Spatial characteristics of maize development and competitive profit in west Lombok regency, Indonesia

by L Sukardi

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Abstract. In addition to its function as the main food, maize has high economic value, so it deserves priority to be developed, including in West Lombok Regency. This study aims to: (1) assess the spatial characteristics of maize development, (2) analyze the competitive profit rate of maize, and (3) analyze the stabilization of maize yields in West Lombok Regency. This study uses descriptive method, with primary data sourced from 75 respondents and secondary data from 2000 to 2016. Data were analyzed by using the analyses of Localization Coefficient, Specialization Coefficient, Location Quotient (LQ), Basic Service Ratio (BSR), Regional Multiplier (RM), and Competitive Profit. The research concluded as follows: (1) The development of maize in West Lombok is not concentrated in certain areas only and does not specialize in maize commodity; (2) Maize has a competitive profit compared to other crops; with the average productivity of 6,190 kg/ha and the price of Rp 3,520/kg; and (3) The level of stability of maize productivity in West Lombok Regency, both for the period of 2000-2010 and 2011-2016 included as low stability.

1. Introduction

In Indonesia, maize is the main commodity of secondary food crops after rice. It is important for business and its uses [1,2]. The role of maize commodity as the main raw material for feed has no substitution so far [3]. Maize is promising as it has multi-functions for food and feed [4]. Similarly, maize has high economic value to be developed including a source of energy and material of industry [1]. Since its multi-functions and business potential, private sector has recently allocated more resources than government in research and development [5], and the Government of Indonesia should allocate adequate land and other inputs to develop maize further.

In the province of Nusa Tenggara Barat (NTB), maize is one of the leading commodities, where its development is packed in a government program called 'PIJAR' (a program for increasing production of Cattle, Maize and Seaweed), promoted since 2008. With the program, maize production increased markedly to 785,864 tons in 2014 from 350,000 tons before the program. In addition to the PIJAR program, maize development has also been improved through the National Program of Special Effort of Paddy, Maize, and Soybean (well known as UPSUS PAJALE) [6].

West Lombok Regency is one of the maize development areas in West Nusa Tenggara Province; with increased harvested area and production. The harvested area increased from 4,355 ha in 2014 to 5,042 ha in 2015 (increased by 15.77%), while production increased from 24,386 tons to 26,771 tons (an increase of 9.78%). It indicates that the percentage increase in harvested area is higher than the increase in production, and results in decreasing land productivity. The average productivity of maize in West Lombok decreased from 5,501 kg/ha in 2014 to 4,536 kg/ha in 2015 or decreased by 17.54%.

For guidance especially for farmers in developing maize in West Lombok Regency, this study of spatial characteristics of development and competitive profit of maize is considered very important to do. The objectives of this study are to (1) analyze the spatial characteristics of maize development, (2) to analyze the competitive profit of maize, and (3) to analyze the stabilization of maize production in West Lombok Regency.

2. Method

This research uses a descriptive method that is directed to the effort of getting insights from data on an activity related to the development of maize and other secondary food commodities (as competitors). Furthermore, the findings are described systematically as factual and accurate as possible according to facts, traits and relationships between the phenomena studied [7].

This research was conducted in West Lombok Regency. To obtain the diversity and variation of data, West Lombok is divided into 3 (three) clusters: (1) Southern West Lombok region, covering: Sekotong, Lembar, and Gerung Districts; (2) the Central West Lombok region; and (3) the Northern West Lombok, covering Narmada, Lingsar, Gunung Sari, and Batu Layar. Further, on each cluster area, five samples (respondents) are determined for each commodity reviewed (maize, soybean, peanut, green bean, and sweet potato). Thus, the total number of respondents becomes 75 persons. Meanwhile, secondary data in the form of time series data were collected from 2000 to 2016, including data on the development of harvested area, production and productivity of maize.

