Vegetables Mapping Using Production and Socioeconomic Indicators Approach

Weksi Budiaji, Juwarin Pancawati and Suherna

Abstract Founded in 2007, Serang was considered as one of the new cities in Indonesia. That was why vegetables commodities mapping was not available yet. This mapping was essential for a new city to create an accurate policy in order to develop and maintain sustainable agriculture practices. Many agriculture commodities mappings were constructed by using location quotient (LQ) method. Unfortunately, it was based on productivity only. In this paper, we presented a vegetables commodities mapping by using not only production factor, but also farmer's socioeconomic indicators, namely: (1) land width (preservation), (2) future land width (enhancement), and (3) household expenditure. The production factors and the farmer's socioeconomic indicators were mapped and drawn in a biplot as the first and the second layer. These two layers were overlayed in order to obtain a priority commodity in each district. Finally, this study resulted in four commodity priority categories, and they are: first, Cipocok Jaya district as the main priority with cucumber as its potential commodity; second, Curug district with chili as its commodity; third, Walantaka district with chili and Taktakan district with pea bean as their potential commodities; and finally, Kasemen and Serang districts that have no identified commodity yet.

Keywords LQ (location quotient) · Biplot · Mapping · Agriculture commodity

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1 Introduction

National food security can be considered as an essential matter to build a national stability because food security is identical to the national security. Food security is related to self-sufficiency concept, a nation capacity to provide food needs without any imported food [1]. The degree of self-sufficiency is measured by a proportion of the utilized food in the internal and external systems, i.e the more self-sufficiency, the less utilized food from the external system and vice versa.

The self-sufficiency can be supported by the optimal agriculture potential exploration. Banten Province as a new province, for example, has a potential in the agriculture labor force that is 20% from its total [2]. This manpower potency must be optimally and sustainably utilized in order to have a greater income from the agriculture sector. Serang city as a new city in Banten Province must also identify its agriculture potential. A map of agriculture commodities is important in Serang city because it has about 30% of the total land use [3].

Decentralization regulation in Indonesia plays an important role in the optimal agriculture potential exploration [4] by managing and determining the superior commodity. Agriculture land and water resource mapping supported regulatory policy and public investment [5]. Amaliah and Julia [6], moreover, emphasized the importance of agriculture commodities mapping as an agriculture commodity exploration activity to improve their competitiveness when there is abundance of the imported agriculture commodities. This activity intended for superior commodity determination, the leading commodity that has a strategic position to be expanded, depends on the socioeconomic condition of its local community [7, 8]. Preservation and enhancement willingness, on the other hand, are the other important factors because these factors determine the future superior agriculture commodity.

One of the analyses for commodities mapping is location quotient (LQ) using production factor perspective [9–11]. LQ is usually employed as a prior analysis before applying another analysis [12, 13]. Shift share analysis, for example, is often used as a further analysis completing LQ [12, 14]. Yulianti [7], furthermore, utilized attractive–competitive potency in which the commodities were categorized into the first, second, third, and fourth superior commodity in a four quadrant. Land appropriateness analysis can also be applied to evaluate the LQ results to the land use [5], land structure, and composition [15].

Those further analyses are performed after the LQ analysis because it does not allow any additional variable. This constrain also encourages the multivariate analysis approach such as biplot to be applied in the agriculture commodities mapping. The biplot gives a chance for not only the productivity variable but also the other variables to be included in the agriculture commodities mapping simultaneously.

The vegetables commodities mapping which is still unavailable in Serang city becomes problem. There are at least two reasons why it is essential to set up this

mapping, which are: (1) to create an accurate policy in order to support the sustainability of beneficiary agribusiness practices and (2) the lowest growth rate of vegetables commodity when compared to the other [16].

