Agritech, 38 (3) 2018, 375-380

Risk Mitigation on Supply Chain of Rice: Case Study at Demak and Sleman Districts

Adi Djoko Guritno[1]*, Novita Erma Kristanti[1], Megita Ryanjani Tanuputri[1]

[1]Departemen Teknologi Industri Pertanian, Fakultas Teknologi Pertanian, Universitas Gadjah Mada, Jl. Flora No. 1, Bulaksumur, Yogyakarta 55281, Indonesia
*Email: adidjoko@tip-ugm.org

Submission: September 4, 2018; Acceptance: October 29, 2018

ABSTRACT

Rice is a vital commodity in Indonesia because it is the main staple food for most Indonesian people. Balancing supply and demand of rice in Indonesia is complex and has possibly led to polemics, even though the production of rice in Indonesia tends to increase. An analysis of the supply-demand for rice commodity is, therefore, necessary as an effort to improve the national rice condition along with the logistics and supply chain point of view. This study aims to analyze the supply chain risk management of rice to provide recommendations on improving rice supply chain performance on each tier. This study was undertaken at Demak and Sleman Districts, Indonesia. In-depth interviews were used to enrich the information from the respondents along the supply chain. In this study, tiers on the supply chain of rice mainly consists of farmers, collectors who also acts as traders, and retailers. Meanwhile, the role of government is represented by The Indonesia Logistics Bureau (BULOG). The different supply chain pattern could be identified from the role of middleman in each province. This study uses ISO 31000:2009 standard for analyzing the risk in each tier along the supply chain. Based on the risk analysis, on-farm activity plays a vital role in transferring risk along the supply chain in terms of quality and quantity. Risk mitigation of each tier was explored in this study.

Keywords: rice supply chain; risk mitigation; supply demand; ISO 31000:2009

INTRODUCTION

The problematic of rice in Indonesia is complex due to its interrelated to the sufficiency of national rice stock and the followed policy. Recently, the Indonesian government's policy of importing rice has led to polemics from some parties because the decision is inappropriate in response to the national rice production which tends to increase year by year. According to Statistics Indonesia (2017), the increasing of national rice production for the last decade was 3.1%. Moreover, national production of rice on 2015 was approximately 75 million tones, where 15% of those came from Central Java province. Rice is one of the important commodities in Indonesia because rice is the main staple food for 255 million Indonesians with a growth rate of 1.31% per year and rice consumption rate reached 124.89 kg/capita per year (Ministry of Agriculture, 2016). Therefore, an increasing in national rice production is a priority to overcome the shortage of supply in the future. In addition, rice is one of nine basic food items where the government tightly controls on its supply and demand. In order to maintain national rice supply and demand, the government is pursuing several strategies to increase rice production through special effort called "UPSUS program" that is land optimization, expansion of planting area and irrigation rehabilitation.

In the reality, the balance between supply and demand is essential because it affects the market price that the government is trying to control at an acceptable level for the Indonesian people. Supply demand conditions also affect price elasticity where rice is

DOI: http://doi.org/10.22146/agritech.38529
ISSN 0216-0455 (Print), ISSN 2527-3825 (Online)

typically classified as low-price elasticity of demand. This indicates that rice is a necessity for Indonesian people that the change in price may not really significantly affect the demand of the rice. However, rice is essential staple food for Indonesian people which the increasing price may affect the economic stabilization of most Indonesian people. That is one of the reasons for the government to import the rice which should lead to a reduction in price and might benefit not only consumers but also rice farmers. Therefore, an analysis of the supply-demand for rice commodities is necessary in an effort to improve the national rice condition. Furthermore, the national rice problem is interesting to be explored because it is not only influenced by the supply demand condition but also the logistic activity factor along the supply chain such as storage factor, material handling and so on. This study was conducted to analyze the risks along the rice supply chain to provide recommendations on improving rice supply chain performance on each tier.

