the ecosystem (Source: HARA Company)



## HARA: Business Model

The HARA ecosystem retains a modest portion of each dataset transaction, with the remainder to be earned by data providers and data qualifiers (if applicable). Also, HARA provides additional services through the agripreneurs. Currently, HARA already has paid customers (data buyers) from the financial sector in Indonesia. Through HARA the *Kredit Usaha Rakyat* “KUR” (subsidized microcredit: one of the national economic initiatives aimed at improving access to finance for small to medium enterprises in Indonesia) becomes a profitable business since it reduces the operational costs for banks tremendously. HARA’s services, executed by the agripreneur, contain a lead generation, monitoring, and support in repayments. For future revenue streams, HARA is targeting off-takers, input producers and insurance companies.

Data providers consist of data companies, cooperative/plantations, satellites/IoT devices, field agents, NGOs and farmers, while the data category for data providers consists of farmers, location, and cultivation, ecological, and transactional. By becoming a data provider in HARA, farmers will get access to credit, supply and access to markets easily and get additional income. Data qualifiers are everyone who holds HARA Tokens. They interact with the data provider community and transact with the data provider. Proof-of-work from these data qualifiers includes confirming image recognition, answering credibility surveys, photographing objects in demand, and providing purchase proof. The data qualifiers can also rate each other. As for the incentives, the data qualifier will earn HART (HARA Token) every time the data buyers purchase the enriched data in HARA Data Exchange HDX, while the data buyers consist of banks, insurance companies, enterprises, government and retailers. By using HARA services, banks as data buyers can easily be monitoring through the HARA Business Dashboard (Figure 5).

In addition, the value-added services consist of academic institutions, credit bureaus, agritech, analytics companies and certification companies. The value-added

Figure 5. How HARA works (Source: HARA Company)



Source: HARA Company

services can be purchased easily, cheaper and faster at the HDX. They can also upload their enriched data in HDX for access to the marketplace. They are using the HART as a transaction medium. For the data monetization, they earn HART every time the data buyers purchase the enriched data in HDX.

## CONCLUSION

In improving food quality in food companies, efficient supply chain management is needed. This efficiency can be achieved through the availability of data in the food supply chain. In realizing the availability of this data, the blockchain as the latest data storage technology is used in facilitating data exchange and the ownership of the data. HARA is believed to be an intermediary for data availability for stakeholders in the food and agriculture sector.

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