Since socioeconomic of the farmers affects the sustainability commodity production, it is insufficient if the vegetables mapping in Serang city uses productivity perspective (LQ). The intention of enclosing the socioeconomic factors in the mapping construction is to produce a map that is responsive to the policy changing. That is why the vegetables mapping using production and socioeconomic factors becomes the main objectives of this paper.

2 Methods

Descriptive quantitative research, in which there was no statistical test [17], was applied in this study. The primary and secondary data were collected from farmers in Serang city and some institutions, respectively. A set of questionnaire was administered to the farmers chosen by stratified random sampling. Stratification level, which consisted of six districts, was applied to the districts in Serang city. Each district was sampled in order to obtain the farmers using land width producing vegetables approach. The following formula was applied when the number of farmers was taken as samples:

$$n = \frac{\sum_{i=1}^{6} N_i^2 \sigma_i^2 / w_i}{N^2 D + \sum_{i=1}^{6} N_i^2 \sigma_i^2} \tag{1}$$

where N_i is the number of the land width in district i, σ_i is the standard deviation of the land width in district i, w_i is the proportion between the land width in district i and the total land width in Serang city, N is the total land width in Serang city, and D is computed from $\frac{B^2}{4}$ in which B is the bound of the error [18]. Using secondary data of the vegetables land width [19], the land width sampled was 0.7 ha for each district. If each farmer was assumed having 1000–2500 m^2, the number of farmers that should be taken for each district was 3–7.

Primary data were gathered to obtain the farmer socioeconomic characteristics that were household expenditure, farming system expenditure, accessed land width (preservation variable), and future accessed land width (enhancement willingness). These characteristics were intended to construct the second layer of the commodity mapping. On the other hand, the secondary data contained vegetables production formed the first layer. The overlay layers were purposed to take into account the all variables simultaneously.

Both layers were formed using biplot analysis by which there is a link between biplot and location quotient (LQ), an analysis used to agriculture commodities mapping. LQ is based on the proportion between the ratio of a commodity production to the total commodity's production and the ratio of the total commodity

production in its district to the total commodity production of all districts in Serang city. It was computed from a contingency table of the commodity production. The relation between district and commodity produced in a table contingency, nevertheless, can also be measured using chi-squared statistic/χ^2 formula

$$\chi^2 = \sum_{i=1}^{n}\sum_{j=1}^{p}\frac{\left(x_{ij} - E_{ij}\right)^2}{E_{ij}}, \tag{2}$$

where x_{ij} is the value in the cell (i, j) and E_{ij} is the expected value of the cell (i, j) that is computed using $E_{ij} = \frac{x_{i\cdot}x_{\cdot j}}{x_{\cdot\cdot}}$, with $x_{\cdot\cdot} = \sum_{i=1}^{n} x_{i\cdot}$ [20].

The advantage of the chi-squared statistic in a two-way contingency table of district and commodity is the possibility of chi-squared decomposition yielding in a two-dimensional projection of district and commodity simultaneously. The projection has a Euclidean distance interpretation by which a district that closes to another is interpreted as they have similar profile and vice versa. Moreover, a district that closes to a commodity means that the commodity has an important value in this district. The other advantage is that adding variables in the analysis can be applied. It is important because the commodity mapping can not only using the production factor, like in LQ, but also including the socioeconomic of the farmers to create a responsive map to the policy changing.

The first and second layers result in a four-quadrant figure of district and commodity. The first quadrant (the main quadrant) is a district with a high in both the commodity production and the enhancement willingness of the farmers, while the combination of a low commodity production and high enhancement willingness lays in the second priority (second quadrant). The next priority is the third quadrant determined by a high commodity production yet low enhancement willingness. Finally, the last quadrant as the least priority has a low score in both the commodity production and the enhancement willingness of the farmers.

