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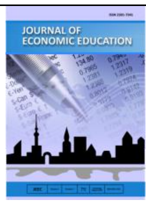


# Analysis of Efficiency of Organic Vegetable Production in Batang Regency Central Java

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**Abstract**

The purpose of this research is to analyze the efficiency level of organic vegetable farming technique in Batang Regency. Twenty seven organic vegetable farmers were taken as samples with saturated samples (census). Stochastic frontier production function has been used to analyze data with the help of frontier 4.1 software. The results of this research indicate that the Efficiency level of organic vegetable farming production in Batang Regency has not been so efficient that there is still a chance to increase the production of organic vegetables. Land area and the use of manure are proved to significantly affect the production of organic vegetables in Batang Regency. Seeds, labor and organic pesticides have no significant effect on the production of organic vegetables in Batang Regency. To increase the efficiency of organic vegetable production in Batang Regency, it is necessary to have the role of stakeholders to provide socialization, mentoring, and facilitation in organic vegetable farming.



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## INTRODUCTION

Food is the ingredients consumed daily to meet the energy's needs in order to do activities optimally and to make health guaranteed. Nowadays people in the world increasingly are consciousthat the use of chemicals in agricultural products, in fact, brings negative effects on health and environment (Sulaeman, 2008). People's consciousness of the healthy life style trend with "Back to Nature" slogan presupposes a guarantee that foodstuffs must have attributes of safely consumed, having high nutrient contents, and friendly to environment. Such attributes can be found in the organic foodstuffs, one of which is vegetables.

According to Winarno in Bahar (2008), consumers, especially in advanced countries such as Europe, Japan, and America, are interested in organic food due to health, more fresh products, delicious taste, and specific texture and character giving specific satisfaction and pleasure. The demand for organic food in some advanced countries is increasing as much as 20% from year to year.

Vegetables are complementary ingredients for the staple food. The demand for vegetables day by day is always increasing as the number of people increasing, so the production and productivity are always increased to meet the demand. People who have high consciousness of health generally will turn to organic vegetables. Producing the organic vegetables and marketing them using organic label require certification process according to SNI (Indonesian National Standard) and the applicable provisions. The organic certification process also requires a long time that makes the harvest area development become limited. It was proved by the relatively slow development of the land area in Central Java, as shown in Table 1.

**Table 1.** Land Area Development (Ha) during five years in Central Java

| No | Location | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| 1 | Semarang Regency | 16 | 26 | 96 | 96 | 96 |
| 2 | Boyolali Regency | 0 | 0 | 10 | 20 | 25 |
| 3 | Batang Regency | 0 | 0 | 0 | 0 | 10 |

Source: Agricultural Office,Food Crops and Horticulture, Central Java Province (2015)

According to the agribusiness development paradigm, the agribusiness success, including organic vegetables, depends mostly on the progress achieved in every subsystem (Arifin, 2004). The agribusiness system will run well unless there are disturbances in one of the subsystems. Every subsystem connects to each other and one's performance affects one another. The performance of farming products as a subsystem in agribusiness is mostly affected by other subsystems' supports. The following problems such as inefficient product facility procurement, untimely availability of superior seeds and fertilizer, conventional cultivation technology, unhealthy processing technology, and less supporting agriculture institutions and marketing mostly affect the performance of farming production (Yuhono, 2004). The identification of farming subsystem production (on farm agribusiness) and the support of off farm agribusiness are useful to formulate the strategy of agribusiness development including the right organic vegetables according to the local situation and condition.

### Efficiency

The efficiency concept applied in this research refers to the one presented by Farrell (1957) and Coelli et.al. (1998). Efficiency is categorized into three those are technical, allocating, and economic efficiencies (Kusnadi et.al., 2011). Timmer in Susantun (2000) defined technical efficiency as an input ratio that is really used together with the available output. Allocating efficiency indicates the relationship of cost and output. It will be achieved if a company is able to maximize the benefit, which is equating the marginal product of each production factor with the cost. It can be found in the technical efficient farming condition. Economic efficiency is the product of technical and cost efficiencies. If the allocating efficiency is found in efficient condition, technically the agricultural industry is in the economic efficient condition. So, economic efficiency can be achieved if both efficiencies have been achieved. According to Farrel in Kusnadi et.al. (2011), there are two approaches in efficiency calculation those are input and output approaches. The input approach is explained through isocost curve as shown by AA' curve and isoquant as shown by BB' curve (see Figure 1).

