SPATIAL VARIATION OF RICE TRADE BETWEEN CHINA
AND ASEAN COUNTRIES OF 2002 - 2016

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Abstract

Rice is the staple food for both China and Association of Southeast Asian Nations (ASEAN). The trade between China and ASEAN countries has increased tremendously in last decade. The paper is to describe the influence of Chinese market on rice production of ASEAN countries by describing the spatial variation of rice trade between China and target countries. The data of rice area and trade in 2002 - 2016 was from United Nations Food and Agriculture Organization Statistics Database (FAOSTAT) and analyzed by the Geographical Information System of natural breaks method. Since the Belt and Road Initiative was released in 2013, rice trade between China and ASEAN countries was increased substantially. However, the pattern of change varied across rice exporting countries in ASEAN. Rice area, yield and rice production were all increased in Vietnam because the volume and value of rice trade between Vietnam and China was increased sharply. Vietnam has surpassed Thailand to become the biggest rice exporter to China. In contrast, rice production in Thailand was decreased due to the decreasing rice area and stable rice yield. The rice trade between China and Thailand was not as stable as that in Vietnam. Chinese market plays important role for all rice exporting countries in ASEAN, further study is needed to figure out the causal effect and quantify the influence and change of Chinese market and policy on these areas.

Keywords: Rice production, trade development, correlation, China - ASEAN countries

INTRODUCTION

Rice is one of the most important staple foods with labor-intensive requirement in the world (Timmer, 2010). This is especially true in Asia and Africa where agriculture continues to be a major source of employment and livelihoods (Agarwal, 2010). Association of Southeast Asian Nations (ASEAN) countries are mostly agrarian economy, particularly Thailand, Vietnam, Cambodia and Myanmar are all main rice export countries and they account for nearly two-fifth rice production in the global market in 2017. Rice provides over 40 - 70% of calorie intake in Southeast Asia developing countries (GRiSP, 2013). Rice income consists of one of the main income resources. In Cambodia, rice accounts for 40% of farm household income (Wang et al., 2012). Rice farming contributes substantially to the poverty alleviation in ASEAN countries (Feng et al., 2018; Cui, 2013; Wang et al., 2012).

Since 2000, bilateral trade between China and ASEAN has gradually deepened, and bilateral trade agreements were signed in 2005. However, affected by factors such as the food crisis in 2008, has always been full of challenges. In 2013, China has launched the strategic Belt and Road Initiative (BRI) with multiple implementation measures including China - ASEAN Free Trade Area Upgrade, the Asian Infrastructure Investment Bank, the Silk Road Fund, the Belt and Road International Cooperation Summit and so on (Wang and Xiao, 2018; Tan, 2017). With the establishment of free trade area of China - ASEAN, the agricultural product trade between China and ASEAN countries has been promoted and facilitated. In 2016, the agricultural product trade between China and ASEAN countries accounted for 14.5% of global agricultural product trade value. The value of agricultural products imported by China from ASEAN countries increased from 1.31 billion USD in 2000 to 15.9 billion USD in 2017 (Wang and Wang, 2018). The development of agricultural product trade benefited both ASEAN countries and strengthen their agricultural cooperation (Zhou and He, 2017; Chen and Liang, 2016).

With the implementation of BRI, the bilateral and regional cooperation were both much more active than earlier period (Zhou and He, 2017; Chen and Liang, 2016; Cheng et al., 2017). The development of agricultural products, especially food crops including rice is one of the priorities of agricultural policy between China and ASEAN countries in the context of Belt and Road initiative (Zheng, 2017; Cao and Hu, 2015). China is the largest rice importer and consumer in the world. In 2016, China imported 1.62 and 0.93 million tons of paddy rice from Vietnam and Thailand, respectively (FAOSTAT, 2019). The amount of rice import from Vietnam and Thailand accounted

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for over 70% of Chinese rice import in the global market. As the world’s major rice growing region and the main rice production and exporting region, ASEAN countries play an important role in food security in China and the world (Wang et al., 2018; Sun et al., 2011; Liu and Cheng Wei, 2007). The trade of rice production is essential to explore the potential of rice production in ASEAN countries, rice farmers in Cambodia, Thailand, Vietnam have been market-oriented (Xu and Wen, 2016; Li and Gu, 2018).