3 Results and Discussion

3.1 Respondent Characteristics

There were 33 respondents consisted of vegetable farmers where 94% of them are male. Their age range was 25–65 years and dominantly (79%) above 40 years. The majority respondents had low educational background. About 95% of them were elementary school and junior high school. Their farming system expenditure had a very large variation from Rp 500,000 to Rp 45,000,000 corresponding to their farming system land width (positively correlated) with 70% of them having less than Rp 6,000,000 for their farming system expenditure. On the other hand, their household expenditure is from Rp 600,000 to Rp 7,500,000 monthly, with 73% of them having the household expenditure less than Rp 2,400,000. Meanwhile, as

much as 91% of respondents had enhancement willingness for their farming system and 9% exception was applied for the farmers in Taktakan district, because of having 0.2–0.5 ha of the accessed land width.

In this study, the following are the important socioeconomic indicators : (1) household expenditure, (2) the farming system expenditure, (3) the number of family members, (4) the accessed land width (preservation factor), and (5) the land width that will be accessed (enhancement willingness factor). The two latter factors were retained to form a commodity mapping as the second layer. The preservation factor is important because it determines the commodity production, whereas the enhancement willingness is closely related to both the future commodity production and the policy development that can be implemented.

The household expenditure, the farming system expenditure, and the number of family members, in contrast, were related to the age and the education level so that they were further explored. Because of the positive correlation between the farming system expenditure and the preservation factor, the variables retained to draw the second layer, the farming system expenditure was excluded in the second layer mapping. Meanwhile, the household expenditure and the number of family members were correlated with the age and the education level. Table 1 shows the correlation between variables.

Table 1 shows that the correlation between variables is not significant (ns). For further analysis, a simple linear regression to detect the variables affecting the enhancement willingness can be applied without any problem. The simple linear regression of the respondent characteristics to the enhancement willingness as the dependent variable yielded in an analysis of variance table (Table 2). Table 2 shows that the household expenditure has an effect to the enhancement willingness, indicated by *. To sum up, the second layer of the vegetables mapping was drawn using three variables, namely the preservation factor, the enhancement willingness, and the household expenditure.

3.2 Commodity Mapping

The contingency table produced is the production and the socioeconomic indicator tables in which the row–column definition is the commodity table and the

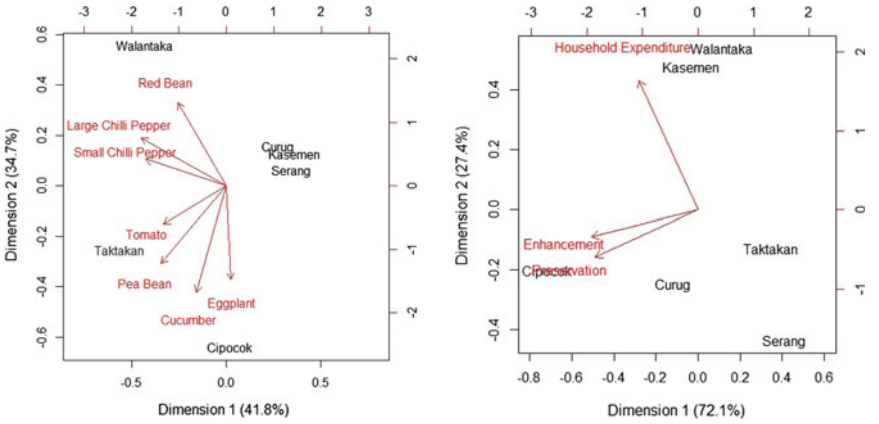
Table 1 Correlation variables

	Age	Education level	Household expenditure	The number of family members
Age	1.00			
Education level	0.22^{ns}	1.00		
Household expenditure	0.00^{ns}	0.40^{ns}	1.00	
The number of family members	0.09^{ns}	0.10^{ns}	-0.03^{ns}	1.00

Table 2 Analysis of variance of the regression model

Source	df	SS	MS	*F*	*P* value
Age	1	0.7861	0.7861	1.1091	0.3020
Education level	3	2.8479	0.9493	1.3394	0.2832
Household expenditure	1	3.1828	3.1828	4.4906	0.0438*
Number of family members	1	1.8077	1.8077	2.5505	0.1223
Residual	26	18.4281	0.7088		
Total	32	27.0526			

