Planting Delay Factors on the Dynamics of Shallot (Allium ascalonicum L.) Supply System in Producing Centre, Bantul Regency, Yogyakarta, Indonesia

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ABSTRACT

Shallot, like other horticultural commodities, has such a sharp price fluctuation because of its seasonal production, perishable (easily damaged, rotten and not durable) characteristics, and inadequate management. Problems emerge when there is a significant increase on the price as the result of supply shortage in Bantul Regency, Yogyakarta, Indonesia. Shallot farmers in this regency grow shallot twice a year. It differs from those in Brebes Regency, Central Java, Indonesia where shallot planted three times a year. This cropping intensity differences resulted in differences on annual production capacity, land use, and land need. Hence, the researchers tried to discuss the phenomena from delay factors perspective. We simulated the behavior change on shallot supply and analyzed the correlation among the factors using dynamic system approach. The results showed that a change on delay factors in Bantul Regency from 0.55 into 0.32 would lead into a significant decrease on the width of shallot field and stock of other commodities such as rice and vegetables, although shallot production would increase.

Keywords: supply analysis, dynamic model, shallot, delay factors

INTRODUCTION

Horticultural product is a group of agricultural products which have strategic value for producers, traders and consumers in Indonesia. Horticultural product markets are relatively open, with extensive market segmentation.

Supply chain is all activities that orientate to fulfill the desire of consumers (Chopra and Meindl, 2007). Shallot supply chain consists of a chain of activities starting from post-harvest handling, storage, and distribution or marketing of the commodities to consumers. High-qualified commodities require a good management at every stage of the supply chain. There are several issues and problems that occur in supply chain such as location determination and warehouse capacity, flow of goods, warehousing management, distribution strategy, relationships with suppliers, and management information system (Georgiadis et al, 2005).

In Bantul regency, Yogyakarta, Indonesia, shallot production centres are located in Kretek, Sanden, and Srandakan sub-districts. Recently, it is also expanded to Pandak, Pundong, Imogiri and Bantul districts. Farmers in Bantul regency still have difficulties to market their crops and it has become a habit to sell their commodities to traders or wholesalers. Farmers do not have strong bargaining power in the shallot supply chain.

Bantul regency is an area which has 2 harvest seasons of shallot, the first in May and the second in September-October. Shallot planting period in Sanden district, Bantul regency ranges between 60-80 days. Problems arise when such a high price spikes during
the shortages of shallot supply in Bantul regency. Farmers in Bantul regency plant shallot twice a year and apply alternating planting system with rice and other horticultures.

Another production centre, Brebes regency, Central Java has different planting periods. In this area, the farmers plant shallot 3 times a year. Brebes regency could be a comparison for it is the largest shallot producer in Indonesia. Delay factor in the study of shallot planting refers to the length of planting time and land use for other commodities. The more frequent planting of shallot, the less the delay factor which is affecting shallot production or land use.

Based on discussion above, we formulated a study entitled Analysis of Delay Factors in Shallots Farmers’ Production System through Dynamic Systems Approach.

RESEARCH METHODOLOGY

Identification of Agents and Behaviour of Shallot Supply Chain System

The distribution flow of shallot in Bantul district is long enough to create a wide range of distribution patterns. Aggregately, the supply chain of shallot sale described above follow the sale pattern shown in Figure 1.

![Figure 1. Basic System of Shallot Supply Chain](image)

Modeling of Dynamic System of Shallot Farmers’ Supply System

The model developed in this research was a dynamic model which derived some parts of the supply chain system of previous study (Rembulan, et al. 2010) entitled Analysis of Quality Standards Implementation in Shallots Supply Chain through Dynamic System Approach. The derived parts were the system which was experienced by the farmers. The new model then was developed based on the system changes toward delay factor due to the intensity of shallot planting period.

Causal Loop

Causal Loop is conducted to describe the linkage among elements of the system which shows their relationship that reveals the dynamic of the system (Bernard all PZ et al, 2000; Forrester, 1961; Minegeshi and Thiel, 2000).

In the analysis using the dynamic modelling, the use of Causal Loop was essential as an initial step to describe the relationships in the system, as well as for the development of farmers' production system dynamic model, as shown in Figure 2.
In Causal Loop there were 2 kinds of relations among the elements, positive and negative. Shallot production was vertically described to land area and productivity. The tendency of land area extension would improve if land use was increasing. Farmers’ production target would give positive influence on the target of land use. Land use would increase if the target of land use which was positively influenced by the production target was also improving. It meant that the crop production of the farmers would increase if the affecting positive factors were also increasing. The number or amount of loss (depreciation) factor would negatively affect or inversely related to the production crop of the farmers. Depreciation due to transportation or post-harvest process would reduce farmers’ yields. Greater shallot production would increase farmers’ stock in their barn or in the warehouse provided by the government.

Input of Model Development

Shallot Production
The shallot production was the amount of shallot produced by the farmers in Sanden district within 1 year. It was obtained from multiplying the land area with productivity, reduced by loss due to transportation.

Land Area
Land area is the area of land that is used by the farmers to plant shallot. The input of the formulation included the initial value of 642 ha of land area according the amount of shallot land area during the base year of the simulation. The function revealed that the width of the area would increase if the land use was also increasing. The function implemented on the land use showed the land used for shallot as a delay function of the targeted land use with initial land area. The time delay of land use target to land area was assumed to be 0.55 years, in accordance with shallot planting period. The land use period was 1 year.

