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The Development of a Traceability System on Organic Rice Production Chain

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Abstract: The production of organic rice has been increasing in the world including Indonesia. Organicproducers have an obligation to ensure the authenticity of organic rice produced and delivered. Nowadays,consumers are getting smarter and more selective to find and buy good and healthy products from trustableproducers. A traceability system is a very useful tool to track and to trace food product transformation flows fromland to consumers, and thus increasing transparency of food production. The development of a web-basedtraceability system for organic rice production chain is discussed in this paper. The developed system allowsthe tracking of products, processes and actors involved in the organic rice production chain from farmers groupsto exporters. The system has been tested and implemented to demonstrate its functionality and workability usingQuick Response Code (QR Code) to allow consumers easily and quickly identify every products, processes andactors in the organic rice production.

Keywords: food transparency, organic rice supply, QR Code, web technology

1. Introduction

Organic farming is an alternative agricultural system which originated early in the 20th century in reaction to rapidly changing farming practices. It is a holistic agricultural system that supports and accelerates biodiversity, biological cycles and soil biological activities. Certification process for producers of organic food and other organic agricultural products, storage, processing, postharvest, and marketing must comply with strict to standards established by the standardization body [1]. The global market for organic agricultural products has grown by more than 4.7 times since 1999 from 15.2 billion dollars to 72 billion dollars in 2013 [2]. In the 15 years period (1999-2014) there was a rapid increase in the expansion of organic agricultural land around the world. Agricultural land in 1999 was only 11 million ha and increased almost fourfold over the past 15 years into 43.7 million ha [3]. The development of organic farmland has also been monitored by the Indonesian Organic Alliance (AOI). In 2007, the total area of organic farming in Indonesia was only 40,970 ha. In 2011, the area of organic farming experienced a slight decrease to 225,063 ha [4]. Factors affecting the increased in organic producers and land use for organic agriculture is the awareness of Indonesian society about organic products. The consumer preference to organic products had increased its demand and consequently, organic farming continued to develop in Indonesia. The largest organic product consumed is organic vegetables, the second is organic rice, the third is the fruit, and the fourth is the spice [5]. Organic rice becomes the second order consumed by the people of Indonesia. Organic rice is also an important commodity exported by organic producers in Indonesia. As one of the commodities exported and consumed, the role of traceability is crucially needed, both by exporters and consumers.

In practice, there are still many fake organic products in Indonesia. In fact, the producers offers non-organic products with organic labels. Another problem of traceability in Indonesia is the paper-based traceability system which has some weaknesses due to manual data filling, processing and analysis that introduce human errors or manipulations, unreliability, time delays and limited data access. Every actor involved in the organic rice supply chain has responsibility in product quality and safety. While producers are responsible for ensuring the the authenticity, safety, and quality of the organic products they offer, consumers have the right to get organicproducts certified by the producers. Therefore a traceability system is needed to enhance food production transparency by providing functionalities for tracking and tracing food production. A traceability system can also be used to cope with sophisticated marketing needs, increasing consumer expectations, assurance of food production best practices and competitive supply chains [6], [7], [8], [9], [10]. The advancement of web-based technology enables farmers to sell their products over the internet; also, a variety of information is available to them for enhancing the knowledge and the productivity of the farm output [11]. A research finding [12]

indicates that the use of web technologies support Small and Medium Enterprises (SMEs) with better competitive advantage. The web-based traceability system is expected to overcome the limitations of paper-based or manual traceability by means of real-time data acquisition and demonstration of integrated data along the organic rice supply chain. More importantly, a web-based traceability system can be utilized as a promotional and educational tool for organic rice consumers. This paper discusses the development and implementation a web-based traceability system for organic rice production in Indonesia.

2. Supply Chain Model of Organic Rice in Indonesia

One example of supply chain for organic rice products is the system utilized by organic rice producer located in Tasikmalaya, West Java, Indonesia. In the organic rice supply chain there are several actors involved such as farmer groups, cooperatives, exporters, and certification agencies trusted by the government. All those involved have distinct roles and responsibilities. Farmers are responsible for cultivating crops according to organic procedures certified by the appropriate authority. The organic rice supply chain is shown in Figure 1.