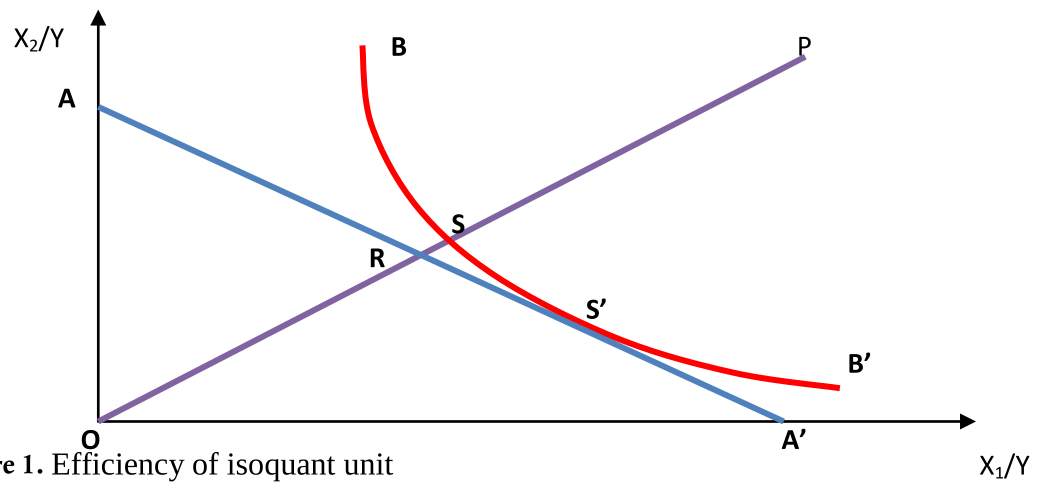


**Figure 1.** Efficiency of isoquant unit
Farell in Coelli et.al. (1998)

Both axes indicate the stage of usage of each input per unit of output, where X shows input and Y shows output. In that figure AA' is the isoquant line indicating various combinations of input X1 and X2 to find one efficient isoquant unit (technically) and also indicating the frontier line of Cobb-Douglas function, which is called Isoquant Unit Efficiency Curve. The area placed in the right of AA' is technically inefficient to find one unit of output, while the area in the left of AA' curve is the one impossible to reach. If a company moves to point P by pulling the straight line from point P to point O that cuts curve AA' on S, SP is the excessive usage of both production factors to the most efficient production factor usage. Therefore, the technical efficiency measure on point P is a ratio between OS and OP, while to find out the cost efficiency requires the relative production factor cost. Line X1 and X2 of the production factor cost are shown by line AA' that offends curve BB' on S' and cuts line OP on point R. Line AA' is the cost line indicating the place of combination of input usage to find one unit of output by the lowest cost indicated by tangent point S' on curve BB'. So, the cost efficiency is for a company that moves to point OR/OS,the economic efficiency is as a result of technical and cost efficiencies OS/OP. OR/OS = OR/OP.

Measuring the technical efficiency may use stochastic frontier production function. The frontier production function was developed at the first time by Aigner et.al. (1977) and Meeusen and Van den Broek (1977). This function describes a maximum production potentially produced for a number of production input that is sacrificed. Such an important characteristic of the frontier production model to estimate the technical efficiency is the impact separation of exogenous variable shock to the output with variation contribution in technical efficiency form (Giannakas et.al., 2003).

Aigner et.al. (1977) with Meeusen and Van Den Broeck (1977) in Coelli et.al. (1988) presentedthat the frontier stochastic function is the expansion of the deterministic original model to measure the unexpected effects (stochastic frontier) inside the production limit. In this production function, random error, vi, are added into non-negative random variable, ui, as stated in the following equation:

$$Ln\,Y = \beta_0 + \sum_{j=1}^{k} \beta_j lnX_{ij} + \varepsilon \qquad (1)$$

where In (Yi) indicates the output logarithm value of the i company and Xi is the vector of input number of the I company. While βi is a parameter being estimated and ui is the positive random variable connected with the production technical inefficiency of the i company. Ratio of the output observation on the i company is relative to the potential output, indicated by the frontier function of the existing input so that the technical efficiency value can be formulated as follows (Tasman, 2006) :

$$ET = \frac{Y_i}{exp(X_i\beta)} = \frac{exp(X_i\beta - u_i)}{exp(X_i\beta)} = exp(-u_i) \qquad (2)$$