* $p < 0.05$



1a Biplot of Production Indicators

1b Biplot of Socio-economic Indicators

Fig. 1 Vegetables commodity biplot based on production and socioeconomic indicators. **a** Biplot of production indicators. **b** Biplot of socioeconomic indicators

socioeconomic variables in each district, respectively. The former table is a secondary data table obtained from Statistics Bureau of Serang city [19]. It has six rows filled by the districts in Serang city that are Cipocok, Curug, Taktakan, Walantaka, Serang, and Kasemen and seven columns filled by the commodity productions in Serang city that are cucumber, eggplant, pea bean, tomato, large and small chili pepper, and red bean. The other table has six rows of the districts in Serang city and three columns of the socioeconomic indicators obtained in the prior analysis that are the preservation factor, the enhancement willingness, and the household expenditure. These two original table data can be provided by the author upon request.

Chi-squared decomposition of the two contingency tables produced two correspondence analyses that can be represented in two-dimensional spaces in a biplot [20]. The first biplot (Fig. 1a) shows the six districts position and seven vegetables commodity. To interpret this biplot, one must consider the commodity arrow direction and the district positions orthogonally from the commodity lines. For example, the most of the eggplant, production is possessed by Cipocok district,

followed by Taktakan, Serang, Curug, Kasemen, and Walantaka districts, respectively.

Figure 1a shows that the commodities that have a potency to become a superior commodity in each district based on its production are eggplant and cucumber in Cipocok district, pea bean and tomato in Taktakan district, and large and small chili pepper in Walantaka district. Curug, Kasemen, and Serang districts do not have any potency in all commodities. The total variance that can be explained by the biplot 1a, moreover, is 76.5% from the both dimensions. It indicates that the biplot well describes the relation between commodities and districts in a two dimensions based on their production.

On the other hand, Fig. 1b shows the district positions and socioeconomic farmers' indicators. Similar to Fig. 1a, socioeconomic indicators arrow direction must be considered because its line can be drawn orthogonally to determine the district position. Cipocok district, for example, is a district that possesses a very high preservation and enhancement willingness indicator compared to the other districts. Curug district is in the second place. Then it is followed by Kasemen, Serang, Taktakan, and Walantaka, respectively. If they are projected on the preservation and enhancement line orthogonally, these four districts are below the average.

The preservation and enhancement willingness indicator has a high correlation indicated by the small angle between these two lines. It means that the farmers who have a wider land width tend to expand their land width in the future. Household expenditure, in contrast, does not have any correlation with the other two indicators representing by the almost 90° angle between the household expenditure and the other two. Furthermore, there is 99.5% of total variance explained by the both two dimensions in the biplot. It means the biplot very well depicts the relation between socioeconomic indicator and districts.

3.3 Priority Commodity per District

The two-layer biplot combination results in a four-quadrant figure of district and priority commodity (Fig. 2). The main priority is Cipocok district possessing cucumber because it has a very high production and high enhancement willingness. The second priority is Curug district due to its low production and high enhancement willingness. The small chili pepper commodity is preferred in this district based on the primary data that the farmers often plant small than large chili pepper. The policy in this district should be focused on the small chili pepper production so that it can be shifted to the first quadrant. The third priority is Taktakan and Walantaka districts with pea bean and small chili pepper commodity, respectively. In these two districts, the farmers should be attracted using empowerment programs that can increase their enhancement willingness so that these districts can become a district with a main priority.

