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# Application of value stream mapping for analysis and performance improvement of black glutinous rice supply chain

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**Abstract**

Thailand has the largest area of glutinous rice plantation in ASEAN and is the top glutinous rice exporting country in the world. This research was aimed to investigate, analyze and propose improvement of a black glutinous rice supply chain. Value stream mapping analysis (VSM) was used to identify and categorize activities in the chain. ECRS technique (Eliminate, Combine, Rearrange and Simplify technique) was then used to improve performance of the supply chain. From the results obtained, it was shown that some activities might be eliminated, and total cycle time could be reduced by 20% and 7%, respectively. ECRS proved to be useful in shortening storage and delivery times, hence, cost reduction in the black glutinous rice supply chain. Farmers, rice milling operators, and rice cooperatives will gain several benefits and become more responsive in future customer demands.

**Keywords:** Black glutinous rice, Value stream mapping, ECRS technique, Supply chain

## 1. Introduction

Thailand is the world's rice leading exporter. Nowadays, consumers have become more health conscious. For this reason, farmers pay more attention in rice production to meet the customers' needs. Distributors or retailers also become more interested in healthy rice ( organic rice) dealing. Thailand is the largest of organic and color rice exporter, and in the top five of organic rice plantation in the world [1]. This study focused on black glutinous rice in northern Thailand. Black glutinous rice is a color and heathy rice, containing important substances such as Gamma Oryzanol, which has the antioxidant ability and can reduce cholesterol level [2]. This provides opportunity to increase the selling price. However, there are several challenges to overcome, such as risk involving weathering and pests, as well as rice milling as it is usually made-to-order of the customer, so it is difficult to plan [3].

Value stream mapping (VSM) and ECRS method are used in developing and managing supply chain system. They have been successfully demonstrated in applying to supply chains of a parboiled rice [4], canned corn [5], typical production line [6], and frozen chicken [7]. VSM and ECRS methods were valuable tools for supply chain improvement. Therefore, in this research, the same techniques were adopted for black glutinous rice in northern Thailand.

## 2. Methodology

This study focused on analysis and performance improvement of the black glutinous rice supply chain. The scope covered from farmers, rice milling factories and cooperatives. Data was collected by interviews, site visits and questionnaires. Nine farmers, two rice milling factories and two cooperatives who involve in black glutinous rice business were interviewed as a supply chain case study. The collected data consisted of processes in black glutinous rice agriculture, processes of milling, transportation, activities of cooperative, cost information and period of time in each process. It was then analyzed. The ways to improve the performance of the supply chain was proposed.

Value Stream Mapping (VSM) analysis was applied to identify and categorize activities in the supply chain. With an indicator of time, each activity could be categorized in terms of value added (VA) activities, non-value added (NVA) activities and necessary non-value added (NNVA) activities. The current state mapping of black glutinous rice was created and improvement in the supply chain could preliminarily identify. ECRS was applied as a tool for eliminating unnecessary activities in black glutinous rice supply chain. The future state after eliminating NVA and reducing time in NVA activities were created as VSM mapping again. Finally the improvement of black glutinous rice was also suggested.

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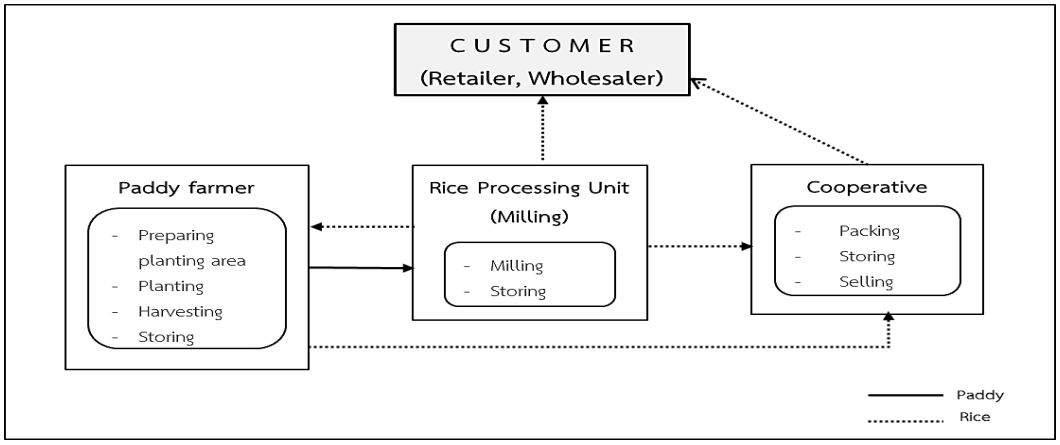


