Analysis of production efficiency and income to support sustainability of cassava farming in Lampung Tengah District, Lampung Province

Murniati K¹, W A Zakaria¹, T Endaryanto¹, and L S M Indah¹

¹Department of Agribusiness, Faculty of Agriculture, University of Lampung, Jl. Prof. Dr. Soemantri Brojonegoro No. 1 Bandar Lampung 35141, Telp 08961147335.

E-mail: ktut.murniati@fp.unila.ac.id

Abstract. This study aims to analyze the efficiency of production, income, and sustainability of cassava farmers revenue in Lampung Tengah Regency, Lampung Province. Lampung Tengah Regency was chosen as the research location with the consideration that the district is a center for cassava production in Lampung Province. The number of respondents was 60 respondents who were taken using simple random sampling. Data collection was carried out in July 2020. The data used in this study are primary and secondary data. Data analysis used the production function stochastic frontier with the Frontier 4.1 program, income analysis, and R/C ratio to know sustainability of cassava farming. The result showed that cassava farming in Lampung Tengah Regency on average, is not efficient both technically and economically but was profitable with R/C > 1 it means the cassava farming in Lampung Tengah district still sustain to cultivate.

1. Introduction
Food crop sub sector has a very important role in realizing national food security, absorption of labor, providers of industrial raw materials and food [1–3] stated that the food crop sub sector has a very important role in realizing national food security, absorption of labor, providers of industrial raw materials and food. One of the important commodities in the food plant group is cassava. Pusat Data dan Sistem Informasi Pertanian showed that Indonesia is the fourth largest producer of cassava after Thailand in the world [4]. It's just that Indonesian cassava is mostly consumed domestically [5].

The harvested area for cassava in Indonesia in 2015 was 0.95 million hectares and the production reached was 21.80 million tons with a productivity of 22.95 tons /ha. In 2016, the harvested area for cassava is projected to be 1.11 million hectares with a productivity of 20.23 tons/ha, so the national cassava production is expected to reach 25 million tons [4]. The opportunity for cassava development is very wide, given the availability of quite extensive land, based on data from BPS in 2005, it shows that there is a potential dry land area of 25,955.901 hectares consisting of 10,775.051 hectares of tegal land, 3,839.093 hectares and temporary undeveloped land for an area of 11.341.757 ha. These lands are available potential for the development of cassava cultivation/ farming areas [4].

The potential productivity of cassava is high in aggregate but is not balanced with the actual productivity of the farmers. The difference in the use of production factors and the managerial ability of farmers causes differences in the productivity of cassava. The use of production factors need to be considered to increase farmers income and will provide maximum profit and production efficiency. Land area is the variable most responsive to the production (frontier) of cassava farming [6]. The low price of cassava can lead to low farmer income because the cost of farming production is not...
proportional to the income earned. Based on the survey on the field the ability of farmers to detect farming problems is still low, while the success of farming is determined by the decisions taken. The allocation of the use of production factors needs to be considered in order to achieve production efficiency, increase productivity and income.

Coelli [7] stated three sources of productivity growth, namely technological changes, increased technical efficiency and economies of scale. Kumbhakar [8] examined the relationship between technical efficiency and productivity, namely that commodity production is affected by efficient input allocation, or the absence of technical inefficiency problems and agricultural production factors. Based on these problems, it is necessary to conduct research on the efficiency of cassava farming production in Lampung Province.

So many research about production efficiency and income, but the research about the relation between production efficiency and income to farming sustainability has not been widely carried out. Therefore, this research objective is to analyze the efficiency of production, income, and sustainability of cassava farmers revenue in Lampung Tengah Regency, Lampung Province.