The rice production in ASEAN countries varies in terms of yield, area, ecosystem and agricultural policy (Paul, 2014; Suthiphand, 2002; Hoa and Meyers, 2015; Meraman, 2016; Sun and Li, 2018; Zhou, 2018). However, to our knowledge, little study has investigated the influence of Chinese market and policy on the regional rice production of ASEAN. The study is to fill the gap by describe the spatial variation of rice trade associated with rice production to understand the pattern of change of rice production and rice trade between ASEAN countries and China.

The rest of the paper proceeds as follows. In section 2, we provided the background information of rice production in China mainland and ASEAN countries by describing briefly the change of area and yield of total ASEAN area and important rice exporting countries. Data and method were provided in section 3. Then followed by the results presented in section 4. Finally, in section 5, we place our findings within relevant literature and policy discussion and conclude.

DATA AND METHOD

Rice sown area, yield and trade data of China mainland and ASEAN countries in 2002 - 2016 are from the United Nations Food and Agriculture Organization Statistics Database (FAOSTAT, 2019). A space vector map of China mainland and ASEAN countries is from the Geospatial Data Cloud (2019) including 11 countries and the provincial maps of China mainland.

Thematic maps are the main form of GIS visualization. GIS organizes computer maps according to layers. Each layer contains different aspects of the entire map. Each layer has a set of data tables behind it. The overlapping of multiple layers forms a thematic map. This study develops a spatial distribution map of sown area and production for China mainland and ASEAN countries. The first layer contains the administrative divisions of 11 countries and Chinese provincial units, and the second layer contains the names of administrative divisions. Temporal properties comprise three layers of rice crops, such as sown area, yield and production. Finally, we use the natural breaks method on the theme map to perform different levels and display it in space. This method is implemented in the ArcGIS 10.5 environment.

Pearson correlation method were applied to investigate the correlation between the change of rice trade between China mainland and ASEAN countries.

RESULTS AND DISCUSSION

Rice production in China and selected ASEAN countries

Total rice sown area in ASEAN countries has been gradually increased in the last decade from 70.7 million ha in 2002 to 78.8 million ha in 2016 (Figure 1), with an average annual growth rate of less than 1%. Similarly, in China, rice sown area increased from 28.2 million ha in 2002 to 30.7 million ha in 2016 and the annual growth rate is 0.62%.
There is a clear spatial variation of rice sown area in China mainland and the center of rice production moved from south to north area (Figure 2). All countries in ASEAN almost kept increasing rice area before the year of 2011, but afterwards the pattern of rice sown area change varies across ASEAN countries.

There are three border countries in ASEAN with China mainland including Lao PDR, Vietnam and Myanmar. The area changes in the three countries are different. Myanmar decreased rice area in 2011 while maintain rice area since 2013.

Figure 2. Change of rice sown area in the selected countries from 2002 to 2016

Thailand is the only one country with decreased rice sown area in the last fifteen years. In contrast, rice area was increased substantially in Indonesia, Cambodia, Laos PDR and Brunei from 2002 to 2016 (Figure 2 and Figure 3). The growth rate of rice sown area in Philippines from 2002 to 2016 is 0.85% that is slightly higher than the average level of ASEAN countries as a whole.

Figure 3. Change of rice sown area in selected ASEAN countries in 2002 - 2016
In general, the rice yield in all countries has been increased substantially from 2002 to 2016 (Figure 4). The average rice yield in ASEAN countries was increased from 3.4 t/ha in 2002 to 4.1 t/ha in 2016. Of them, Cambodia, Lao PDR and Vietnam are the countries with significant increase rice yield. Rice yield in China was increased from 6.2 t/ha in 2002 to 6.9 t/ha in 2016. Although the growth rate of rice yield in China is smaller than that in ASEAN countries, the level of rice yield in China is much higher than that in ASEAN countries where most rice yields are lower than 4 t/ha.