Target of Land Use
Land use target is the target of the farmers to use land in the next year. Target land use was calculated based on the division of the targeted production with productivity.
Productivity
The productivity used as the input of this shallot supply chain system model was the actual productivity data which the distribution data were tested and then resurrected with the function in vensim. Data distribution test was conducted on data of actual productivity of Sanden district in year 2002-2009 with Kolmogorov Smirnov test. The test showed the tendency for the data to spread according to the normal distribution. The distribution of normal opportunity depended on two parameters, i.e. mean and standard deviation. Based on the Kolmogorov Smirnov test, shallot productivity data had median and standard deviations values 10091.38 and 12534.09 respectively.

Model Verification and Validation
Verification of model aims to determine whether a simulation model is well programmed and executed. In addition, in verification stage we can also reveal whether there are errors on the logic and visualization of the simulated model by comparing it with the real system (Banks, 1998). Verification of the shallot supply chain model was done using Unit Check and Model Check in Ventana Simulation software. The Unit Checking used in the model was considered to be correct if it looked like Figure 3, while the Model Checking was true if it looked like Figure 4. Mean Absolute Percentage Error (median values of absolute percentage error) is one of relative measurements of error percentage. This test can be used to determine the suitability of the predicted data with the actual one.

\[
MAPE = \frac{1}{n} \sum_{i=1}^{n} \frac{|x_{m,i} - x_{d,i}|}{x_{d,i}} \times 100\% \tag{1}
\]

Using MAPE method, a 5.5 % error value was obtained, meaning that the model accurately described the real situation.

Results and Discussion
The verified and validated model was then simulated for 10 years period (2007-2017). The result of initial simulation, with 0.55 delay value based on the intensity of shallot planting period in Sanden district, Bantul regency, Yogyakarta, can be seen in Table 1. According to the Department of Agriculture and Forestry of Bantul District (2008), shallot acreage in Bantul regency reached 1,290 ha, while the total field area was 16,200 ha. From Table 1, it can be seen that every year, Bantul regency requires land expansion for shallot, particularly in the producing central areas. In year 2013, it is
estimated that the existing field in Bantul district will not sufficient to meet the needs of shallot planting. This is due to the constant increase of shallot demand per capita.

Brebes had a total shallot land field of 20,000 hectares, which were located in the Centre and Southern parts of the region, with an average of productivity 240,000 tons per harvesting time. The use of land for shallot agriculture resulting in good growth, hence, it also provided good productivity. This was influenced by environmental factors which affected the growth of the plant such as climate and soil type. The suitable climate and soil condition for shallot in Brebes area resulted in good shallot product.

<table>
<thead>
<tr>
<th>Time (Year)</th>
<th>Land use (ha)</th>
<th>Land area</th>
<th>Shallot production (1000 kg)</th>
<th>Demand of shallot in Yogyakarta Province (1000 kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.007</td>
<td>642</td>
<td>642</td>
<td>5,818</td>
<td>6,900</td>
</tr>
<tr>
<td>2.008</td>
<td>1,483</td>
<td>1,284</td>
<td>13,829</td>
<td>11,868</td>
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<td>2.009</td>
<td>2,215</td>
<td>2,767</td>
<td>28,457</td>
<td>20,413</td>
</tr>
<tr>
<td>2.010</td>
<td>4,148</td>
<td>4,983</td>
<td>45,506</td>
<td>35,111</td>
</tr>
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<td>2.011</td>
<td>7,200</td>
<td>9,130</td>
<td>92,962</td>
<td>60,391</td>
</tr>
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<td>10,196</td>
<td>16,330</td>
<td>170,618</td>
<td>103,873</td>
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<td>16,305</td>
<td>26,526</td>
<td>275,992</td>
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<td>23,970</td>
<td>42,831</td>
<td>441,629</td>
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<td>44,718</td>
<td>66,801</td>
<td>598,955</td>
<td>528,555</td>
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<td>2.016</td>
<td>90,666</td>
<td>111,519</td>
<td>1,141,643</td>
<td>909,115</td>
</tr>
<tr>
<td>2.017</td>
<td>150,391</td>
<td>202,185</td>
<td>2,086,269</td>
<td>1,563,677</td>
</tr>
</tbody>
</table>

Source: Processed data

Brebes applied 3 times a year of shallot panting system, which implied smaller delay factor. The delay factor of shallot production in Brebes was 0.32.

Through simulation, various kinds of alternative supply chain scenarios can be made without disrupting the existing supply chain system (Chang and Makatsoris, 2003). From the simulation results using the land area of Sanden district, a scenario which was based on the cropping pattern of Brebes regency, i.e. 3 times planting period was developed, resulting in higher demand of land area. The actual land areas were not sufficient for the needs. Although the production of shallot would increase rapidly, the shift of production of other farming commodities such as rice and other horticulures would cause a shortage on producers. Moreover, if Bantul regency implemented such cropping pattern like Brebes regency which had 20,000 ha of shallot land areas and 62,703 ha of total field area, there would be an extra demand of field for shallot and land shortage would occur on the beginning of 2012 onward.

**CONCLUSION**

Brebes Regency, Central Java is a shallot production centre that can be used as a references in terms of land planning, procurement of seeds, and post-harvest management. Therefore Bantul regency, Yogyakarta needs to improve various production factors to maintain shallot supply. The delay factor in Bantul regency which reached 0.55, would affect on the shortage of planting land and other commodities such as rice and vegetables when it was adjusted to the delay factor of Brebes regency, i.e. 0.32.
REFERENCES