RESEARCH METHOD

This study was conducted in two districts: 1) Demak, Central Java province, and 2) Sleman, Special Region of Yogyakarta (DIY). Demak district was chosen to represent Central Java because it was in the 3rd highest rice producer in Central Java and accounted for 5.8% of total rice production in Central Java on 2015 (Statistics of Central Java, 2016). Meanwhile, wetland area for agricultural purpose in Sleman districts was the largest in Special Region of Yogyakarta (Statistics of Special Region of Yogyakarta, 2017). It may indicate that the crop production including rice is the highest among all districts in Special Region of Yogyakarta. We put the main concern on risk scale aspect along the supply chain of rice. We used convenience sampling and in-depth interview to collect data from the respondent. In-depth interview was chosen to obtained information that illustratively describe the real condition thoroughly. It helps us identify the potential risks for each tier whose probability and impact will be assessed and mapped in the risk mapping. For the risk analysis method, we used ISO 31000:2009 standard. This is conducted to know the categorization of each risk and then recommend the preventive action based on the prioritized risk level. According to Guritno and Harsasi (2013), the development of risk management includes the development of dashboards used for monitoring, feed-back management, control and prevention as well as guidance on the implementation, the perception of the regulations concerned, the benefit of economics, analyzes financially as well as analysis of the impact that occurred

RESULTS AND DISCUSSION

The Supply Chain of Rice

In this study, general supply chain of rice in both districts consists of four main tiers including farmer, collector who also acts as large trader, large retailer and small retailer as shown in Figure 1. Post-harvest activities i.e. drying, milling, and packing are mostly undertaken in the collector because generally farmer sells their rice yield to the collector in the form of undried paddy rice. But, the different characteristic was found in Demak where most of the farmers do selling before harvesting to the middleman called as "penebas". In Figure 1, the supply from farmer to the collector is represented by dashed line to the indirect selling. The middleman who buys the crop when it still standing in the field and employs his own labor has role to estimate the crop yield, buy it from the farmer typically two weeks before harvesting time, harvest the rice and sell it to the collector. Meanwhile, this kind of thing is rarely found in Sleman. In the supply chain of rice, the role of The Indonesia Logistics Bureau called BULOG as the representative of government is inseparable. BULOG is a state-owned company engaged in food logistics. BULOG

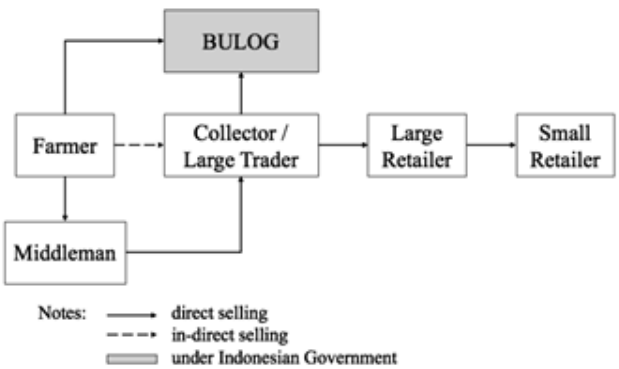

Figure 1. Supply chain of rice in Demak and Sleman Districts

has a role in maintaining the basic price of purchasing for paddy rice, price stabilization, especially for cost of goods, distributing rice for the poor called "Raskin" and managing food stock. Through BULOG, the government seeks to strengthen the achievement of food security by realizing food sovereignty with food resilience and food security. BULOG focuses on accommodating and balancing between aspects of supply or production and demand.