2. Research Method
This research was conducted in Bandar Agung Village of Terusan Nunyai sub-district of Lampung Tengah Regency, Lampung Province. The location of this study was determined purposively with the consideration that Lampung Province is the largest cassava producing province in Indonesia. The research time on July 2020. This study used a survey method at the location of cassava production centers in Lampung Province. The sample farmers were estimated to be 60 cassava farmers who were taken by *simple random sampling*. Analysis of the data used to answer the first objective of cassava farming used the production function *stochastic frontier* with the frontier 4.1 program using computer assistance. The *stochastic frontier* production function model for efficiency and technical inefficiency in cassava farming is as follows.

\[ \ln Y = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_3 + \cdots + b_9 \ln X_9 + b_{11} \ln Z_1 + b_{12} \ln Z_2 + b_{13} \ln Z_3 + b_{14} \ln Z_5 + b_{15} \ln Z_6 + e_i + U_i \]  

*Description:*
- \( Y \) = Cassava production (kg)
- \( b_0 \) = Intercept
- \( b_1, b_2 \ldots b_9 \) = Estimator variable parameter/ regression coefficient
- \( X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8 \) = Land area (ha), Seed (kg), NPK fertilizer (kg), Urea fertilizer (kg), SP36 fertilizer (kg), KCl fertilizer (kg), Pesticides (gba), Labor (HOK)
- \( Z_1, Z_2, Z_3, Z_4, Z_5, Z_6 \) = Age of farmer (years), Formal education level, Farming experience (years), Participation in counseling, Number of dependents (person), Distance to factory (km)
- \( e_i \) = Errors due to random factors
- \( U_i \) = Technical inefficiency factors

Van Passel et al [9] describe factors affecting technical inefficiencies related to age, education, experience, credit and markets. Similar research also performed by Fauziyah, Baree, and Nahraeni et al [10]; [11]; [12]. Economic efficiency is obtained by using cost function parameter estimation. The variable used is the weighted price of each variable using the formula for the total cost of each input divided by the production of each farmer. The function of the overall economic efficiency estimation model can be written as follows:

\[ \ln C_i = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + \ldots + b_8 \ln X_8 + U_i \]  

*Description:*
- \( C_i \) = Cassava production (kg)
- \( b_0 \) = Intercept
- \( b_1, b_2 \ldots b_8 \) = Estimator variable parameter/ regression coefficient
- \( X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8 \) = Land area (ha), Seed (kg), NPK fertilizer (kg), Urea fertilizer (kg), SP36 fertilizer (kg), KCl fertilizer (kg), Pesticides (gba), Labor (HOK)
- \( Z_1 \) = Age of farmer (years)
- \( Z_2 \) = Formal education level
- \( Z_3 \) = Farming experience (years)
- \( Z_4 \) = Participation in counseling
- \( Z_5 \) = Number of dependents (person)
- \( Z_6 \) = Distance to factory (km)
- \( Z_7 \) = Errors due to random factors
- \( Z_8 \) = Technical inefficiency factors

\[ \ln C_i = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + \ldots + b_8 \ln X_8 + U_i \]  

(2)
Description:

\( C_i \) = Total production cost (Rp)

\( X_1 \) = Land rental price (Rp / ha)

\( X_2 \) = Seed price (Rp / kg)

\( X_3 \) = NPK fertilizer price (Rp / kg)

\( X_4 \) = Urea fertilizer price (Rp / kg)

\( X_5 \) = SP36 fertilizer price (Rp/ kg)

\( X_6 \) = KCl fertilizer price (Rp/kg)

\( X_7 \) = Pesticide price (Rp/kg)

\( X_8 \) = Labor price (Rp/kg)

\( b \) = Regression coefficient

\( U_i \) = error

Results obtained from application frontier 4.1 with a cost function model is Cost Efficiency so that to get economic efficiency uses the formula:

\[
EE = \frac{1}{CE} \tag{3}
\]

Analysis of price efficiency or allocative efficiency is obtained from the calculation of economic efficiency divided by technical efficiency written with the formula:

\[
EH = \frac{EE}{ET} \tag{4}
\]

Description:

\( EH \) = Price efficiency

\( EE \) = Economic efficiency

\( ET \) = Technical efficiency

The income analysis is calculated to see how much the farmer's income is and the R/C value of cassava farming to see the feasibility of farming using the following formula:

\[
\pi = TR - TC \tag{5}
\]

\[
\pi = (Y.Py) - (X.Px) \tag{6}
\]

