Comparison Analysis of Tajuk’s Onion Production Efficiency (Allium Ascalonicum) in Rejoso Sub-District – Nganjuk

D R Ulansari\textsuperscript{1,4} and I N Pujawan\textsuperscript{1,3}

\textsuperscript{1}Institut Teknologi Sepuluh Nopember, Jalan HOS Cokroaminoto 12, Surabaya, Indonesia
\textsuperscript{2}dewirekno140@gmail.com, \textsuperscript{3}pujawan@ie.its.ac.id

Abstract. Nganjuk is one of production area for Tajuk’s onion. This research aimed to compare the results of technical and allocation efficiency from Tajuk’s onion production in rejoso sub district, whether there are any differences or not. In addition, it will be used by the researcher to determine the factors which cause inefficiency and find sorts of way to fix the problems. The method used in this study was DEA and would be continued by conducting comparative test. The results in this study showed that there was difference between technical effeciency and allocation effeciency of Tajuk’s onion production in Rejoso Sub-District on June-September, 2019, showed that W value on Mann Whitney test met 67.94 percent, contained sig value 0.000. The three main factors which caused technical inefficiency were pesticide, water flow, and the land area. Meanwhile, allocative inefficiency is caused by certain main factors; pesticide, seeds, land area, and working hour. The pesticide usage can be dealt by conducting studies and comparative study among farmers, remesured the land area of sewer and flowerpot along with plants gap; making new irrigation; using stored up seeds only before the harvest time, and allocating the numbers of labors that arranged by land capacity.

Keywords: Onion, Data Envelopment Analysis, Efficiency, Production.

1. Introduction

Onion is a seasonal plant whereas everyone demands for this comodity everyday. The demands for onion will consistently increase as the people’s necessities keep increasing, along with the growth numbers of citizen populations. The following is the Projection Results of Onion Consumption in Indonesia in 2016-2020, which is explained on Table 1.

The onion consumption has increased from year to year. Looking at the projection on the national onion consumption in 2016-2020, conducted by the Agricultural Data and Information System Center, illustrates that the consumption of onion in 2016 to 2018 will consistently increase (eventhough the calculation from 2018 to 2019 have decreased). Whereas, the national consumption is obtained from consumption per capita multiplied by the total population calculated by BPS. The national onion consumption in 2020 is calculated to reach 755,687 tons with an average growth of 2.03% per year. Through this information, therefore it can be concluded that national consumption until to the next calculations will increase and thus it is necessary to make a strategy for managing the onion supply, in order to be competent in meeting the national consumption needs, including in minimizing onion import activity.
Table 1. The Projection Results of Onion Consumption in Indonesia in 2016-2020

| Year | Consumption (kg/cap/year) | Development (%) | Population (000 person) | Development (%) | National Consumption (Ton) | Development (%) |
|------|--------------------------|-----------------|-------------------------|-----------------|---------------------------|-----------------|
| 2015 | 2.71                     |                 | 252.165                 |                 | 684.124                   |                 |
| 2016 | 2.73                     | 0.74            | 255.462                 | 1.31            | 698.178                   | 2.05            |
| 2017 | 2.73                     | 0.04            | 258.705                 | 1.27            | 707.299                   | 1.31            |
| 2018 | 2.84                     | 3.84            | 261.891                 | 1.23            | 743.509                   | 5.12            |
| 2019 | 2.79                     | -1.73           | 265.015                 | 1.19            | 739.392                   | -0.55           |
| 2020 | 2.82                     | 1.08            | 267.974                 | 1.12            | 755.687                   | 2.20            |

Mean (%/year) 0.79 1.22 2.03

Source: Outlook onion Center for Data and Information Systems Ministry of Agriculture, 2016