Then Aigner et.al. (1977) and Meusen and Van den Broek (1977) in Coelli et.al. (1998) presented the frontier stochastic production function with additional random error (vi) into the positive random variable so that the equation model becomes as follows:

$$\ln(Y_i) = X_i\beta + v_i - u_i \quad i=1,2, \ldots\ldots\ldots n \qquad (3)$$

Random error Vi accommodates the measure mistake and other random factors outside the control such as climate effect, condition of a country, advantage, and others above the value of output together with combination effect of variable input that cannot be specified in the production function. Aigner et.al. (1977) assumed that Vi is independently and identically distributed-i.i.d), the variable random with the zero average and constant variant $\sigma_v^2$ independently from ui that is assumed i.i.d random variable exponential or half normal.

The equation model (3) is called Stochastic frontier production function because the output value is limited above by stochastic (random) variable, *exp(X$_i$β+v$_i$).* Random error vi can be positive or negative, and also frontier stochastic output varies limitedly from frontier model, , *exp(X$_i$β)* (see Figure 2.5). Input is represented on horizontal axis and output is on vertical axis. The deterministic component of frontier model, Y=, *exp(X$_i$β)* assumed diminishing return to scale. Output and input are observed from two companies i and j and the i company uses level input X to produce output Yi. The value of frontier stochastic output, Yi* = exp($X_i\beta+v_i$) indicated by point above the production function because random error vi is positive. While the j company uses level input Xj and produces output Yj* = exp($X_i\beta+v_i$) below the production function because random error vj is negative. Output Yi* and Yj* are not observed because random error vi and vj are not detected, but the deterministic part of frontier stochastic model seems to exist between frontier stochastic output. The observation output may be bigger than the deterministic part of frontier if random error connecting with it is bigger than the inefficiency effect.

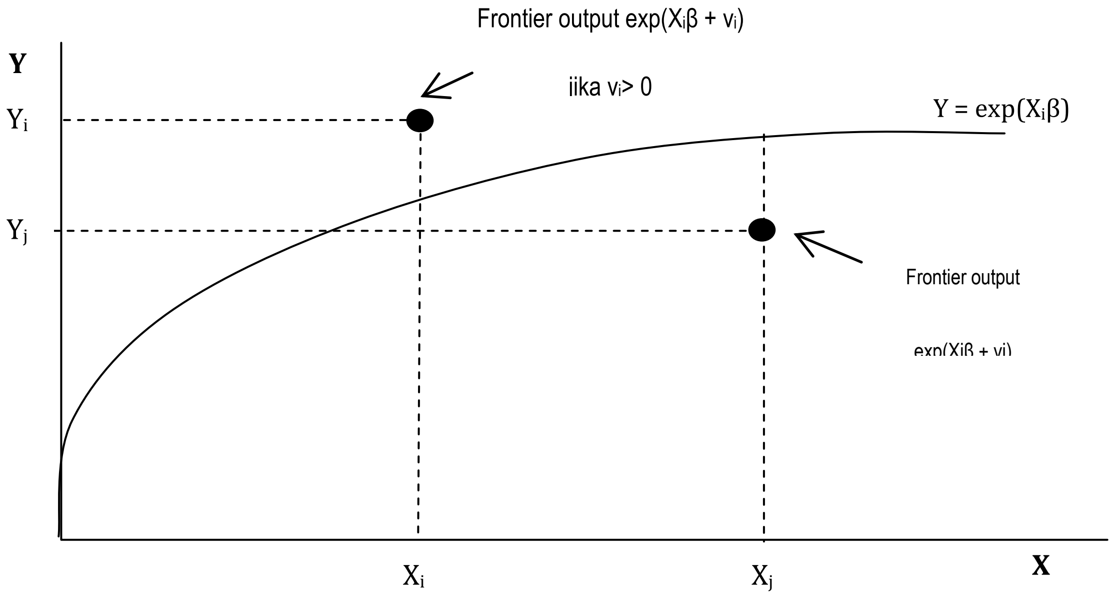


**Figure 2.** Production Function of Frontier Stochastic
Source: Tasman (2006)

The production function of frontier stochastic describes the maximum production potential to produce for a number of production input satisfied. Green (1993) explained that the frontier production model possibly estimates or predicts relatively a certain industry group, which is found from a relationship between production and production potential observed. Moreover, based on the production theoretical frame, a lot of model has been developed to estimate the technical efficiency of an industry (firm) by considering the different theoretical and empiric aspects (Coelli et.al., 1998; Greene, 1999; Kumbhakar & Lovell, 2000).