To answer the problems and objectives that have been set, then the collected data are analyzed as follows:

1. The localization coefficient applied to measure relative concentration for maize development in West Lombok. The formulae for this calculation is as follows:

$$\alpha i = [Si / Ni] - [\Sigma Si / \Sigma Ni] \quad (1)$$

2. The specialization coefficient applied to indicate the specialization of West Lombok on maize. This coefficient is calculated with the following formulae:

$$\beta i = [Si / \Sigma Si] - [Ni / \Sigma Ni] \quad (2)$$

Note:

S_i = Maize harvested area in the researched area (district)
Ni = Maize harvested area in West Lombok Regency
$\sum S$ = Total harvested area of secondary food crops in researched are (district)
$\sum N$ = Total harvested area of secondary food crops in West Lombok Regency
α_I = Localization coefficient with positive sign, with value of $0 < \propto < 1$
β_i = Specialization coefficient with positive sign, with value of $0 < \beta < 1$

Decision criteria for α :

$\alpha < 1$: Location distribution for maize development is in some districts in West Lombok
$\alpha \geq 1$: Location distribution for maize development is concentrated in a certain location in West Lombok

Decision criteria for β :

$\beta < 1$: West Lombok is not specialized in maize commodity
$\beta \geq 1$: West Lombok is specialized in maize commodity

3. Whether maize is a base or non base commodity is determined with *Location Quotient* (LQ), formulated by Wibowo and Januar (1998) as follows [8]:

$$LQ = [Si/\Sigma Si] / [Ni/\Sigma Ni] \quad (3)$$

Note:
LQ = *Location Quotient* of maize commodity in West Lombok Regency.
S_i = Maize harvest area in study location (district)
Ni = Maize harvest area in West Lombok
$\sum S$ = Total of secondary food crop harvest area in study location (district)
$\sum N$ = Total of secondary food crop harvest in West Lombok

Decision criteria:
LQ < 1 : maize is a non base commodity in the district
LQ ≥ 1 : maize is a base commodity in the district

4. Determining the role maize commodity as a base sector in supporting the sector of food crop agriculture in West Lombok is applied by the analysis of "Basic Service Ratio (BSR)" and "Regional Multiplier (RM)".
   a. BSR (Basic Service Ratio) is applied to determine the capacity of the base commodity in serving the nonbase area of development need. Windiarti (2011) formulate BSR as follows [9]:

$$BSR = \Sigma \text{ Base Sector} / \Sigma \text{ Non Base Sector} \quad (4)$$

   Note:
   Σ Base Sector: Quantity of maize production in base area (ton)
   Σ Non-Base Sector: Quantity of maize production in nonbase area (ton)

   b. RM (Regional Multiplier), is used to determine the distribution power of base activity and its influence directly and indirectly. RM using the following formulae:

$$RM = 1 / (1- NB/Y) \quad (5)$$

   Note:
   NB : Quantity of maize production in non base area (ton)
   Y : Quantity of maize production in base and non base areas (ton)

   Decision Criteria:
   BSR and RM > 1: The base sector of maize commodity supports agricultural activity in West Lombok
   BSR and RM ≤ 1: The base sector of maize commodity does not support agricultural activity in West Lombok

5. Analysis of Competitive Profit
   a. Competitive Yield
   Minimum yield needed by maize to be competitive to other commodities is analyzed with the analysis of competitive yield using formulae of Siregar (2016) below[10].

$$Y_j^1 = (TC_j^0 + NR_j^0) / P_j^0 \quad (6)$$

   Note:
   Y_j^1 = Maize yield to be competitive with other commodities (kg/ha)
   TC_j^0 = Initial maize total cost (Rp/ha)
   NR_k^0 = Net revenue of initial competing commodity (Rp/ha)
   P_j^0 = Initial maize price (Rp/kg)

b. Competitive Output Price
For maize to be competitive to other commodities, it has a certain price level that results in net profit at least as much as competing commodities. This can be calculated with metode of Siregar (2016) below [10].

$$P_j^1 = (TC_j^0 + NR_k^0) / Y_j^0 , \quad (7)$$

with P_j^1 = marked up maize price

6. Analysis of Yield Stability
Yield stability is determined through coefficient of variety (CV) of times series data on maize yield. This study examines maize yield from 2000 – 2016. Agustian and Hutabarat make the following criteria:
1. Stable : CV < 5 %
2. Intermediate : 5 % < CV ≤ 10 %
3. Low : CV > 10 %

The probability of stability improvement as follows:

$$P = \frac{100 - CV_a}{100 - CV_t}$$

Note:
CV_a = Coefficient of variety of actual yield
CV_t = Coefficient of variety of target

Furthermore, yield savable (YS): Std x Probability;

$$Std = \frac{(CV_t - CV_a)}{100} Y_a$$

With Y_a is actual production. Thus, yield savable = **La x PS,** with La is harvested area.