Nganjuk, as one of the onion production area in East Java, has locations as onion’s planting and growth area in several districts. One of them is Rejoso Sub-District with one of their superior onions so called the Nganjuk Original Local Plant (Tajuk’s Onion). One effort that can be used to measure the productivity is to measure the productive efficiency. Data Envelopment Analysis (DEA) method is the most popular method of measuring efficiency. DEA method was first developed by Charles Cooper and Rhodes through his paper which has been published by the European Journal of Operation Research in 1978 (Falhanawati, 2013: 23). Agricultural research using the DEA model and yet closely related to onion research has been done by previous researchers, including a research of the difference of onion production efficiency based on its types by Gebremariam et al. (2019), Anik et al. (2017) who puts efficiency measurement points on natural resource use, and Ray et al. (2016) who researches the driving factors of onion cultivation’s production and efficiency. In this research, the results of DEA testing for technical efficiency and allocative inefficiency will be compared using different tests with a view to knowing whether there are differences in efficiency or not. This is due to the fact that the allocation of inputs in technical terms is obviously different, that can be seen from the real use of production factors (with technical units, such as kg and liters) and in the form of funding. This is also considering that the funding allocation from one farmer and another farmer is different, although in terms of technique they are the same but have different prices. Therefore, the researchers feel the urge to conduct a comparative test, which hopes to contribute in realocating the use of proper inputs both technically and allocatively funding.

Based on the introduction above, and knowing that Rejoso district in Nganjuk as the location of Tajuk’s Onion cultivate area, thus this research aims to find out:

1. Is there any level difference on technical efficiency and allocative efficiency of Tajuk’s onion in Rejoso district-nganjuk?
2. What factors do influence the technical efficiency and allocative inefficiency of Tajuk’s onion in Rejoso district-nganjuk?

2. Research methods

2.1 Research Approach

This research elaborated the efficiency of onion production by using quantitative approach through non parametric DEA method by CSR approach. The quantitative approach integrated hypothesis testing by measured data and would be discovered how a variable’s effect towards another variable, therefore it would make a generalized conclusion.

2.2 Research Scope And Limitation

This research was conducted in Nganjuk, rejoso sub-district. The sample was a part of populations’ characteristic and quantity (Anshori and Sri, 2009:94). This research’s sampling was conducted by two stages; purposive sampling and quota sampling. Sugiyono (2007:68) explained that purposive
sampling is the determining technique sample by certain consideration. The purposive sampling in this research had criteria as follows:

- Farmers who had/rented a land to farming with more than 0.700 Ha large, based on RDKK data of Rejoso district, Nganjuk. In working the agricultural land, the farmers who worked on field more than 0.700 Ha large, employed another labors other than their family; and
- Farmers over than 20 years old.

And to meet the purposive sampling criteria above, the research continued by conducting quota sampling. According to Sugiyono (2007:67) quota sampling is a technique to determine the population sample which has certain characteristics up to the wanted amount. The terms from quota sampling in this research were:

1. Choosing the farmers who had/rented a land with more than 200 rho (the unit determined by the Nganjuk community, 1 rho = 14 m²) or equivalent to 2.800 m².
2. Taking 30 samples of farmers in each village that met the criteria above.

Based on the determined sample above, the villages sample in this research were, Mungkung Village, Ngadiboyo Village, Setren Village, Rejoso Village, Sidokare Village, Gempol Village, Sukorejo Village, and Mojorembum Village.

2.3 The definitions of Variable

This research used six variable input and one variable output. The used data in this research was racio data. Because, there were two types of efficiency counting, the operational definitions of each variables was showed on Table 2.