The R / C formula used is:

\[
R/C = \frac{TR}{TC} \tag{7}
\]

Description:

\( R / C \) = Ratio revenue and cost

\( TR \) = Total Revenue or total revenues (Rp)

\( TC \) = Total Cost (Rp)

\( Y \) = Output (kg)

\( Py \) = Price of cassava (Rp)

\( X \) = Input (kg)

\( Px \) = Input Price (Rp)

3. Results And Discussion

3.1. Analysis of Cassava Production Efficiency

Based on Table 1 the variables that have a significant effect on production in Lampung Tengah Regency are the variable land area (X1), seeds (X2), NPK fertilizer (X3), KCL fertilizer (X6), pesticides. (X7), and labor (X8). The urea (X4) and SP36 (X5) fertilizer variables did not significantly affect production, meaning that the use of fertilizers was not efficient. The use of inefficient fertilizers needs to be paid attention to the dosage and time of fertilization. Based on the regression results in Table 1, the production function is frontier as follows:

\[
\ln Y: 7.8280 + 0.3825 \ln X_1 + 0.2953 \ln X_2 + 0.0129 \ln X_3 + 0.0032 \ln X_4 + 0.0029 \ln X_5 - 0.0065 \ln X_6 - 0.0230 \ln X_7 + 0.2972 \ln X_8 + U_i
\]
Table 1. Estimation results of the production function of stochastic frontier cassava farming in Lampung Tengah Regency in 2020.

| Variable                  | Lampung Tengah |  
|---------------------------|----------------|
| Intercept                 | 7.8280 ***     |
| Land area (X1)            | 0.3825 ***     |
| Seeds (X2)                | 0.2953 ***     |
| NPK Fertilizer (X3)       | 0.0129 ***     |
| Urea fertilizer (X4)      | 0.0032         |
| SP36 Fertilizer (X5)      | 0.0029         |
| KCl Fertilizer (X6)       | -0.0065 ***    |
| Pesticides (X7)           | -0.0230 ***    |
| Labor (X8)                | 0.2972 ***     |
| sigma-squared             | 0.6417 ***     |
| Gamma                     | 1.0000 ***     |
| OLS Log Likelihood        | -22.2586       |
| Log Likelihood MLE        | -3.8368        |

Source: Primary data, processed research results, 2020  
Information:  * = 90% confidence level (t-table = 1.6630)  ** = 95% confidence level (t-table = 1.9833)  *** = 99% (t-table = 2.6349)

The results of the stochastic frontier production test can produce the factors that affect the production of cassava farming and the level of technical efficiency of each farmer. The distribution of the technical efficiency of cassava farming in Lampung Tengah Regency in 2020 is presented in Table 2.

Table 2. The distribution of the efficiency level of cassava farming in Lampung Province.

| Technical Efficiency | Lampung Tengah | Information |
|----------------------|----------------|-------------|
| Amount (people)       | (%)            |             |
| <0.70                | 31             | 51.67       | Not efficient |
| 0.70 – 0.90          | 20             | 33.33       | Quite efficient |
| > 0.90               | 9              | 15.00       | Very efficient |
| Total                | 60             | 100.00      |
| Average              | 0.70           |             |
| Min                  | 0.15           |             |
| Max                  | 1.00           |             |