![Figure 4. Rice yield change in China mainland and ASEAN from 2002 to 2016](image)

Although rice yield in ASEAN countries is lower than that in China, the increasing yield contributed significantly to increase the rice production in ASEAN countries in the last fifteen years except Thailand and Myanmar (Figure 5). Vietnam and Cambodia play important role in exporting rice to the world, the rice production has been increased 1.62% and 7.07% from 2002 to 2016, respectively. The increased rice production in the two countries to some extent show that there would be surplus rice production can be provided in the global market. Rice production in Thailand was decreased from over 38 million tons in 2011 to 26.7 million tons in 2016, the production of Thailand in 2016 is even lower than that in 2002 which is over 28 million tons.

![Figure 5. Change of rice production in the selected countries from 2002 to 2016](image)
Rice production in China has been increased continuously in the country. However, the structural reform of rice production in China indicated that rice with good quality is still in shortage (Ma et al., 2003) and China may go through the international market to satisfy the food demand. The following section is to analyze the rice trade between China and ASEAN countries.

Rice trade between China and ASEAN countries

China is the largest producer of rice production in the world and has been active in the global market. In 2002 - 2016, the amount of rice production China export to the international market fell from nearly 2 million tons in 2002 to only 459 thousand tons in 2016. ASEAN countries are not the main areas for China to export the rice, especially after 2000, less than 6% of rice production exported by China was exported to ASEAN countries (Figure 6). Comparing to the significantly decrease of rice export, the amount of rice import by China from international market has been increased substantially, from 236 thousand tons in 2002 to 3.5 million tons in 2016. The rice import by China in the global market in 2016 is more than ten times that in 2002.

From 2002 to 2011, China basically only imported rice from ASEAN countries and the amount has been doubled in ten years. Since 2012, China increased the amount of rice import significantly and the majority of rice import was from Vietnam. The amount of rice import by China from Vietnam was increased from 234 thousand tons in 2011 to 1,545 thousand tons in 2012. At the same time, China started to import rice from other countries out of ASEAN, such as Pakistan and Russian Federation, and the share of rice imported from ASEAN in total rice import by China decreased to 80 - 85%.

In ASEAN countries, China mainly exported rice to the countries of Indonesia, Philippines and Malaysia, but it was with a significant downward trend, with an average annual growth rate of - 42%, - 27% and - 55%, respectively (Figure 6). In contrast, China only import rice from five countries, including Thailand, Vietnam, Myanmar, Cambodia and Lao PDR (Figure 7).

Rice import from ASEAN countries by China

With the BRI policy launched, the amount of rice imported from ASEAN countries by China was increased tremendously. However, the pattern for different countries are different. Thailand used to be the biggest rice exporter for China until 2010. The amount of rice trade between Thailand and China was not always constant in 2002 -2016. The amount of rice imported by China from Thailand increased from 230 thousand tons in 2002 to nearly 700 thousand tons in 2006, consequently decreased continuously to less than 300 thousand tons in 2013. Afterwards, it was increased to nearly 1 million tons per year, but the share of rice imported from Thailand in total rice import by China was decreased substantially.

In 2011, it is the first time that China imported more rice from Vietnam, over 200 thousand tons of paddy rice, than that from Thailand. Afterwards, the
amount of rice imported from Thailand by China was decreased sharply while China increased the amount of rice import from Vietnam tremendously. Since 2012, China annually imported paddy rice ranging from 1.4 million tons to nearly 1.8 million tons from Vietnam. Simultaneously, China also increased the amount of rice imported from Cambodia, Myanmar and Laos PDR significantly since 2014.