According to Prasch (2008), low elasticity of demand can occur when consumers believe that they need the commodity and that its unique attributes render it difficult to identify worthy substitutes over the short or medium period. It can also occur when the commodity in question absorbs a trivial percentage of the income of the median consumer. The elasticity of demand (E_d) is the absolute value of the percentage change in the quantity demanded ($\%\Delta Q_d$) induced by a 1 percent change in price ($\%\Delta P$) (Equation 1).

$$E_d = \frac{\% \Delta Q_d}{\% \Delta P} \quad (1)$$

Moreover, market equilibrium is the unique point where the quantity supplied (Q_s) is exactly equivalent to the quantity demanded (Q_d) where both Q_s and Q_d can be affected by the price (Equation 2).

$$Q_s = Q_d \quad (2)$$

Based on the results of the study, the condition of rice field in Demak and Sleman has significant differences. It can be identified that the land area owned by farmers in Demak is 11,723 m^2 on average, while in Sleman is 7,300 m^2 on average. In terms of production results, a single hectare of land in Demak can produce around 8,147 kg on average, while in Sleman it produces 6,107 kg on average. Farmers in Demak typically sell their paddy in the field to the local middleman at the certain period, mostly two weeks, before harvesting season. During the harvesting time, middleman use combine harvester to harvest the paddy due to the time efficiency reason. The scale of rice milling unit (RMU) in Demak is larger than Sleman because they get the raw material not only from local area but also comes from outside Demak. Their average production per day is around 20,000 – 40,000 kg/day. Furthermore, most collectors in Demak and Sleman also act as large trader who owns the RMU to support their business, then packs and distributes the milled rice to the next tier. The retailers of rice in Demak and Sleman can be easily found in the traditional market and can be classified into large and small retailer. Large retailers typically buy and sell the packaged milled rice in the big size package and specialized in selling milled rice in the traditional market. They have ability to buy the packaged milled rice from the trader in larger quantity than smaller retailer, while some of the large retailers also supply the packaged milled rice to the small retailer in the same traditional market. For the small retailers, they may specialize on selling packaged milled rice in retail packaged size or also sell other staple foods. Meanwhile in Sleman, the role of middleman is not significant since most of the farmer harvest their paddy rice by themselves. In other case, a few farmers also sell their paddy rice to middleman who comes from other area such as Klaten and Demak and manually harvests the paddy rice.

In most cases where rice is purchased by the middleman, farmers cannot calculate the quantity of paddy rice harvested from their field. Payment system made by middleman is in accordance with the area of land owned by farmers and the price of paddy rice is determined by the middleman. Several issues was identified from the collector stage: (1) mislabeling because packaged milled rice from the local farmer (Sleman) is labeled with "Delanggu rice" which claimed as good quality of rice, (2) when rice scarcity occurred, the collector buy the paddy rice from other districts i.e Delanggu and Muntilan, and (3) cross and long supply chain is identified in which paddy rice from Sleman was sent to Demak for milling process, then sent to Sragen, then delivered to Delanggu to be packed with "Delanggu rice" label. In the end, this "Delanggu rice" is brought back to Sleman and sold in local traditional market. Therefore, rice in the retailers in Sleman mostly comes from wholesalers from Sukoharjo, Klaten, Sragen, and Solo while the supply from local collector or wholesaler is small.

Risk Analysis and Risk Mitigation of Rice

The average rainfall during 2011–2015 in Central Java was higher than in Special Region of Yogyakarta (Statistics Indonesia, 2018). This difference in meteorological condition may affect the pre-harvest activity and may causes the different perceived risk in each tier along the supply chain (Figure 2) even though most of the risks are similar. The risk matrix is divided into avoid (red), manage (green), transfer (yellow) and appetite risk (white). Risk which classified into avoid risk should be prioritized through preventive action, while appetite risk can still be tolerated by the risk owner. In Demak, risk of brown planthopper (*Nilaparvata lugens*) attack, risk of mouse (*Rattus argentiventer*) attack and risk of insect (*Scirpophaga innotata*) attack are identified risk in the farmer which classified as avoid risk. It is because those pests and insects may cause

crop failure. Insect pest attacks frequently occur with varying intensities and frequencies possibly induced by the changes in climate and cropping systems in modern rice cultivation. Both brown planthopper and insect bore into the rice stems, usually killing the stems. The rice brown planthopper usually exists in two forms at the height of an outbreak, namely the long-winged form or macropterous form and the short-winged or brachypterous form. The previous study revealed that frequent outbreaks of N. lugens are not only related to suitable weather conditions, but also with other factors. They found that the outbreak of brown planthopper in the Yangtze River Delta, China is caused by reproduction rather than immigration from distant sources (Hu *et al.*, 2014).