3. Results and Discussions

3.1. Characteristics of the distribution of maize commodity in west lombok regency
Based on the harvested area, it appears that the planting or development of maize is not spread in all districts in West Lombok Regency. From 10 districts in West Lombok, two districts did not develop maize in 2015, i.e. Narmada and Lingsar districts. Also, spatial development of maize is uneven across the whole of West Lombok; evidenced by the coefficient of variety of harvest areas among regions that reached 113.29%. The largest development area is in the Districts of Gerung, Lembar, and Labuapi (Table 1). Furthermore, the spatial characteristics of maize development in West Lombok Regency can be reviewed from 2 (two) indicators, i.e. localization coefficient and specialization coefficient.

Table 1. Harvested area, Production, and Productivity of Maize by Districts in West Lombok, 2015.

District	Harvested area (ha)	Production (ton)	Productivity (ton/ha)
Sekotong	528	2,434	4.61
Lembar	1,244	6,667	5.36
Gerung	1,547	8,271	5.35
Labuapi	251	1,351	5.38
Kediri	1,008	5,530	5.49
Kuripan	425	2,303	5.42

Narmada	0	0	0.00
Lingsar	0	0	0.00
Gunungsari	39	210	5.38
Batu Layar	1	5	5.00
West Lombok	5.043	26.771	5.31
Standard of deviation	571.31	3070.80	2.23
Mean	504.30	2677.10	4.20
Coefficient of variety	113.29	114.71	53.07

Source: BPS Lombok Barat

a. Localization Coefficient of Maize Development in West Lombok Regency

Localization analysis is used to determine whether maize development in West Lombok regency is concentrated in one region only or spread to some areas. The results showed that the value of the localization coefficient (α) of maize in West Lombok Regency was 0.4028 (α <1) as presented in Table 2 this means that the location of maize development spread in some districts in West Lombok Regency. In other words, the development of maize in West Lombok is not concentrated in one region but spread to several areas.

Based on the harvested area, from 10 districts in West Lombok Regency, there are only 4 (four) districts, which are areas with positive localization coefficient (α), i.e. the districts of Lembar, Gerung, Kediri, and Kuripan. This indicates that the four districts are areas with higher maize harvest areas among other areas. The distribution of maize commodities that are not concentrated in one region alone indicates that this maize commodity has relatively equal development opportunities in all areas in West Lombok. The nonconcentrated area of maize development in one area provides advantage, among others, maize is produced by several areas, such that maize becomes available for market.

Table 2. Results of Analyses of Location Quotient (LQ), Localization Coefficient and Specialization Coefficient for Maize Development in West Lombok, 2015.

District	Land size (ha)	Harvest area (ha)	Coefficient LQ	Localization Coefficient	Specialization Coefficient
Sekotong	1.782	528	0.5125	-0.0996	-0.2818
Lembar	1.857	1,244	1.1587	0.0338	0.0918
Gerung	1.923	1,547	1.3915	0.0863	0.2263
Labuapi	532	251	0.8161	-0.0112	-0.1063
Kediri	1.086	1,008	1.6055	0.0754	0.3501
Kuripan	654	425	1.1241	0.0093	0.0717
Narmada	33	0	0.0000	-0.0038	-0.5781
Lingsar	110	0	0.0000	-0.0126	-0.5781
Gunungsari	546	39	0.1236	-0.0549	-0.5067
Batu Layar	200	1	0.0086	-0.0227	-0.5731
Total	8.723	5.043		0.2048*	0.7399*

Not: *) = Total of positive value

b. Analysis of Specialization of Maize Development in West Lombok Regency

In this study, a Specialization analysis is used to find out whether the district in the region of West Lombok has specificity or specialize in maize commodity. The results of the analysis (as presented in Table 2) show that the value of the specialization coefficient (β) of maize in West Lombok is 0.7399 (β <1). This means that West Lombok regency does not specialize in maize commodity in its agricultural activities. In other words, West Lombok regency does not specialize in the development of maize but develops various commodities.

3.2. Role of Maize as Base Commodity in Supporting Agricultural Activity in West Lombok

The analysis shows that the coefficient of *Location Quotient* (LQ) is more than 1 in 4 districts, i.e. Gerung, Lembar, Kediri, and Kuripan. This means that in these areas maize is a base commodity or the main commodity for the economic growth of the districts. While in the other six sub-districts, maize is not a base commodity (Table 2).