Table 2. Operational variables and definitions according to research objective

| Variable’s Name        | Symbols | Units | Information                                                                 |
|------------------------|---------|-------|-----------------------------------------------------------------------------|
| First Purpose          |         |       |                                                                             |
| Production Amount      | Y       | Kg    | The amount of shallots/onion varieties produced by farmers in one harvest season. |
| Fertilizer             | X₁      | Kg    | The amount of fertilizer used to produce Red Onion Varieties in one harvest season. |
| Pesticide              | X₂      | Liter | The amount of pesticide used to produce Red Onion Varieties in one harvest season. |
| Seeds                  | X₃      | Kg    | The amount of seeds used to produce Red Onion Varieties in one harvest season. |
| Water flow             | X₄      | Liter | The amount of water flow used to produce Red Onion Varieties in one harvest season. |
| Working Hours          | X₅      | Hour  | The amount of working hour used to produce Red Onion Varieties in one harvest season. |
| Land Areas             | X₆      | M²    | The amount of land areas used to produce Red Onion Varieties in one harvest season. |
| Second Purpose         |         |       |                                                                             |
| Production Sales       | Y       | Rupiah| Farmer’s income from the sale of Onion produced in one harvest season.        |
| Fertilizer             | X₁      | Rupiah| Fertilizer costs paid by farmers to produce onion in one harvest season.       |
| Pesticide              | X₂      | Rupiah| Pesticide costs paid by farmers to produce Onions in one harvest season.       |
| Seeds                  | X₃      | Rupiah| Seeds costs paid by farmers to produce Onions Varieties in one harvest season. |
| Water flow             | X₄      | Rupiah| Water flow costs paid by farmers to produce Onions Varieties in one harvest season. |
| Working Hours          | X₅      | Rupiah| Working hours costs paid by farmers to produce Onions Varieties in one harvest season. |
| Land Areas             | X₆      | Rupiah| Land areas costs paid by farmers to produce Onions Varieties in one harvest season. |
2.4 Analysis Technique
The technique used in this study was the DEA model *(data cross section)*. The analysis model in this study was used to analyze the obtained data in order to discover to what extent the efficiency values of each sample in each Decision Making Unit (DMU). Decision Making Unit (DMU) in this research was sample or farmers.

2.4.1 Descriptive Statistics. In descriptive statistics was presented and was explained from the mean, lowest value (minimum), and highest value (maximum), from the input and output variables, and the standard deviation of each input variable were fertilizer, pesticides, seeds, water flow, working hours, and land area and pest repeller; as well as the output variable, which was the total production of Tajuk’s Onion.

2.4.2 Data Envelopment Analysis. The steps that needed to be taken to analyze the DEA were as follows: determined DMU (farmers), inputs and outputs; imported the data and performing the optimization methods; output maximization and CRS assumptions; executed the efficiency table for the target to see the efficiency of each village as well as from each input and output; and interpreted all of the results. Pre-determined input and output variables would be analyzed using the CRS model to determine Overall Technical Efficiency. The measurement of efficiency values assuming the CRS would be based on formula 1 and 2. The measurement results would produce an efficiency value scale.

\[
\begin{align*}
\text{Max } h_k = & \sum_{r=1}^{m} u_r y_{rj} \\
\sum_{j=1}^{n} u_j x_{ij} & \geq y_{rk}
\end{align*}
\]

2.4.3 Independent Sample Mann-Whitney Test. Comparative test was conducted to answer the hypothesis that had been set in this research. The first step was conducted a Kolmogorov-Smirnov data normality test to discover whether the data was normally distributed or not (Siregar, 2014: 152). The purpose of the Mann-Whitney Test model was to determine whether there is a significant difference between the technical efficiency and the allocative efficiency of the Tajuk’s Onion in the Rejoso Sub-district, Nganjuk, in the Harvest Season of 2019. This study was classified as a large sample, where \( n_1 \) or \( n_2 \geq 20 \) and both sample groups had standard deviations or was obtained from the same variant. Because of that, the significance test for the null hypothesis test used the criticism price in the Normal Table.

3. Result and discussion

3.1 Statistical description
This research used six variable inputs, along with one variable output, which will be reviewed from two aspects; namely technical aspect and allocative aspect. Furthermore, descriptions from each variables are presented and are therefore described on Table 3.