In Sleman, the highest risk is mouse attack due to catastrophic crop failure. This condition is affected by unparalleled time of planting. Although the government has imposed simultaneous planting policies, but because of the landowner is generally not a local citizen then make this proclaimed program difficult to be optimally realized. A study from MacKay *et al.*, (2011) has proven that trapping followed by poisoning proved to be an effective method of mouse eradication on a 6-ha land. Collected information about the population and individual behavior of mouse prior to eradication helps to determine the eradication method. Based on the risk analysis, risk of pest and insect attack during on-farm may lead to the crop failure which may affect the lack of supply. Risk in agriculture has wider complexity and pre-harvest activity should be prioritized because it results on-farm risk that may affect the risk in the next tier (Guritno, 2015). Therefore, on-farm risk is necessary to be managed and mitigated to reduce the catastrophic effect. Based on risk analysis at the farm stage, it can be concluded that the risk of supply shortages in large quantities can affect the market supply as a whole and the national rice stock so that a shortage in the market clearing equilibrium is achieved.

For collector stage in Demak, the highest risk is risk of price fluctuations due to its uncontrollable event and it may affect the loss obtained by the collector. Whereas in Sleman, the risk of theft during storage should be mitigated because it is often occured in the warehouses with no strict security guard at night and the impact is a considerable loss. For large retailer in Demak, the risk of price fluctuations and risk of low quality of rice classified as avoid risk because the price level in the market cannot be controlled and happens unpredictable. Whereas the low risk of rice usually occurs due to received rice is old rice. Lastly, small retailers in Demak have the highest risk in price fluctuations, this situation is unpredictable based on how supply and demand that available in the market. The risk mitigation for each risk along the supply chain are presented in Table 1.