The important characteristic in frontier production model to estimate the technical efficiency is the impact separation of exogenous variable shock to the output with contribution of variation in the form of technical efficiency (Giannakas et.al., 2003). In other words, this method application makes it possible to estimate the inefficiency of a production process without ignoring the standard mistake of the model. This is possibly because an error term in the model consists two mistakes in which both are distributed freely (normally) and similar for each observation, in which the first is the standard mistake typical in a model (v) and the other is to represent the inefficiency (U) and e=u-u (Baek and Pagan, 2003; Coelli et.al., 1998; Giannakas et.al., 2003). Technical efficiency can be measured using variant ratio parameter with the total variant $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\lambda = \sigma_u / \sigma_u$as follows (Battese and Corra, in Coelli et.al, 1996)

$\gamma = (\sigma_u^2) / \sigma^2)$

where $\sigma^2 = \sigma_u^2 + \sigma_v^2$and $0 \leq \gamma \leq 1$

If $\gamma$ is close to one, $\sigma_v^2$ is close to zero, and ui is the level of mistake in the equation (4) indicating inefficiency. Here, the difference between management and efficiency result is the most important part due to the specification in management. Furthermore, the analysis is to identify an effect of differences among the factors. Technical efficiency of a company can be assumed by using an equation formulated by Bettese and Coelli; Kumbhakar and Lovell in Sukiyono (2005) that can be calculated using the following formulation:

$$E\,[\,\exp(-u_i \mid E_i)\,] = \exp\,[\,\mu_i^* + 0{,}5\,\mu^{*2}\,] \times \frac{\Phi\left(\dfrac{-----}{\sigma^*} - \sigma^*\right)}{\Phi\left(\dfrac{\mu^*}{\sigma^*}\right)} \qquad (5)$$

where $E_i = \eta_i - u_i$ ; $\mu_i = \dfrac{\sigma^2_\eta - \sigma^2 u}{\sigma^2_\eta - \sigma^2 u}$ and $\sigma^{*2} = \dfrac{\sigma^2_\eta \times \sigma^2 u}{\sigma^2_\eta + \sigma^2 u}$ and

a representation of normal distribution functions for random variable. While Jondrow et.al. in Zen et.al. (2002) showed that the average condition of ui and $\varepsilon_i$in an equation in the following:

$$E(u_i \mid \varepsilon_i) = (\sigma_u \sigma_v/\sigma)\ \{[f(\varepsilon_i\lambda\ \sigma^{-1})/(1-F(\varepsilon_i\lambda\ \sigma^{-1}))] - (\varepsilon_i\lambda\ \sigma^{-1})\} \qquad (6)$$

where $\varepsilon_i$ is the sum of vi + ui, $\sigma$ is an equation for $(\sigma_u^2 + \sigma_v^2)^{½}$ , $\lambda$ is a ratio of $\sigma_u$on $\sigma_v$, f and F are the normal density standard and the evaluation distribution function on $\varepsilon_i\lambda\ \sigma^{-1}$. The measure of technical efficiency (TE) for each company can be calculated by:

$$TE_i = \exp\,[E(u_i \mid e_i)] \qquad (7)$$

where $0 \leq TE_i \leq 1$

**METHODS**

Twenty seven farmers of organic vegetables in Batang Regency are taken as samples (census). This research uses Stochastic frontier production function to analyze the technical efficiency of organic vegetable production as having been applied in various sectors, for example on the industrial sector conducted by Parsons (2004), Salim (2006), Yuk-Shing and Dic Lo (2004), Ovewo et.al. (2009). While in the agricultural sector it has been conducted by Sukiyono (2005) and Puspitasari (2009), Kusnadi et.al. (2011). Based on the equation (1), the empiric form of production function model of Cobb-Dauglass stochastic frontier in this research can be written as follows:

Y = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + (Vi – Ui) (8)

Explanation:

$X_1$ = Land area
$X_2$ = seeds
$X_3$ = labors
$X_4$ = fertilizer
$X_5$ = pesticide
b0 = Constanta
$b_{1-5}$ = regression coefficient
(vi-ui) = error

The above model is assumed by Maximum Likelihood (MLE) using Frontier 4.1.