Based on the Table 3, it can be described further in the following points:
- The data from fertilizer variable, seed variable, working hour, land area, both of technical and allocative, the \textit{mean} value were greater than the standard of deviation. Since the mean > deviation, then those variables data were not extensively expanded.
- The data from pesticide variable and water flow, both of technical and allocative, the mean value were lower than the standard of deviation. Since the mean < standard of deviation, then those variables data were extensively expanded.
- The variable data of total product, technically, were not greatly expanded since the mean value > standard of deviation, yet allocatively expanded largely since the mean value > standard of deviation.
Table 3. Descriptions of research variables

| Variables         | Information | Mean  | Min  | Max  | Std. Deviation |
|-------------------|-------------|-------|------|------|----------------|
| Fertilizer        | T: (Kg)     | 830.78| 112  | 6800 | 690.27         |
| (input)           | A: (Rp)     | 2.379.274| 175.000| 8.745.000| 1.571.353      |
| Pesticide         | T: (ML)     | 12184.93| 700  | 110000| 14444.5        |
| (input)           | A: (Rp)     | 4.101.012.5| 45.000| 35.493.000| 4.593.852.47   |
| Seeds             | T: (Kg)     | 573.53 | 200  | 2500 | 282.33         |
| (input)           | A: (Rp)     | 12.231.827| 3.940.000| 50.000.000| 6.094.924.1    |
| Water flow        | T: (l)      | 11478.45| 1943 | 96464 | 14905.72       |
| (input)           | A: (Rp)     | 1.974.551| 50.000| 21.325.000| 2.143.725      |
| Working Hours     | T: (Hour)   | 778.37 | 364  | 1794 | 289.33         |
| (input)           | A: (Rp)     | 7.608.404.2| 960.000| 35.500.000| 4.841.728.9    |
| Land Areas        | T: (m²)     | 4403.12 | 2800 | 16800| 2072.2         |
| (input)           | A: (Rp)     | 2.974.313.7| 9.250| 19.000.000| 2.888.470.1    |
| Total Production  | T: (Kg)     | 12185.13| 6000 | 110000| 10323.22       |
| (output)          | A: (Rp)     | 51.095.958.3| 7.000.000| 640.000.000| 54.549.568.2   |

*a*: 240 farmers; *b*: Technique; *c*: Allocative

3.2 Analysis of The Calculation Result in Technical and Allocative Efficiency Values

Productive efficiency was a method from several relative capability from certain companies in order to use input for producing output on the certain level (Nurhapsa et.al, 2017:17). Soekartawi (1993) also described exactly the same thing. Meanwhile, the farmers were stated to have attained the allocative efficiency if they got great profit. In this part, the researcher would discuss further the results of efficiency values from each village, both technically and allocatively. It turned out that DMU-DMU had technical efficiency than allocative efficiency. There was a summary from the discussion result of technical and allocative efficiency in each villages on Table 4 as follows:

Table 4. Results of calculation of technical efficiency and allocative efficiency

| No | Villages     | Technical Efficiency | Allocative Efficiency |
|----|--------------|-----------------------|------------------------|
|    |              | E = 1                 | E < 0,5                | E = 1                 | E < 0,5                |
|    |              | dim %                 | dim %                  | dim %                 | dim %                  |
| 1  | Mungkung     | 4/30                  | 13,33                  | 8/30                  | 26,67                  | 8/30                  | 26,67                  | 4/30                  | 13,33                  |
| 2  | Ngadiboyo    | 4/30                  | 13,33                  | 0/30                  | 33,33                  | 7/30                  | 23,33                  |
| 3  | Setren       | 19/30                 | 63,33                  | 0/30                  | 33,33                  | 1/30                  | 3,33                   |
| 4  | Rejoso       | 10/30                 | 33,33                  | 0/30                  | 6,67                   | 23/30                 | 70                     |
| 5  | Sidokare     | 14/30                 | 46,67                  | 0/30                  | 5,00                   | 5/30                  | 16,67                  |
| 6  | Gempol       | 15/30                 | 50                     | 0/30                  | 3,33                   | 6/30                  | 20                     |
| 7  | Sukorejo     | 13/30                 | 43,33                  | 0/30                  | 5,00                   | 5/30                  | 16,67                  |
| 8  | Mojorembun   | 18/30                 | 60                     | 0/30                  | 13,33                  | 5/30                  | 4/30                   |
|    | Total        | 97/240                | 40,42                  | 8/240                 | 3,33                   | 65/240                | 27,08                  |
|    |              | 68/240                | 28,33                  |                        |                        |