**Figure 1** Physical flow within the black glutinous rice supply chain

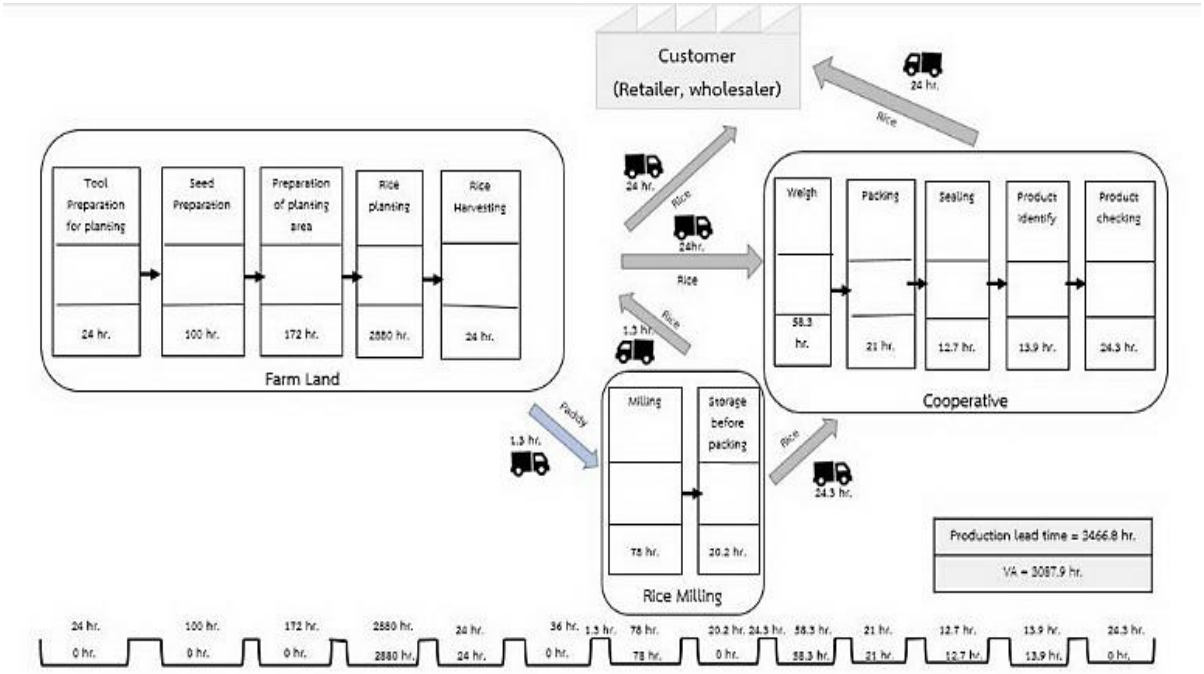


**Figure 2** Current state value stream mapping of black glutinous rice

## 3. Results and discussion

The rice supply chain starts from paddy farmers (producers). They contact with middle men before sending the paddy products to the rice milling factory and cooperative. Then, the middle men called "Yong" purchases rice from milling factory before exporting or selling to customers. In this study, the black glutinous rice supply chain was created, as shown in Figure 1. It demonstrates the physical flow within black glutinous rice supply chain to understand the relationship between the main components in the chain i.e. farmers, rice milling operators and cooperatives.

It was shown that paddy farmers acted as the initial source of the chain. They can sell the product directly to the rice milling operators and cooperatives without the middle men. VSM method could help visualize the current state and future state of black glutinous rice supply chain in order to offer the guideline for performance improvement.

The current VSM of the black glutinous rice supply chain was created, as shown in Figure 2. The black glutinous rice supply chain can be grouped into 15 activities from farmers to customers. The activities of farmers appeared to take the longest time, about 93% of total cycle time. Seven activities were identified as VA activities (89.1%), i.e. rice planting, rice harvesting, milling, weighing, packing, sealing and product identification. There was one NVA activity (0.6%) which was storage before packing. For NNVA, there were seven activities (10.3%) including tool preparation for planting seed preparation, preparation of planting area, storage before milling, product checking transportation from farmland to rice milling and transportation from rice milling to cooperative.

These activities were categorized and summarized in Table 1. It was realized that the major activity in supply chain is VA, taken from rice growing activities. However, the ratio of NVA and NNVA was about 53% of overall activities which included the stocked process and transportation. If the stocking and transportation times were reduced, the total cycle time in supply chain can also be decreased.