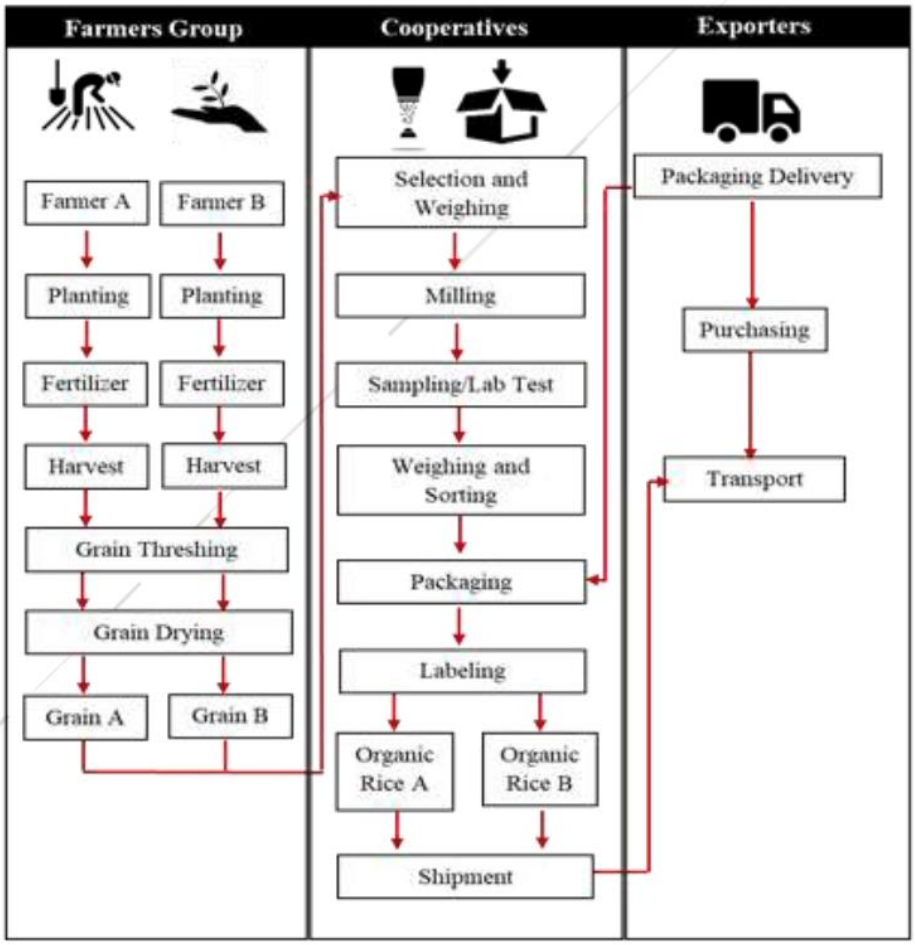

Figure 1: The model of organic rice supply chain at Tasikmalaya, Indonesia

Farmers are the first actors in the organic rice supply chain. Farmers are responsible for cultivating organic rice to produce organic rice grain. Organic rice cultivation process conducted by farmer groups is the process of planting, fertilizing, harvesting, threshing of grain, and drying of grain. The next process is followed by cooperatives that have a role in selecting and weighing paddy of farmers. The cooperatives then will take samples randomly of them for laboratory tests. Standard Test Methods for Laboratory Determination of water (moisture) content, ash, carbohydrate, protein, fat, coarse fibercontent, and pesticide residue. The next process of cooperatives is to weigh and pack the rice. Then packaging and labelling process for the organic rice. Those which are labelled have already been ordered and they ready for export. Exporters are actors that provide the bags, labels, and everything required to develop the finished products. Orders will be placed by exporters by providing handling and transportation to bring the rice directly to the warehouse of the cooperative. Standards and certification is to ensure the food security. Food security covers all aspects from production to supply till it

reaches the consumer. The application of technology is needed at all stages for which innovation would be required to feed the ever increasing world population. A key issue of this millennium is to feed a future population right quality, healthy and safe food at all time with limited natural resources [13]. Certification bodies that play a role in ensuring the quality, safety, and authenticity of organic rice are BioCert under the auspices of the Indonesian Organizational Alliance (AOI). Cooperatives and certification bodies cooperate in conducting Internal Control System (ICS) to record all processes from farmers, cooperatives themselves, and exporters for certification purposes. Farmers who do not comply with the organic standards established by BioCert will not pass the ICS and the cooperative will not cooperate with the farmer group. The data required by ICS are data on farmer identity, area and location of inspected land, organic fertilizer, organic pest control, organic plant variety, organic farm ecology, and social quality data. ICS is an important document needed for certification of farmers.