Source: Processing Results with OSDEA

Based on the summary of the results of Table 4, in the technical calculation, the highest efficiency value from the eight villages observed in this study was in Setren Village (63.33%), followed by Mojorembun Village (60%), Gempol Village (50%), Sidokare Village (46.67%), Sukorejo Village (43.33%), Rejoso Village (33.33%), Mungkung Village (13.33%) and Ngadiboyo (13.33%). If they were accumulated, the total number of DMUs that had been efficient was 97 out of 240 observational samples or equivalent to 40.42 percent in the calculation of technical efficiency. There were only two villages that had a total efficiency value of more than 50 percent, namely Setren and Mojorembun.

The allocative calculations in eight villages turned out to be different from the technical calculations. The total results of efficiency in eight villages presented 27.08 percent with the sequence and details of Gempol Village (40%), Ngadiboyo Village (33.33%), Setren Village (33.33%), Mojorembun Village (30%), Mungkung Village (26.67%), Sidokare Village (20%), Rejoso Village
(16.67%), and Sukorejo Village (16.67%). That was, still farther from expected. This certainly would give influence in productivity unless the efficiency can be managed properly. Furthermore, the calculation results of efficiency values less than 0.5 even the allocative calculation enhanced and turned into 28.33 percent (68/240). Results that were more than two digits were in Sukorejo Village (24) and Rejoso Village (21). All villages needed to pay attention to the allocation of inputs so that there were no waste so that efficiency could be achieved and could be even more productive. On the calculation results in Table 4 showed that efficiency value still farther than the target (80 percent farmers had efficiency) both from technical and allocative efficiency.

3.3 Model Analysis and Hypothesis Testing

3.3.1 Normality Test. The normality test is the basis for determining what statistical models are best for conducting hypothesis testing. In this study the normality test was carried out with the Kolmogorov-Smirnov test. Since P_{value} < P_{table}, thus the decision of this test was received H_{0} and refused H_{1}, this meant that the data was not normally distributed. Because the data groups were not normally distributed, then the analysis model used was the non-parametric independent sample Mann-Whitney Test model.

![Probability Plot of Technical Efficiency](image1.png)

**Figure 1** and **Figure 2**: Efficiency and Allocative Efficiency Normality Test Results

3.3.2 Independent Sample Mann-Whitney Test. The Mann-Whitney Test results showed that for the efficiency value the CRS assumption had W value of 67938.00 or 67.94 percent with a significance value of 0.000 or less than 0.05. Since the value of W_{value} < W_{table}, then the decision of this test was to reject H_{0} and accept H_{1}, which means that there were differences in technical efficiency and allocative production of Tajuk’s Onion in Rejoso Sub-district in the June-September 2019 harvest season.

3.3.3 Analysis Causes of Technical Inefficiency and Allocative Production of Tajuk’s Onion in Rejoso Sub-district. This research used DEA method with the assumption of CRS and output oriented approach, thus the slack variable results would show how much the excess input was used. The over input allocation with the same output, can cause the inefficiency. The slack variable calculation was conducted using OSDEA and summarized on Table 5.