Source: Primary data, processed research results, 2020

Based on Table 2, cassava farming in Lampung Tengah Regency is on average quite technically efficient with a value of 0.70. However, most of them are not efficient. The average efficiency level value of 0.70 means that farmers still have the opportunity to increase their efficiency by 30 percent. Similar research on technical efficiency, Fauziyah [10] on tobacco in Madura provides a technical efficiency index between 0.56 to 0.99 with an average of 0.78. Saptana, Daryanto, Daryanto and Kuntjoro [13] found that the average technical efficiency was 0.90 for Central Java red chili. A study by Banani and Koestino [14] on shallots in Brebes found that technical efficiency levels ranged from 0.65 to 0.99, with an average of 0.80. Darmansyah, Sukiyono and Sugianti [15] on Cabbage in Rejang Lebong Regency produces technical efficiency between 0.78 to 0.99, with an average value of 0.91. Meanwhile, Abiola and Daniel (2014) examined the technical efficiency of melons in Nigeria giving an index between 0.43 to 0.97, with an average of 0.84. A study conducted by Baree [11] on onions in Bangladesh produced a technical efficiency index ranging from 0.58 to 0.99 with an average...
A study by Taiwo, Dayo and K. O B [16] about the technical efficiency of cassava in Nigeria resulted in a technical efficiency level ranging from 0.42 to 0.97 with an average of 0.904. Kareem and Isgn [17] regarding the technical efficiency of cassava in Ghana produced a technical efficiency level of between 9.1 to 99.6 with an average of 95.6. This efficiency value means that cassava farmers in Lampung Tengah can still improve technical efficiency by 30 percent.

Technical efficiency can be increased by fostering ideal cropping patterns and cultivating seedlings. The majority of the cassava spacing applied by farmers in Lampung Tengah Regency was 50 cm x 50 cm and 30 cm x 40 cm. Based on the recommendation of cropping patterns in monocultures, the ideal can be done with a distance of 1 m x 1 m; 1 m x 0.8 m; 1 m x 0.75 m and 1 m x 0.7 m. Whereas for less fertile soils, dense spacing is used 1 m x 0.5 m, 0.8 m x 0.7 m. Multiple row spacing in an intercropping planting pattern that supports cassava plants planted at a spacing of 0.6 m x 0.7 m x 2.6 m [18]. Spacing that is too dense will affect the decline in production. Then to use the seeds must be in the form of stem cuttings from the bottom to the middle. To achieve the cropping pattern and superiority of a cassava seed, it is necessary to have an educational strategy for farmers to be able to add insight and knowledge, so that it can influence production results more optimally.

Table 3. Estimated parameters of technical inefficiency factors of cassava farmers in Lampung Tengah Regency in 2020.

| Variable                  | Lampung Tengah Coefficient | t-ratio |
|---------------------------|----------------------------|---------|
| Intercept                 | 7.8280 ***                 | 19.6829 |
| Age (Z1)                  | -0.1432                   | -0.3791 |
| Level education (Z2)      | 0.0788                    | 0.3305  |
| Farming experience (Z3)   | -0.1138                   | -0.5795 |
| Number of dependents (Z4) | 1.0187 ***                | 3.3586  |
| Participating farmer (Z5) | -1.1454                   | -1.6673 |
| Distance to factory (Z6)  | -0.7300 *                 | -1.9169 |
| sigma-squared             | 0.6417 ***                | 2.7071  |
| Gamma                     | 1.0000 ***                | 1.5708  |
| Log Likelihood OLS        | -22.2586                  |         |
| Log Likelihood MLE        | -3.8368                   |         |

Source: Primary data, processed research results, 2020
Information: * = 90% confidence level (t-table = 1.6630)
** = 95% confidence level (t-table = 1.9833)
*** = 99% (t-table = 2.6349)

These factors are technical inefficiency factors which are analyzed using the technical inefficiency model of the stochastic frontier production function. Estimated parameters of factors affecting the technical inefficiency of cassava farming are presented in Table 3. Based on the results in Table 3, the gamma value in Lampung Tengah Regency is 1.000, which means that 1.000 percent of the errors in the stochastic frontier production function are caused by technical inefficiency. The variables that affect the technical inefficiency factor in Lampung Tengah Regency are the number of dependents (Z4) and the distance to the factory (Z6).