3. Development of Traceability System for Organic Rice Supply Chain

The IT-based traceability system is developed on the web platform to allow all actors and stakeholders to access the system for traceability purposes and data entries. The traceability system model developed by [14] is adopted to build the traceability system discussed in this paper.

3.1 System Architecture

The system architecture is built on the modification of the cooperative traceability system and the organic rice supply chain. The traceability system architecture was developed using multiple functional structures. The architecture has several layers, among others, user layer, communication layer, application layer, data layer, and infrastructure layer. Infrastructure layer consists of computer peripheral, network infrastructure, printing device, and mobile phone along with scanning application. Computer devices are useful for processing the system. The system can be assisted by the network infrastructure in processing the information needed into the system. The printing device is used to print QR Code results from the system to be included on the packaging.

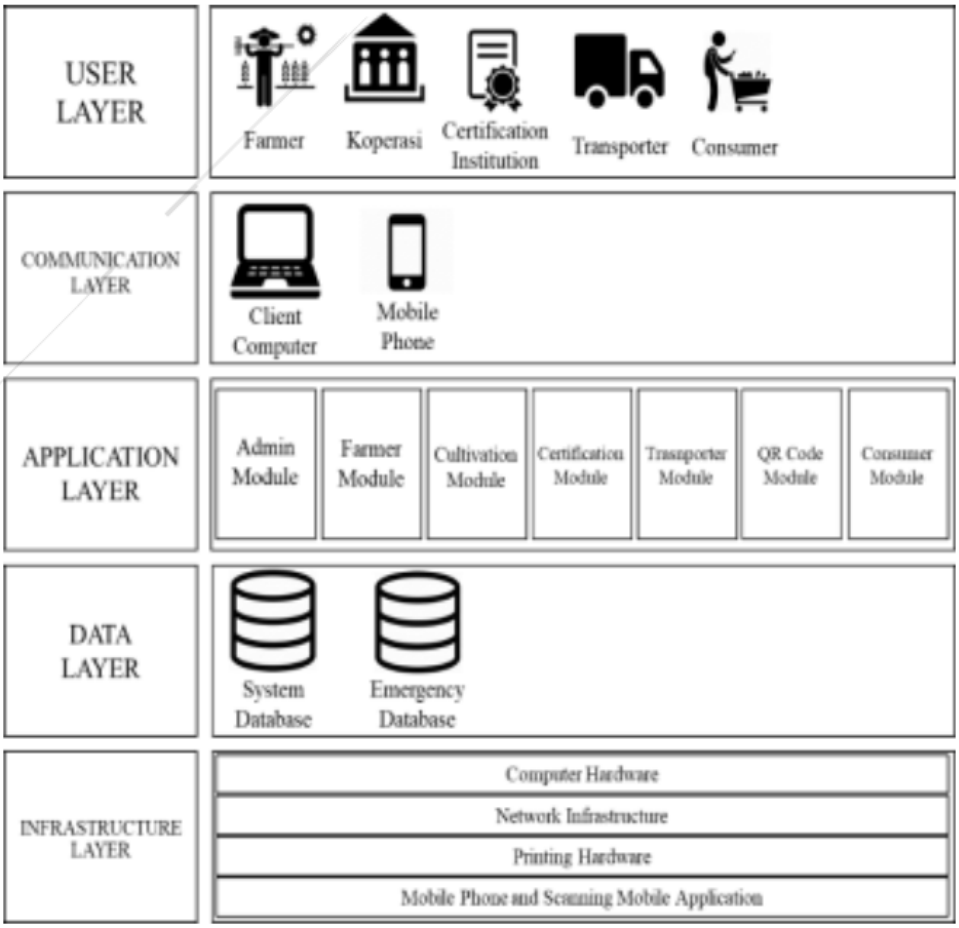

Figure 2. System Architecture on Traceability Organic Rice with Multiple Functional Structure