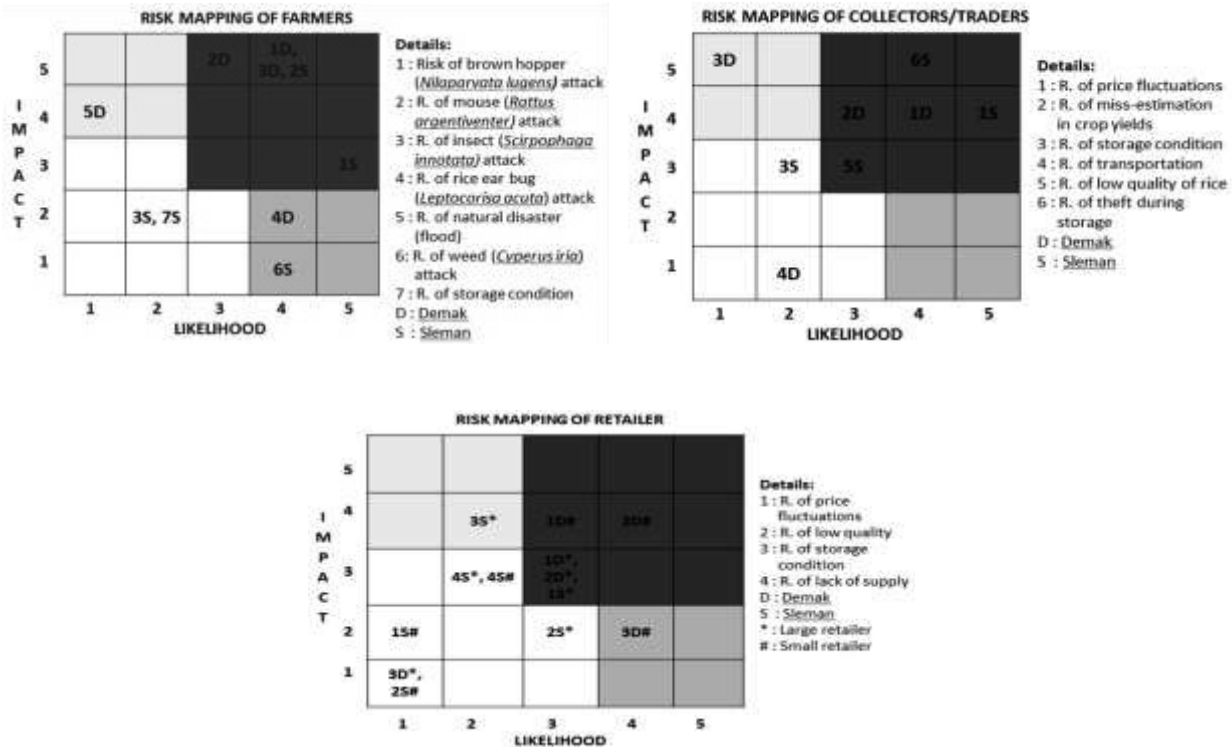

Figure 2. Risk mapping of each tier along the supply chain of rice in Demak and Sleman

Risk of insect attack in Demak is categorized as avoid risk, while in Sleman is categorized as appetite risk. This happens because in Sleman, insect (*Scirpophaga innotata*) is controlled by the use of pesticides with certain routinely doses at the beginning of the planting period. While in Demak, the use of pesticides still cannot eradicate the insect. The quantity of sales between large retailers in Demak is higher than in Sleman, so the existence of rice with poor quality will be affect the level of sales and lead to greater decreasing in the price of rice.

In the risk of price fluctuations, sales in large quantities also create inventory. When the price declines, the rice sold is rice in the storage warehouse that has been purchased with the previous price level so that the profit margin obtained decreased. Sales with a retail system can be an alternative for retailer in minimizing losses. Moreover, losses caused by fluctuations in rice prices can be reduced with the sale of products other than rice sold by small retailers. Risk of low quality of rice can be minimized by rice selection before purchasing and also do supplier selection.

CONCLUSION

The supply chain of rice in Central Java and Special Region of Yogyakarta consists of four main tiers: farmer, collector and trader, large retailer and small retailer. In this system, the role of BULOG as government representative is also inseparable to maintain national rice stock stability. The different supply chain pattern in Demak and Sleman can be identified from the role of middleman in which more dominant in Demak with greater production potential. Based on the risk analysis, on-farm activity plays a vital role in transferring risk along the supply chain in terms of quality and quantity. Risk of pest and insect attack are classified as avoid risk which those risks may lead to the lack of supply and affect the quality of paddy rice. This excessive lack of supply may turn to price fluctuation in the next tier and the low quality of paddy rice may lead to the low of bargaining power in terms of price. Low quality of product also affects the length of storage. Meanwhile, in macro level, it may affect to the national supply and demand and increasing market price. The integrated supply chain through partnership between farmer and middleman or collector should be encouraged in order to reduce the risk during on-farm activity and selling risk. However, the role of government should be strengthening in control the transaction price and shortening the long supply chain of rice.