Furthermore, the Basic Service Ratio (BSR) Analysis (BSR) is applied to see the carrying capacity of the sector base area of agricultural activities in West Lombok Regency. The value of maize BSR in West Lombok Regency in 2015 based on production indicator (ton) is 5.6928. The BSR value means that 1 part of the maize commodity production is used to meet the need for developing the base area, while 4.6928 parts are used to serve the need for the development of non-base areas.

Furthermore, the analysis of the Regional Multiplier (RM) is a continuation of BSR analysis, wherefrom the analysis result can be known a relationship directly or indirectly of the existence of base sector. The value of Regional Multiplier (RM) of maize in West Lombok Regency based on indicator of production (ton) is 1.1757 (> 1). Based on the results of the calculation (BSR and RM value more than one), it can be interpreted that the existence of base commodity (maize) can support the economic development of agricultural sector in West Lombok Regency and give multiplier effect for other regions.

3.3. Maize Competitive Profit

The competitiveness of a commodity is often measured using a comparative and competitive advantage approach. Comparative advantage is a concept developed by David Ricardo to explain the efficiency of open resource allocation [11]. One of the ways to measure competitiveness is by using competitive profit.

The results of the analysis show that net income (profit) per hectare of the maize crop is higher than the four competitive commodities, i.e. soybean, peanut, mung bean, and sweet potato. The comparison of profit rate (net income) amongst secondary food commodities in West Lombok Regency can be seen in Figure 1.

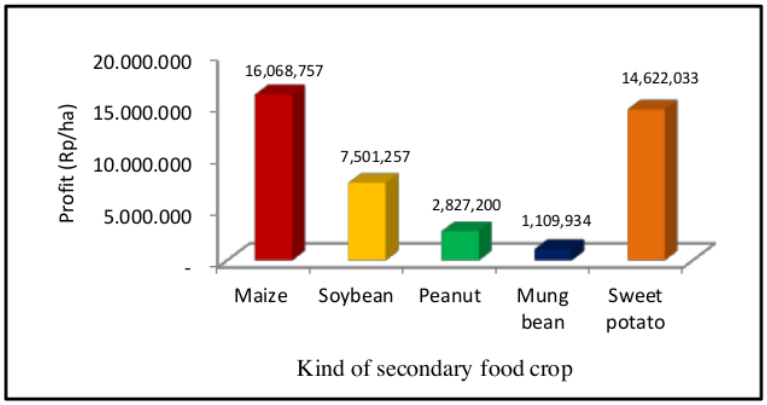

Figure 1. Profit of various secondary food crop farms in West Lombok Regency, 2017 (Rp/ha).

3.3.1. Competitive Yiel. This research found that the average productivity of maize in West Lombok Regency is 6,190 kg/ha. Assuming the prices of inputs and outputs remain unchanged (constant), this level of maize productivity has far exceeded the minimum productivity required to compete with other secondary food crops. The minimum productivity of maize to be achieved to compete with other secondary food commodities is presented in Table 3.

Table 3. Minimum productivity of maize (kg/ha) to be able to compete with its competitors in West Lombok, 2017.

Competing Crop	Minimum Productivity of Maize (kg/ha)	Note
Soybean	3,736	60.68% of current productivity
Peanut	2,428	39.23% of current productivity
Mung bean	1,940	31.35% of current productivity
Sweet potato	5,779	93.96% of current productivity

The result of the analysis showed that to be able to compete with soybean, the required maize productivity is only 3,756 kg/ha or 60.68% from the current productivity (6,190 kg/ha). Meanwhile, to be able to compete with peanut, green bean, and sweet potato respectively, the required maize productivity level is 2,428 kg/ha (39.23%), 1,940 kg/ha (31.35%) and 5,779 kg/ha (93.96%). Therefore, the most intense competition level is with sweet potato.

3.3.2. Competitive Price. As with competitive yield, maize can give competitive profit when it is compared with other crops (soybean, peanut, mung bean, and sweet potato). Assuming the level of yield and input prices are constant, then with the current price level, maize has been able to provide a competitive profit to its competing' crops. The minimum price of maize to compete with other crops is presented in Table 4.