Furthermore, the QR Code can be scanned with a smart phone equipped by scanning application. Data layer will be the database on the system. The system will require two databases, for the system and for emergencies. The database for emergencies is used in case they system encounter constraints on the system database, so the system can be used as usual. The application layer contains the modules that exist in the traceability system. The module consisted of admin module, farmer module, cultivation module, certification module, transporter module, QR Code module, and consumer module. Each module can be accessed by users who are registered on the system. Users who are qualified to access the system are farmers, cooperatives, certification bodies, transporters, and consumers. Only farmers, cooperatives, transportations, and certification bodies are allowed to access the system, while consumers can access by scanning QR Code on the package and displayed in the consumer module. The developed system traceability architecture is shown in Figure 2.

Note that all actors involved in the organic rice supply chains include farmer groups, cooperatives, certification institution, and exporters who are registered and linked through the traceability system. All actor are required to enter relevant data system, including cultivation process, processing, packaging, laboratory testing and transporting activities and all relevant data. The laboratory testing process consists of testing water content, dust concentration test, nutrient test contained in rice, crude fiber test, and pesticide residue testing.

4. System Implementation

The IT-based traceability system has been developed and implemented in the web-based and mobile-based platforms to allow flexibility and easy access by actors involved in the organic rice supply chain and by stakeholders including certification and government agencies as well as buyers and consumers of organic rice. This enhancing traceability and transparency of added value organic rice chain from land to consumers (land-to-table transparency).The developed system requires actors to be registered so that all the profile data can be stored in the system. Each actor can enter, update and retrieve data for their specific purposes based on each actor's needs and roles in the supply chain (Figures 3-6).The traceability system is managed by a system administrator to maintain and update the system resources and functionalities based on the current and future needs. The developed system is expected to store and demonstrate all forms of documentation, quality, and safety of each process along the organic rice supply chain, from farmer groups to exporters. The QR code is embedded in the system to easily detect and trace organic rice product (Figure 7-8). The documentation system has an integrated and interlinked system of each page to explain all kinds of conditions of processes carried out by actors.