![Figure 7. Spatial distribution of rice import by China from ASEAN countries in 2002 - 2016](image)

**Rice export by ASEAN countries**

With the increasing rice production, ASEAN countries contributed to the global rice market in the last fifteen years. The amount of rice exported to the world by ASEAN countries during the food crisis in 2008 and the following two years were at low level. Since 2012, ASEAN countries significantly increased the amount of rice export from 15.48 million tons in 2012 to 16.06 million tons in 2016 (Figure 8). The share of rice being exported to China by ASEAN countries increased from less than 5% to over 15% and Chinese market plays more and more important role for ASEAN rice exporting countries.

![Figure 8. Rice export by ASEAN countries and the share of Chinese market in 2002 - 2016](image)

Taking the main rice exporter countries like Cambodia, Myanmar, Thailand and Vietnam as example to analyze the change of rice trade with China. It shows that China is still the important driven force for the rice production of rice export countries (Figure 7) as China imported the majority of rice production producing by these countries.
Less than 10% of rice export by Thailand was sold to China and this accounted for 3.88% of rice production in 2016. In Cambodia, over 60 thousand tons and 0.12 million tons of paddy rice was exported to China in 2015 and 2016 and that accounted for 13.76% and 23.58% of total rice export amount. It occupied for 0.69% and 1.26% of rice production in Cambodia. In Myanmar, the share of rice imported by China was increased sharply from less than 0.5% in 2014 to over 2.51% in 2016. China is one of the important countries to import rice from Cambodia and Myanmar. As most rice farmers in Cambodia and Myanmar are below the international poverty line, rice trade may contribute significantly to household income and poverty alleviation as well as employment.

Vietnam almost stopped exporting rice to the global market in the year of food crisis in 2008 and the following year of 2009. The rice trade between Vietnam and China were not active until 2010 and the amount of rice export from Vietnam to China is quite small compare to that in Thailand. However, the rice trade between Vietnam and China was boosted since 2012 and the amount reached over 1.5 million tons accounting for nearly 45.9% of total rice import by China. Vietnam became the most important rice exporter subsequently. The rice trade between Vietnam and China may contribute to promote the rice production in Vietnam as the amount of rice trade accounted for nearly 4% of rice production in 2016.

**Correlation analysis**

It showed that with large area growing rice in ASEAN countries, there would be more rice exported by the countries (Figure 10). Similarly, the change of rice export and rice yield in ASEAN showed the similar trend which may indicate the rice yield would be increased as the rice export increased (Figure 11). The rice farmers in rice exporting countries like Thailand, Cambodia and Vietnam are known as commercial orientated producers. The international rice market including Chinese market may influence farmers’ practices such as technology adoption and management activities. To analyze the correlation between rice trade and rice production in ASEAN countries, correlation analysis was applied in the selected rice exporting countries.
The relationship between rice export and rice sown area in the countries are mostly positive (Table 1). It showed that more rice being exported to China, larger area would be grown to rice, especially in ASEAN and Vietnam. However, the relationship between the amount of rice export to China and Thailand is different. As the rice trade between China and Thailand has been fluctuated, the relationship between the amount of rice export to China and rice sown area in Thailand showed different pattern before and after the year of 2013 that the BRI launched. But the time period after BRI is quite short and that may affect the results of correlation analysis.

For the amount of rice export to China and rice yield in the country, the results showed that more rice being exported to China, higher rice yield would be achieved in the ASEAN as a whole. For the exporting countries of Cambodia, Thailand and Vietnam, the correlation between rice export and rice yield were all significantly positive. This might be helpful to show that the contribution of rice yield increasing in providing sufficient surplus rice production being exported to China and the world in these countries.