The results of the calculation of Table 3 show that the variables that have a significant effect on cassava production are the number of dependents (Z4) and the distance to the factory (Z6), while other variables have no significant effect. The t-count value of the number of dependents (Z4) is greater than the t-table, which is 3.3586. These results indicate that the variable number of dependents of cassava farmer families in Lampung Tengah Regency has a significant effect on cassava production with a confidence level of 99 percent. This means that if the number of family dependents is increased by one percent, it will reduce the level of efficiency by 1.0187 percent.
Table 4. Estimation results of the production cost function of stochastic frontier cassava farming in Lampung Tengah Regency in 2020.

| Variable                                      | Lampung Tengah | coefficient | t-ratio |
|-----------------------------------------------|----------------|-------------|---------|
| Intercept                                    | 14,9370 ***    | 12,0278     |
| Land rental price / output (X1)               | 0,3222         | 1,0006      |
| Seed / output price (X2)                      | -0,0632        | -0,2635     |
| Price of NPK fertilizer / output (X3)         | 0,0353 **      | 2,5965      |
| Price of urea / output fertilizer (X4)        | -0,0422        | -1,3970     |
| Price of fertilizer SP36 / output (X5)        | 0,0572 ***     | 4,6989      |
| Price of KCl / output fertilizer (X6)         | 0,0335 *       | 1,9986      |
| Pesticide price / output (X7)                 | 0,0556 *       | 1,9425      |
| Labor / output wage (X8)                      | -0,0393 **     | -2,2494     |
| sigma-squared                                | 0,7254 ***     | 3,5001      |
| Gamma                                         | 0,8890 ***     | 9,4821      |
| Log Likelihood OLS                           | -49,8120       |
| Log Likelihood MLE                           | -48,1753       |

Source: Primary data, processed research results, 2020.

Note: *

Based on Table 4, the variables that have a significant effect on the profits of cassava farming in Lampung Tengah are the price of NPK fertilizer/output (X3), the price of fertilizer SP36 / output (X5), the price of KCl/fertilizer output (X6), pesticide price / output (X7) and wages for labor / output (X8). Economic efficiency is obtained through an analysis of the cost of production inputs using weighted prices, namely by dividing the variable costs of inputs by the total production. Based on the results in Table 4, the frontier production cost function is as follows:

\[
\ln C: 14,9370 + 0,3222 \ln X1 - 0,0632 \ln X2 + 0,0353 \ln X3 - 0,0422 \ln X4 + 0,0572 \ln X5 + 0,0335 \ln X6 + 0,0556 \ln X7 - 0,0393 \ln X8 + Ui.
\]

Table 5. Distribution of the economic efficiency of cassava farming in Lampung Tengah Regency in 2020.

| Economic Efficiency of | Lampung Tengah | Information     |
|------------------------|----------------|-----------------|
|                        | Amount (person) | (%)            |
|                        | 44              | 73,34           |
| 0,70 – 0,90            | 16              | 26,66           |
| > 0,90                 | 0               | 0,00            |
| Total                  | 60              | 100,00          |
| Average                | 0,46            |
| Min                    | 0,14            |
| max                    | 0,88            |

Source: Primary data, processed research results, 2020

The results of the analysis show that the constant in the model that affects the economic efficiency factor is 14,9370 with the t-count value greater than the t-table, meaning that the variable value of land rental price/kg, the price of seeds/kg, the price of NPK/kg, the price of urea/kg, the price of SP36/kg, the price of KCl/ kg, the price of pesticides/kg, and the price of labor / kg are equal to zero then the value of farming profits cassava amounted to 14,9370 percent. The results of the estimation of the
The production cost function of stochastic frontier cassava farming in Lampung Tengah Regency are presented in Table 5.

After obtaining the results of the factors that affect the benefits of cassava farming, it will be obtained the value of economic efficiency. Based on Table 5, the average cassava farming is not economically efficient (0.46). This is because farmers are less able to allocate inputs properly so that they are not able to equalize input prices with marginal products. Although allocatively (price) it is efficient. The distribution of price efficiency in Lampung Tengah Regency is presented in Table 6.