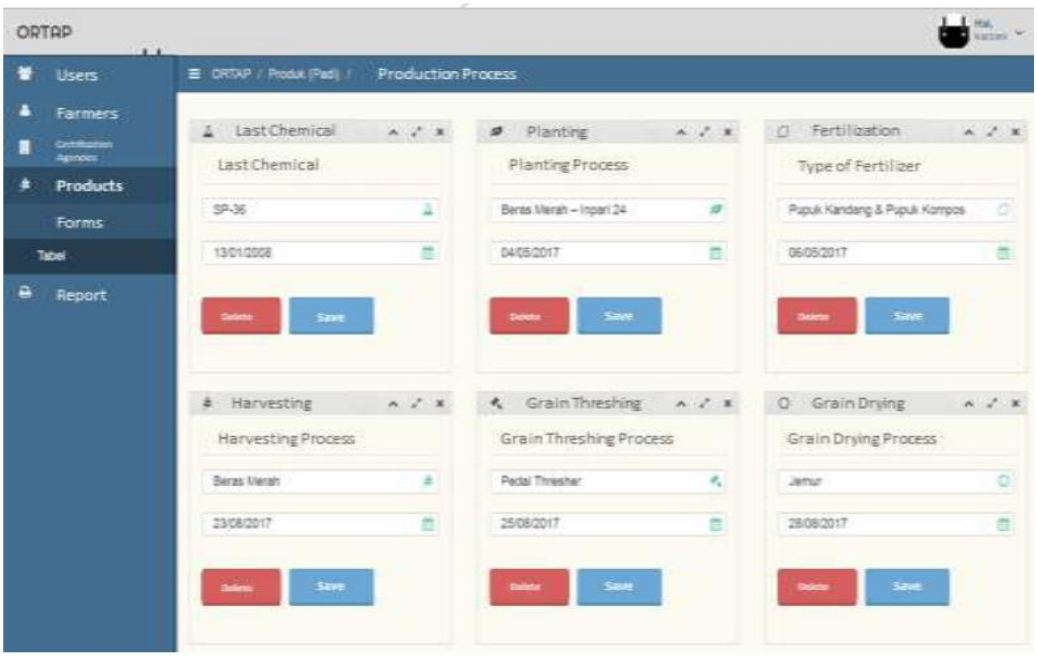

Figure 3. Page for Plant Cultivation Process

There are five important things to be considered to maintain the quality and safety of organic rice products such as rice cultivation and production process, laboratory test results, certification registration page, QR Code printing end page, and scanned page with smartphone. Figure 3 shows the registration page of the process of organic rice cultivation conducted by farmers and the production process undertaken by the

cooperatives. In thisprocess that needs to be completed immediately is the last chemical usage data, and all processes of planting, the fertilization, the harvesting, the grain threshing, the grain drying, weighing, and the milling of organic rice. Any process should be supported by process performances and the executing time of the process. The next process will document the requested laboratory test to maintain the quality and safety of organic rice. On this page the cooperatives are required to include nutrition data for organic rice. The information that needs to be included is percentage of moisture content, ash percentage, carbohydrate percentage, protein percentage, fat percentage, percentage of coarse fiber content, and pesticide residue. Registration page for laboratory test results is presented in Figure 4.

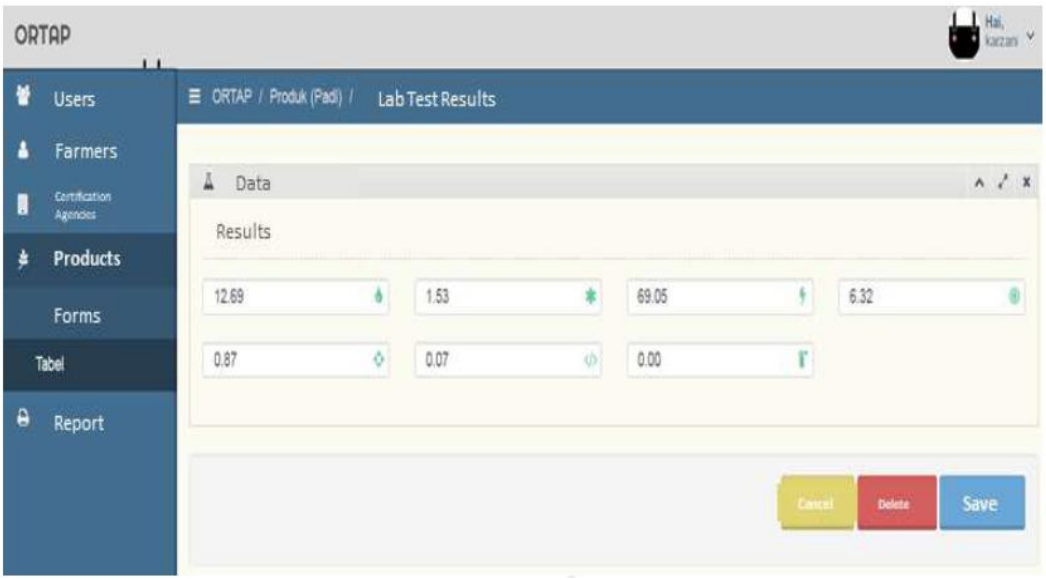

Figure 4. Page for Required Laboratory Tests

The completed data can be monitored by the admin i.e. cooperatives and certification institutions by selecting menu on the right as shown in Figure 5. If the certification processes performed by certification bodies recognized by BioCert, they must provide the certificate components. Name and Address of Certifying Body; Title of Document; Description of Material; Reference Material Code and Batch Number; Description of CRM; Intended Use; Hazardous Situation; Level of Homogeneity; and more. The registration page for certification is shown in Figure 6. All data and information inputted by each actor can be monitored and QR Code printing can be generated which will contain data and all the process data information. The page showing the required information is shown in Figure 7. The results of the printed QR Code can be scanned by the consumer when the QR Code has been included on the rice label. The scan results contain the same information as in Figure 7, but the page is formatted in the form of scanning results for smartphones. The scanned page by smartphone is shown in figure 8.