**Table 1** Current and future state value stream analysis of black glutinous rice supply chain

| Type of activities | Current state | | | | Future state | | | |
|---|---|---|---|---|---|---|---|---|
| | Activity | | Time | | Activity | | Time | |
| | Number of activities | % | Hrs. | % | Number of activities | % | Hrs. | % |
| **VA** | 7 | 46.7 | 3,087.9 | 89.1 | 5 | 33.3 | 3,055.6 | 94.7 |
| **NVA** | 1 | 6.7 | 20.2 | 0.6 | - | | - | - |
| **NNVA** | 7 | 46.7 | 358.8 | 10.3 | 7 | 66.7 | 170.3 | 5.3 |
| **Total** | 15 | 100 | 3,466.8 | 100 | 12 | 100 | 3,224.9 | 100 |

**Table 2** Performance comparison of current and improved black glutinous rice supply chains

| Performance indicator | Current state | Future state | % Reduction |
|---|---|---|---|
| **Number of NVA activities** | 1 | 0 | 100 |
| **Total time of NNVA activities (Hrs.)** | 358.8 | 170.3 | 52.5 |
| **Number of activities** | 15 | 12 | 20 |
| **Total cycle time (Hrs.)** | 3,466.8 | 3,224.9 | 6.9 |

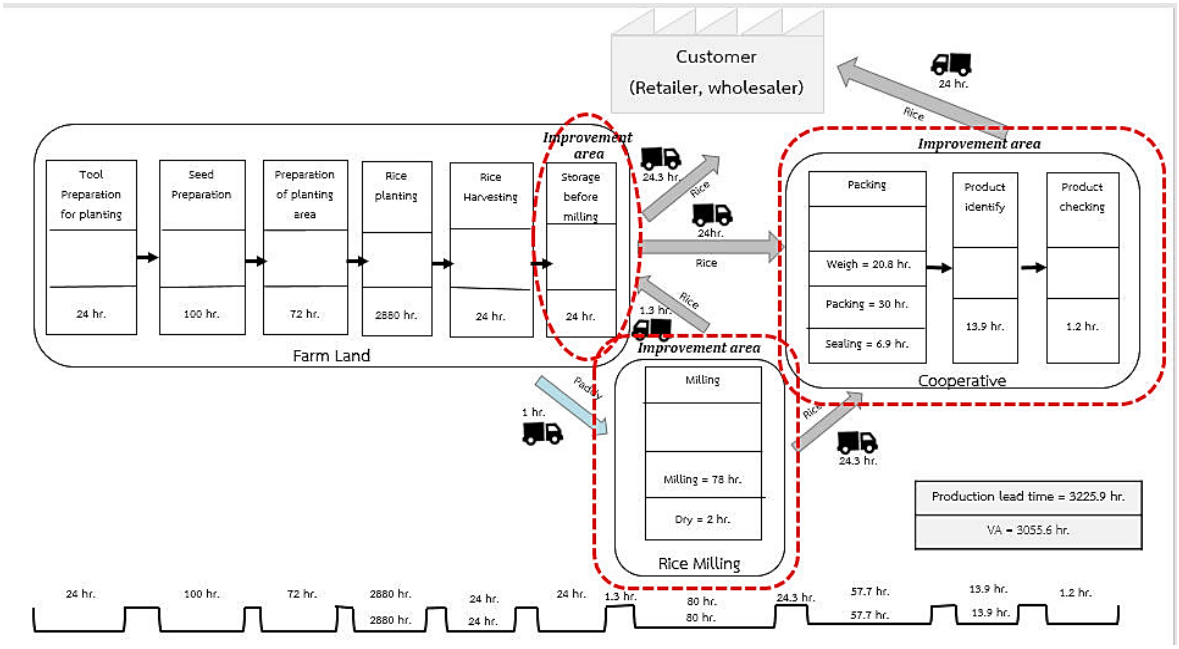


**Figure 3** Future state value stream mapping of black glutinous rice

Based on above analysis, the main challenge affected the total cycle time of the supply chain can be found in the storage and transportation processes. The ECRS technique was used to eliminate NVA activities ( storage before packing) , reduce the time of some NNVA activities including, preparation of planting area, storage before milling, product checking, transportation from farmland to rice milling and combine the operations in packing process. The improved state value stream mapping was created, as shown in Figure 3.

In the future state, the black glutinous supply chain performance is expected to be significantly improved, as activities of the future state can be grouped into 12 from 15 activities and the total cycle time was reduced by 7% to 3225 h. The activities of future state are summarized as shown in Table 1. Comparison of current and future state is in Table 2.

## 4. Conclusion

In this work, supply chain of the black glutinous rice supply chain was analyzed using VSM. The guidelines to improve the supply chain performance were proposed using ECRS technique. It was shown that the efficiency of supply chain could be increased by eliminating the NVA activities and reducing the time of NNVA activities. The farmers can reduce the time of some NNVA activities and shorten transportation time. The rice milling operators and cooperatives can eliminate and reduce the NVA and NNVA activities in the supply chain. The black glutinous rice supply chain performance can be improved by reduction of the number of activity (20%) and total cycle time (7%), which will be beneficial in reducing operation costs and cycle time.

**5. Acknowledgements**

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