On Table 5 explained that what dominates the cause of technical inefficiencies in Mungkung and Ngadiboyo Villages were the land area, meanwhile in Setren, Rejoso and Sidokare Villages were Pesticides, while in Gempol, Sukorejo, and Mojorembun Villages were water flow. Table 5 also explained that what dominates the causes of allocative inefficiency in Mungkung, Rejoso, and Gempol Villages were Pesticides, while in Ngadiboyo and Sukorejo Villages were Seeds and in Setren village was Working Hours. The cause of allocative inefficiency in the villages of Sidokare and Mojorembun was Land Area.
Table 5. Slack variable that causes inefficiency

| No. | Village   | Main Cause of Technical Inefficiency | Main Cause of Allocative Inefficiency |
|-----|-----------|--------------------------------------|---------------------------------------|
| 1   | Mungkung  | Land Areas                           | Pesticide                             |
| 2   | Ngadiboyo | Land Areas                           | Seeds                                 |
| 3   | Setren    | Pesticide                            | Working Hours                         |
| 4   | Rejoso    | Pesticide                            | Pesticide                             |
| 5   | Sidokare  | Pesticide                            | Land Areas                            |
| 6   | Gempol    | Water Flow                           | Pesticide                             |
| 7   | Sukorejo  | Water Flow                           | Seeds                                 |
| 8   | Mojorembun| Water Flow                           | Land Areas                            |

This result was supported by Yadav (2015: 193) which stated that doing unnecessary work efficiently is not fully productive and it would be more appropriate to do things efficiently in output oriented (rather than input oriented) to achieve results. Whereas, in order to achieve the efficiency, Curristine (2007: 9) explains that it can be obtained by increasing the scale of operations. In line with this, Sheth (2002) in Roghanian et al. (2012) in his research also explained that productivity can be achieved through a combination of effectiveness and efficiency.

4. Conclusions and suggestions

After conducting research at that location and processing it according to the research method, the researcher gets some discussion of the results that can be concluded, as follows:

1. There was a difference on the technical efficiency level and allocative production level of the Tajuk’s onion in the Rejoso Sub-district in the June-September 2019 harvest season.

2. Factors that influenced the efficiency of the technique based on its slack calculation were pesticides, land area, and water flow. While the factors that influence the allocative efficiency in the slack calculation were pesticides, land area, seeds, and working hours.

Based on the results of research and empirical studies, the following authors submit some input / suggestions that are expected to be useful, as follows:

1. Based on the calculation results of the technical and allocative efficiency, it is recommended that farmers who have not meet the optimum efficiency to follow the amount of allocation of the farmers’ used input that has been stated as efficient.

2. Factors causing inefficiencies that occur in both types of technical and allocative calculations are land area and pesticides. The problems on land area can be minimized by rearranging the size of the ditches and flowerpot, as well as plant gap, therefore the land of production can be optimal because the spacing will affect the land itself. As for pesticides, it would be better for farmers in one village to do comparative study among farmers to discover which types of pesticides are effective and have realistic prices. Thus, it is necessary to reduce costs yet people’s needs are still fulfilled. Furthermore, water flow input factors also influence the technical inefficiencies. This can be minimized by creating new irrigation channels for villages that do not yet have irrigation channels. Because, from the price facet, irrigation channels are cheaper when compared to diesel (especially renting it).

3. The seeds problem, as one of the factors causing the allocative inefficiency can be minimized by using seeds that have been stockpiled by the farmers themselves (leaving some previous harvests) and not buying additional seeds near the harvest season. Because, when it is close to harvest season, the price of seeds will be more expensive. The problem of working hours can be overcome by allocating the amount of labors that is adjusted to the land capacity.

4. The last suggestion is for the local government to pay attention to the primary production for the crops productivity, especially Onion. This is related to the provision of irrigation facilities which will influence for the farmers. In addition, the regulations are needed related to the sale of onion

| Table 5. Slack variable that causes inefficiency |
commodities thus that local farmers do not experience decreasing selling prices as a result of the soaring commodities from other regions. Besides, the government is expected to be able to determine the ceiling price and floor price limits and controls the prices of commodity sales in the marketplace, so that the selling prices of the main producers (farmers) to consumers (last) do not experience great gap.

Thus, this research still limited to:
1. The technique of sampling on the second phase, after determining the main sample which uses purposive sampling, is quota sampling
2. The methode analysis which uses non-parametric approach is DEA. Therefore, it is not capable in identifying the external factors or environmental variable that cause inefficiency.

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