The results show that to be able to compete with soybean, the minimum price of maize is Rp 2,136/kg or 60.68% from the current price (Rp 3.520/kg). Meanwhile, to be able to compete with peanut, green bean, and sweet potato; respectively, the minimum price level of maize is Rp 1,381 /kg (39.23%), Rp 103/kg (31.35%), and Rp 3,286/kg (93.96%). Thus, the most intense competition level is with sweet potato.

Table 4. The minimum price of maize (Rp/kg) required to compete with other crops in West Lombok Regency, 2017.

Competing Crop	The minimum price of maize (Rp/kg)	Note
Soybean	2.136	60.68% of the current price
Peanut	1.381	39.23% of the current price
Mungbean	1.103	31.35% of the current price
Sweet potato	3.286	93.96% of the current price

3.4. Maize Yield Stability in West Lombok

The yield stability of food crops is strongly influenced by the biological environment and the climate of the region concerned. The two factors can have a direct impact on the timing of planting and expected production success. The level of yield stability could be measured by the coefficient of variance (CV), which is the ratio between the standard deviation from year to year and the average result. Furthermore, the development of yield in a certain period is categorized as stable if it has CV < 5%; medium if 5% ≥ CV ≤ 10%; and low if CV > 10%.

In this study, the yield stability analysis is based on the development of productivity of production (in this case is maize) during the last two decades (2000 - 2016). Furthermore, to describe periodically the progress of the results achieved, the range of analysis is termed into 2 (two) periods: (1) 2000 - 2010 period) and (2) 2011 – 2016 period.

The results showed that the level of maize productivity in each period is quite fluctuating (varied), even from one period to another period; the coefficient of variant becomes greater (means that the productivity level tends to be more unstable). The high level of variation of this result is reflected by the value of the coefficient of variant (CV) is quite high, i.e. 13.93% in the period of 2000 - 2010

increased to 16.98% from 2011 to 2016. Based on this variant value it can be concluded that the level of stability of maize production in West Lombok Regency is still included in the category of "low stability".

Given the high variations in productivity, much lost happened to production, which is a source of production growth. The analysis and estimation amount of production that can be saved in each period can be seen in the following table 5.

Table 5. Result of analysis of maize yield stability in West Lombok, during 2000 – 2016.

Item	2000 - 2010	2011 - 2016	2000 - 2016
Average:			
a. Harvest area (ha)	5.312	5.390	5.342
b. Production (ton)	16.181	28.907	20.673
c. Productivity (ton/ha)	3.08	5.14	3.81
Standard Deviation (Std) of productivity	0.43	0.87	1.17
Actual Coefficient of a variant (Cva)	13.93	16.98	30.79
Yield stability	Low	Low	Low
Delta Std (for CVt = 2.5 %)	0.35	0.74	1.08
Probability	0.88	0.85	0.71
Yield saved (ton/ha)	0.31	0.63	0.76
Production save (ton)	1.652.74	3.418.82	4.085.61
(% of average production)	10.21	11.83	19.76

Note: CVt = target coefficient of variant

4. Conclusion

This study concludes the following:

1) Spatial characteristics of maize development in West Lombok Regency are as follows:
   a. The development of maize in West Lombok is not concentrated in one region but spread in some areas indicated by localization coefficient value (α) of 0.4028 (α <1).
   b. West Lombok Regency does not specialize in maize commodity; indicated by the value of the specialization coefficient (β) of 0.7399 (β <1).
   c. Maize is a base commodity in the districts of Gerung, Lembar, Kediri, and Kuripan. The existence of base commodity (maize) can support the development of the agricultural sector and give a multiplier effect
2) Maize has a competitive profit over other secondary food crops; with the average productivity of 6.190 kg/ha and the price of Rp 3.520/kg. To compete with soybean, peanut, green bean, and sweet potato; the minimum yield of maize is 3.736 kg/ha, 2.428 kg/ha, 1.940 kg/ha, and 5.779 kg/ha, respectively. While the minimum price levels, respectively, are Rp 2.136/kg, Rp 1.381/kg, Rp 1.103/kg, and Rp 3.286/kg.
3) The level of stability of maize yield in West Lombok Regency, both for the period 2000-2010 and 2011-2016 included in the category of "low stability". If the level of variation for a period of 2011-2016 can be reduced to 2.5%, then yields that can be saved through increased yield stability is 630 kg/ha; so with an average harvest area of 5.390 ha, the total yield that can be saved is about 3.419 tons/year.

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