Table 1. Risk mitigation for each risk

Tier	Name of risk	Risk mitigation
Farmer	Risk of brown planthopper	Regularly spray insecticide
	Risk of insect	
	Risk of rice ear bug (*Leptocorisa acuta*)	
	Risk of mouse	Regular crop maintenance, concurrently planting, regular and collective eradication
	Risk of weed	Regularly weeding the land
	Risk of flood	Insurance for natural disaster
Collector	Risk of price fluctuations	Agreement with the buyer
	Risk of miss-estimation in crop yields	Crop maintenance after the agreement, delay the agreement until the rice grains are filled
	Risk of low quality of rice	Quality checking before buying, partnership with the farmer to encourage good quality of
	Risk of storage condition	Encouraging high inventory turnover, applying first in first out method, avoiding paddy or
	Risk of theft	Tightening security i.e. CCTV
Large retailer	Risk of price fluctuations	Buying agreement, encouraging immediate selling, order based on customer or market
	Risk of low quality of rice	Agreement with a few suppliers, establishing quality standard with the price range,
	Risk of storage condition	Encouraging immediate selling, avoiding placement directly to wall and floor, turnover
Small retailer	Risk of price fluctuations	Buying in smaller quantity but higher intensity, pull supply chain
	Risk of low quality of rice	Quality checking before buying, supplier selection
	Risk of storage condition	Turnover acceleration, separating rice with other commodity during inventory

ACKNOWLEDGEMENT

Funding for this study was provided by Ministry of Agriculture, Republic of Indonesia while this study took place under the Department of Agroindustrial Technology, Universitas Gadjah Mada, Indonesia. Thanks to all enumerator who help during data collection in Demak and Sleman districts.

REFERENCE

Guritno, A.D. (2015). Supply Chain Risk Management: An Approach to Reduce The Agricultural Product's Logistics Costs. *KnE Life Science*, vol. 3. http://dx.doi.org/10.18502/kls.v3i3.397DOI: 10.18502/kls.v3i3.397

Guritno, A.D. & Harsasi, M. (2013). *Supply Chain Management* (2nd ed.). Yogyakarta: Penerbit Universitas Terbuka.

Hu, G., Lu, F., Zhai, B., Lu, M., Liu, W., Zhu, F., Wu, X., Chen, G., & Zhang, X. (2014). Outbreaks of the Brown Planthopper *Nilaparvata lugens* (Stal) in the Yangtze River Delta: Immigration or Local Reproduction?. *PLoS ONE*, vol. 9 (2). https://doi.org/10.1371/journal.pone.0088973

MacKay, J.W.B., Murphy, E.C., Anderson, S.H., Russell, J.C., Hauber, M.E., Wilson, D.J. & Clout, M.N. (2011). A successful mouse eradication explained by site-specific population data. In Veitch, C. R., Clout, M. N. & Towns, D. R. (Eds.), *Island invasives: eradication and management* (pp. 198-203). Switzerland: IUCN.

Ministry of Agriculture. (2016). Outlook Agricultural Commodity: Rice – Center for Agricultural Data and Information Systems, Ministry of Agriculture, Republic of Indonesia.

Prasch, R.E. (2008). *How Markets Work: Supply, Demand and the 'Real World'* (pp. 35-44). UK: Edward Elgar Publishing Ltd.

Statistics Indonesia, Number of Precipitations and Number of Rainy Days at BMKG Monitoring Station, 2011-2015, accessed on https://www.bps.go.id/statictable/2017/02/08/1959/jumlah-curah-hujan-dan-jumlah-hari-hujan-di-stasiun-pengamatan-bmkg-2011-2015.html , October 2018.

Statistics Indonesia, Production of Paddy by Province (ton), 1993-2015, accessed on https://www.bps.go.id/dynamictable/2015/09/09/865/produksi-padi-menurut-provinsi-ton-1993-2015.html, March 2017.

Statistics of Central Java Province, Harvested Area, Production and Productivity of Paddy by District 2013-2015, accessed on https://jateng.bps.go.id/dynamictable/2016/12/19/44/ luas-panen-produksi-dan-produktivitas-padi-sawah-dan-padi-ladang-jawa-tengah-menurut-kabupaten-kota-2013-2015.html , December 2016.

Statistics of Special Region of Yogyakarta. (2017). Daerah Istimewa Yogyakarta Province in Figure – BPS Statistics of DIY.