**Table 1.** Correlation analysis of rice sown area and rice export quantity

<table>
<thead>
<tr>
<th>Amount of rice export to China</th>
<th>Rice sown area in the area</th>
<th>Rice yield on average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson correlation</td>
<td>P-value</td>
</tr>
<tr>
<td>ASEAN countries</td>
<td>0.632**</td>
<td>0.011</td>
</tr>
<tr>
<td>Cambodia</td>
<td>0.387</td>
<td>0.154</td>
</tr>
<tr>
<td>Thailand</td>
<td>-0.628**</td>
<td>0.012</td>
</tr>
<tr>
<td>Thailand (2002 - 2012)</td>
<td>0.840**</td>
<td>0.047</td>
</tr>
<tr>
<td>Thailand (2013 - 2016)</td>
<td>-0.953**</td>
<td>0.047</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.884***</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: The stars of *, **, *** were used to indicate the significance level of 10%, 5% and 1%, respectively.

**CONCLUSIONS**

Rice is the most important food crop of the developing countries in ASEAN countries accounting for 40 - 70% of calorie intake and contributing to household income and poverty alleviation. The rice trade between China and ASEAN countries has increased over time. In 2017, China imported 4.03 million tons of rice and paddy with the value of 1860 million USD dollars. Over 90% of them are from ASEAN countries including Vietnam, Cambodia, Myanmar, Thailand and Laos PDR.

The food crisis in 2008 has promoted the investment by the government and collaboration between local government and international organizations like...
International Rice Research Institute (IRRI). With the efforts made by different sectors including both public and private sectors in the last decade, rice production has been maintained stable in ASEAN countries. Then returning to the international market would be concerned by the commercialized farmers in these countries.

With the BRI policy launched and promoted by Chinese government, a series of implementations have been applied to promote the trade between China and ASEAN countries, especially the agricultural products. This brought another opportunity to strengthen the cooperation between China and ASEAN countries. More rice trade has been facilitated since 2012 based on the trade activities, although the policy was firstly raised in 2013. The total amount of rice imported by China from ASEAN countries was significantly increased than that of ten years ago.

China mainly imported rice from five countries in ASEAN including Vietnam, Cambodia, Myanmar, Thailand and Laos PDR. Although China started to import rice from Pakistan and Russian Federation. Since 2012, the five countries still accounted for 90% of rice import for China. China is also the important market for these rice exporting countries as over 17.7% of rice export was sold to Chinese market. With the increased rice export, the trend of rice area and yield in Vietnam and Cambodia were also increased. In contrast, the influence of Chinese market is not constantly correlated to rice production in Thailand.

From the spatial distribution of rice production and rice trade between ASEAN countries and China, the rice exporting countries bordered to China seemed to be able to export larger amount of paddy rice to China. Although there is not direct and robust evidence to show the causal effect of Chinese market on local rice production, the trend may provide a description on the variation of rice production associated with the rice trade in ASEAN countries. Particularly in Vietnam and Thailand, the change of rice production and rice yield is correlated with rice export to China, but the pattern is different. Vietnam is the biggest rice trade partner for China and 45.94% of rice imported by China was from Vietnam. China has been exported rice technologies in the last decade and implemented mega-projects such as “Green Super Rice (GSR)” project led by Chinese Academy of Agricultural Science on rice technology diffusion in Asia and Africa countries. Vietnam is one of the important collaborators in the project. Various collaboration may also contribute to the rice trade as both the technology and market information would be exchanged during the implementation of the project.

Basically, the relationship between these rice exporting countries and China has been strengthen especially after the BRI policy launched. China increased the amount of rice import for all countries in ASEAN. With a big market like China promoted by the bilateral cooperation, there would be more opportunities for ASEAN countries. However, there would be challenges as well because China is undergoing the transition with supply-side structural reform. For one thing, the economy of scale is important for a big market and increasing the yield potential of rice remains a priority of critical importance because yields in many of the most productive rice-producing areas in ASEAN countries are growing slowly or are stagnating as average farm yields showed decreasing growth rate. Besides, the structure of rice demanded by the market is changing as well and rice with good quality and special processing and function purpose are with increasing demand. The growing complexity of science, the rise of the private sector, and the emerging scientific strength of China provides new opportunities for partnerships. Making these partnerships function effectively will be crucial to meeting the major challenges facing the ASEAN rice economy to promote rice export in the global market in the coming decades.