Table 6. Distribution of the efficiency of cassava farming prices in Lampung Tengah Regency in 2020.

| Price efficiency | Amount (people) | Information |
|------------------|-----------------|-------------|
| <0.70            | 21              | 35.00       | Not efficient |
| 0.70 - 0.90      | 15              | 25.00       | Quite efficient |
| > 0.90           | 24              | 40.00       | Very efficient |
| Total            | 60              | 100.00      |              |
| Average          | 0.96            |             |              |
| Min              | 0.15            |             |              |
| Max              | 1.00            |             |              |

Source: Primary data, processed research results, 2020.

Based on the results of research the efficiency distribution of cassava farming prices in Lampung Tengah Regency, it was obtained 35 percent with an average of 0.96 in Lampung Tengah Regency. This means that cassava farming is included in the very efficient category in terms of price.

3.2. Cassava Farming Income

In this research, apart from discussing production efficiency, it also discusses the income of cassava farming in Lampung Tengah Regency, Lampung Province. Income is measured as revenue minus production costs. Analysis of cassava farming income is presented in Table 7.

Table 7. Revenue, costs, income and R / C farming of cassava in Lampung Tengah 2020.

| Description       | Unit  | Price (Rp) | Lampung Tengah |
|-------------------|-------|------------|----------------|
|                   |       |            | Farming per 1 ha |
|                   |       |            | Amount | Value (Rp / yr) |
| Revenue           | kg    | 957,25     | 22,270,99 | 21.318.907,44 |
| Production        | kg    | 2,959,01   | 327,77    | 969.865,67    |
| NPK fertilizer    | kg    | 2,376,31   | 366,13    | 870.049,62    |
| Urea fertilizer   | kg    | 5,114,65   | 170,31    | 871.075,29    |
| TSP /SP36 fertilizer | kg   | 5,694,69   | 200,97    | 1.144.439,18  |
| KCl Fertilizer    | kg    | 65.681,82  | 79,89     | 5.247.442,46  |
| Pesticides        | HOK   | 1240,776,08| 69,615,14 | 10.911,498,72 |
| TKLK              |       |            |          |               |
| Cost transportation| Rp    |            |          |               |
| PBB               |       | 69,615,14  | 10.911,498,72 |

II. Cost Calculated
Based on Table 7, it can be seen that the largest use of input costs is the cost of labor outside the family (TKLK). This is because in cassava farming, the process of cultivating the land, planting, and harvesting usually uses workers outside the family (TKLK). Cassava production in Lampung Tengah Regency is low (22,270 tons / ha), whereas the potential for cassava farming can reach 40 tons/ha. The low production of cassava in Lampung Tengah Regency is due to: the use of spacing and the use of fertilizers that are not in accordance with the recommendations and the use of seeds from the harvest (not native seeds-F1). Cassava farming income from cash costs in Lampung Tengah Regency is Rp10,407,408,72/ha with an R/C of 1.95, which means that the cost of one rupiah spent by the farmer for cassava farming in Lampung Tengah Regency will get a profit of Rp1,95.

3.3. The sustainability of cassava in Lampung Tengah Regency
The sustainability of technical farming can be seen from the efficiency of production and income. Based on the analysis results, cassava farming in Central Lampung is technically and economically inefficient, so the production is low and not optimal. The less of optimal production was caused by the use of spacing, seeds, and harvest age. The spacing used by the farmers, ranging from 0.5 x 0.5 and 0.3 x 0.4 m, was not following the recommendations and did not provide an optimal result. Recommendations from the Agricultural Research and Development Agency (IAARD) [19] are 1 x 1 m, 1 x 0.8 m, 1 x 0.75 m, and 1 x 0.7 m, adjusted to soil fertility level. The seeds used by farmers are seeds that come from previously harvested trees will reduce cassava productivity. In order to optimize productivity, farmers have to use new or original seeds (F1). Most of the farmers harvest the cassava at the age of 6 months, so the farmers’ price is low. According to the Agricultural Research and Development Agency (2016), farmers tend to harvest cassava following the regular selling price. When cassava's price is high, farmers will harvest early even though the harvest age determines the water content and starch content of cassava. The older harvest age the less water content and more starch content. The harvest age recommendation by the IAARD is around 7-10 months [19]. The sustainability of cassava farming and increasing production efficiency and farmer income, education is needed to farmers through strategies in the short term that can be taken through restructuring the use of production factors.