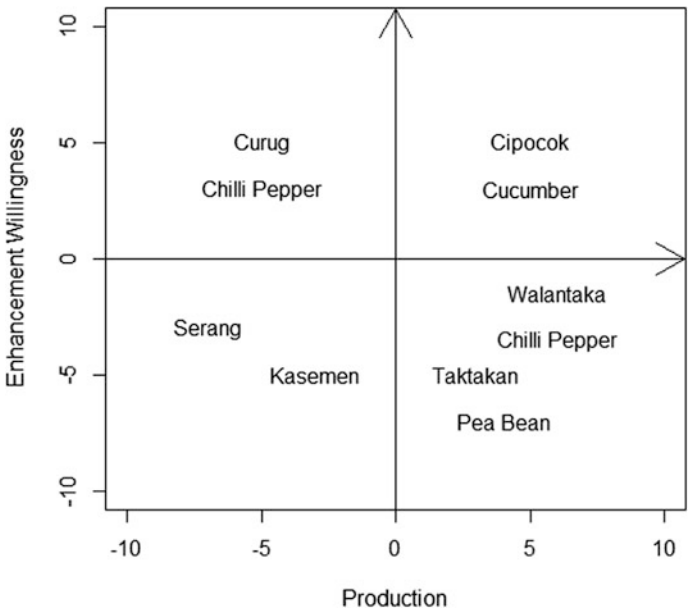


Fig. 2 A four quadrant of district and priority commodity

The last two districts lying in the fourth quadrant are Serang and Kasemen districts. These districts have low in both commodity production and enhancement willingness. Because of low commodity production, specific commodity that can be developed in these districts is unidentified. Geographically, the priority commodities are mapped in Fig. 3.

4 Conclusion

Socioeconomic analysis applied in the data resulted in household expenditure indicator affected to the enhancement farmers' willingness. This indicator, the preservation and enhancement willingness variables simultaneously form the second layer that is combined with the first layer based on commodity production yielded in a map of district and commodity. The district and commodity map produced four priority areas. The first priority was Cipocok district with cucumber commodity. The second priority was Curug district having small chili pepper. Meanwhile, Walantaka and Taktakan districts with small chili pepper and pea bean commodity, respectively, were the third priority. Last, the fourth priority was Serang and Kasemen districts that had unidentified commodity. These two districts need more exploration to determine their priority commodities.

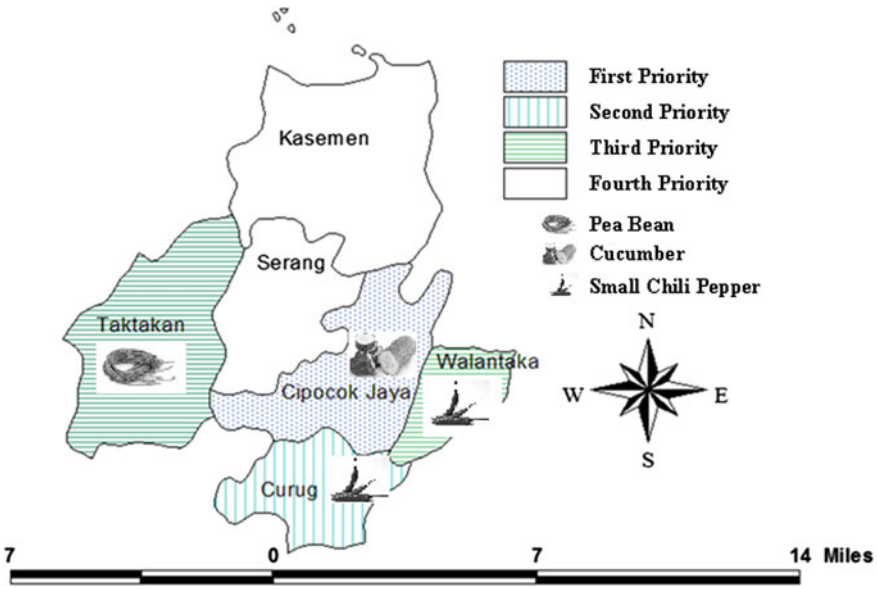


Fig. 3 District and priority commodity map

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