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AN OVERVIEW OF AGRICULTURAL COOPERATION
RESEARCH BETWEEN CHINA AND MYANMAR

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Abstract
Myanmar is an important member of ASEAN and is located in the strategic buffer zone between China and India. Since Myanmar has responded positively to China’s “Belt and Road” initiative, China’s cooperation with Myanmar will continue to deepen. China and Myanmar have great potential for cooperation in agricultural production and trade, agricultural science and technology, and agricultural investment. Clarification of the situation of agricultural development in Myanmar and analysis of the current situation and problems of agricultural cooperation between China and Myanmar can provide a strong basis for formulating relevant policies of China-Myanmar cooperation.

Keywords: Agriculture cooperation, Agricultural products, China, Myanmar

INTRODUCTION
Myanmar actively responds to China’s “Belt and Road Initiative” and is an important fulcrum of the Bangladesh-China-India-Myanmar Economic Corridor. Myanmar is an important member of ASEAN and is located in the strategic buffer zone between China and India. Going out from southern Myanmar is the best choice for China’s land rights and maritime rights expansion. Myanmar plays an important role in the Bangladesh-China-India-Myanmar Economic Corridor and will help to solve the problem of China’s “Hu Huanyong Line.” With the full-scale integration of China-Myanmar oil and gas pipelines and the introduction of the China-Myanmar high-speed rail plan, cooperation between China and Myanmar will continue to deepen, and relations between China and Myanmar will be further tightened. China is a big agricultural country, and Myanmar has also set agriculture as a key development industry. China and Myanmar have great potential for cooperation in agricultural production and trade, agricultural science and technology, and agricultural investment.

STATUS OF AGRICULTURAL COOPERATION BETWEEN CHINA AND MYANMAR

Trade
In recent years, Myanmar’s total agricultural trade volume has continued to expand, which expanded from 1.897 billion US dollars in 2010 to 7.49 billion US dollars in 2017. Among them, both the export volume and the import value have increased substantially, and the increase in import value is greater than the export value. The import value increased from 3.85 billion US dollars in 2010 to 2.774 billion US dollars in 2018, the increase was 620.43%; Exports increased from 1.513 billion US dollars in 2010 to 4.675 billion US dollars in 2018, the increase was 208.99%. Myanmar has a surplus in the trade of agricultural products throughout the world, the trade surplus has changed significantly, reaching a maximum in 2012 at 2.045 billion US dollars, and in 2016 it was reduced to 1.309 billion US dollars.

Table 1. Myanmar agricultural trade with the world

<table>
<thead>
<tr>
<th>Years</th>
<th>Export amount</th>
<th>Import amount</th>
<th>Total trade</th>
<th>Trade surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>15.13</td>
<td>3.85</td>
<td>18.97</td>
<td>11.28</td>
</tr>
<tr>
<td>2011</td>
<td>23.82</td>
<td>8.30</td>
<td>32.12</td>
<td>15.53</td>
</tr>
<tr>
<td>2012</td>
<td>30.63</td>
<td>10.18</td>
<td>40.81</td>
<td>20.45</td>
</tr>
<tr>
<td>2014</td>
<td>29.37</td>
<td>16.17</td>
<td>45.54</td>
<td>13.19</td>
</tr>
<tr>
<td>2015</td>
<td>36.90</td>
<td>19.63</td>
<td>56.53</td>
<td>17.27</td>
</tr>
<tr>
<td>2016</td>
<td>43.84</td>
<td>30.76</td>
<td>74.60</td>
<td>13.09</td>
</tr>
<tr>
<td>2017</td>
<td>44.81</td>
<td>30.09</td>
<td>74.90</td>
<td>14.72</td>
</tr>
<tr>
<td>2018</td>
<td>46.75</td>
<td>27.74</td>
<td>74.49</td>
<td>19.02</td>
</tr>
</tbody>
</table>

Source: UN Comtrade Database.

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