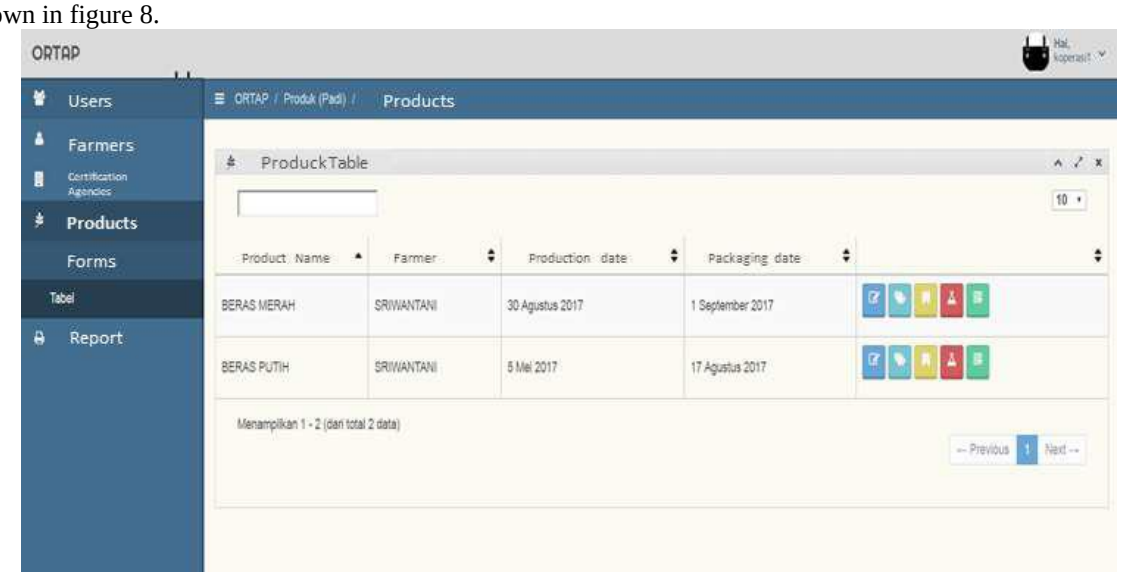

Figure 5.Page for Rice Production

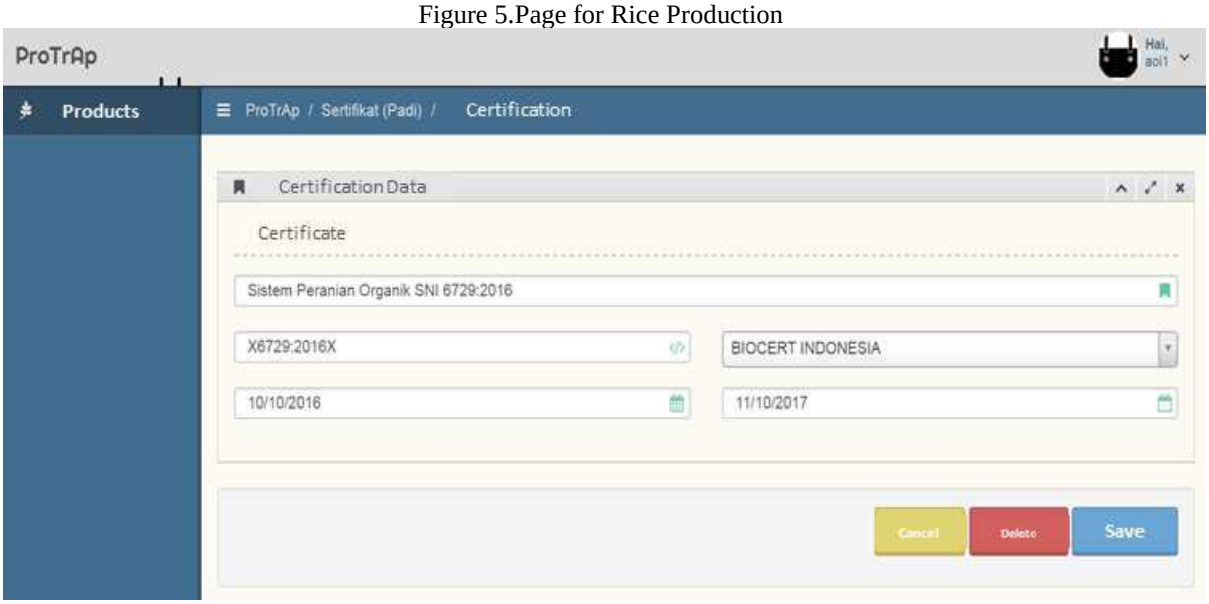

Figure 6. Page for Registration of Product Certification

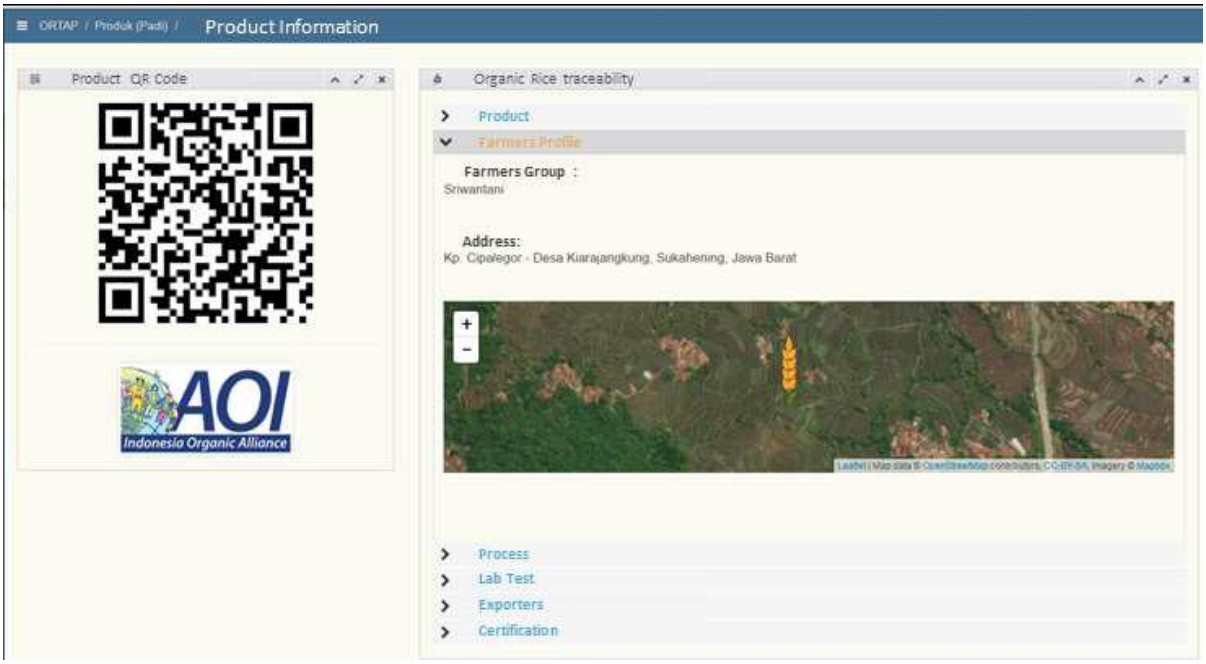

Figure 7. Page for Latest QR Code Printing

Figure 8. Page for Scanned Results

5. Conclusions

Architecture and prototype system traceability for organic rice supply chain has been developed and implemented to demonstrate its usefulness to ensure the authenticity, quality, and safety of organic rice. The developed traceability system will be meaningful for all actors in the organic rice production supply chain and stakeholders such as certification and governmental agencies as well as customers and buyers. Traceability improves transparency which in turns improves the ease and quality assessment and certification processes to theauthenticity of the products they rice organic rice products before being delivered to consumers. Manufacturers or processors of organic rice products are able enter and report processing-relevant data that occurs along the production chain, while certification bodies can monitor and include data that the product is assured with the attached certification. The QR code is embedded in the system to easily trace organic rice product, and to quickly acquire pertinent data and information by actors and stakeholders. Moreover, the developed traceability system is expected to become a means of education and promotion of food safety for consumers of organic rice.

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