4. Conclusion
Cassava farming in Lampung Tengah Regency is mostly not technically efficient nor economically efficient. However, cassava farming in Lampung Tengah Regency is still worthy of being cultivated. In order to improve the sustainability of cassava farming in Lampung Tengah regency, the farmers need to get education about short term strategies and following the recommendations of cassava cultivation.
References

[1] Zulkarnain, Haryono D and Kasymir E 2010 Keunggulan Komparatif dan Kompetitif dalam Produksi Padi di Kabupaten Lampung Tengah Propinsi Lampung J. Penelit. Pertan. Terap. 10 185–99

[2] Kristian and Surono S 2014 Faktor-Faktor Yang Mempengaruhi Produksi, Konsumsi Dan Harga Ubi Kayu Indonesia (Studi tahun 1991-2013 dengan menggunakan persamaan simultan) (Universitas Indonesia)

[3] Kaizan 2014 Analisis Kelayakan Finansial dan Nilai Ekonomi Lahan (Land Rent) pada Penggantian Usahatani Kopi menjadi Karet di Kabupaten Way Kanan Propinsi Lampung (Universitas Lampung)

[4] Kementerian Pertanian 2016 Outlook Komoditas Sub Sektor Tanaman Pangan Ubi Kayu (Pusat Data dan Sistem Informasi Pertanian)

[5] Hermanto 2015 Ketahanan Pangan Indonesia di Kawasan ASEAN Forum Penelit. Agro Ekon. 33 19–31

[6] Anggraini N, Harianto and Anggraeni L 2015 Efisiensi pada Usahatani Ubi Kayu di Kabupaten LampungTengah Provinsi Lampung (Institut Pertanian Bogor)

[7] Coelli T J, D.S. Prasada, Rao Christopher J O and George E B 2005 An Introduction to Efficiency and Productivity Analysis 2nd (Boston: Springer)

[8] Van Passel S, Lauwers L and Van Huylenbroeck G 2006 Factors of farm performance: An empirical analysis of structural and managerial characteristics Nov. Sci. Publ. 3–22

[9] Fauziyah E 2010 Analisis efisiensi teknis usahatani tembakau ( suatu kajian dengan menggunakan fungsi produksi frontier stokhastik ) 7 1–7

[10] Banani A and Koestinono D 2013 Production Management and Technical Efficiency of Red Onion Farming in Brebes Regency J. Basic Appl. Sci. Res. 3 85–90

[11] Darmansyah A, Sukiyono K and Sugiartri S 2013 Analisis Efisiensi Teknis Dan Faktor Yang Mempengaruhi Efisiensi Pada Usaha Tani Kubis Di Desa Talang Belitar Kecamatan Sindang Dataran Kabupaten Rejang Lebong (Analysis of Technical Efficiency and Factors Affecting Efficiency Cabbage Farming in Talang Be AGRISEP 12 177–94

[12] Kareem M A and Isgin T 2016 Technical Efficiency of Cassava Production in the Savannah Zone of Northern Ghana: Stochastic Frontier Analysis Supply response analysis of perennial crops View project Technical Efficiency of Cassava Production in the Savannah Zone of Northern Ghana: Sto J. Biol. Agric. Healthc. 6 62–72

[13] Sundari T 2010 Petunjuk Teknis Pengenalan Varietas Unggul Dan Teknik Budidaya Ubi Kayu (Materi Pelatihan Agribisnis Bagi KMPH) (Malang: Balai Penelitian Kacang Kacangan dan Umbi Umbian)

[14] IAARD 2016 Pedoman Budi Daya Ubi Kayu Di Indonesia (Jakarta: IAARD Press)