**RESULT AND DISCUSSION**

**Characteristics of Regions and Farmers of Organic Vegetables**

The organic vegetable farming in Bawang Regency is located in Bawang District (Agricultural Office,Horticulture Agricultural Plants, 2015). Bawang District is geographically bordered with Tersono District in the North, with Kendal Regency in the East, Wonosobo Regency and Banjarnegara Regency in the South. This region is extending from West to East with land area about 7,384.5 Ha, consisting farm land of 1,696.4 Ha and dry land of 5,688.1 Ha. The irrigation system for farm land in Bawang District is simple irrigation and rain system (Regional Statistics, Bawang District, 2016). Some villages in Bawang District are located in the slope of the mountain, one of which is Deles Village. In Deles Village, most inhabitants conduct the horticulture farming activities such as potatoes, white cabbage, scallions, leek, tomatoes, chilies, and others in organic way.

The organic vegetable farming in Batang Regency existing in Deles Village is conducted by Peni Murni farmer group, which is led by Nurcholis Mlayan and has 27 members of people. The potency of organic vegetable production in Bawang District is relatively high because the topography condition and the climate are supporting. In fact, many farmers are reluctant to conduct organic vegetable farming due to some reasons, some of which are:

1. The price of organic and anorganic vegetables in the market is not different
2. People's consciousness of consuming organic vegetables is still relatively low
3. Organic vegetables physically are less interesting than the anorganic ones

Experiences and trainings that have ever been taken by the organic vegetable farmers in Deles Village, Bawang District, Batang Regency can be seen in Table 2 and 3.

**Table 2.** Experiences of Organic Vegetable Farming

| Experience (year) | Numbers of Respondent (people) |
|---|---|
| 3 | 17 |
| 4 | 2 |
| 5 | 7 |
| 6 | 1 |

Source : primary data processed

Based on Table 2, it is known that most respondents have experiences in running organic vegetable farming for three years (63%). The detailed percentage can be seen in Figure 3.

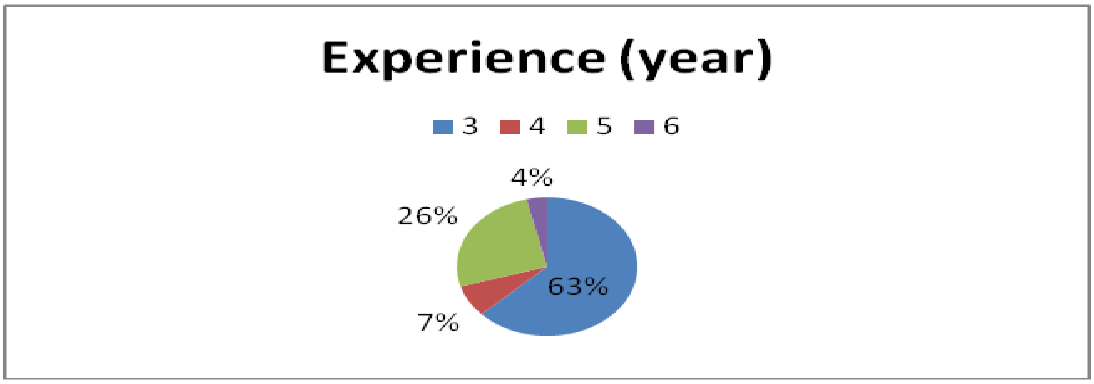


**Figure 3.** Percentage of Respondents Based on Organic Vegetable Farming Experience

**Table 3.** Types of Trainings that are followed

| Types of Trainings | Numbers of Respondents |
|---|---|
| SOP of Organic | 14 |
| Cultivation | 5 |
| Post-harvest | 8 |

Source : primary data processed

Based on Table 3, it is known that most respondents have ever followed the organic SOP trainings of fourteen people (52%). The detailed percentage can be seen in Figure 4.

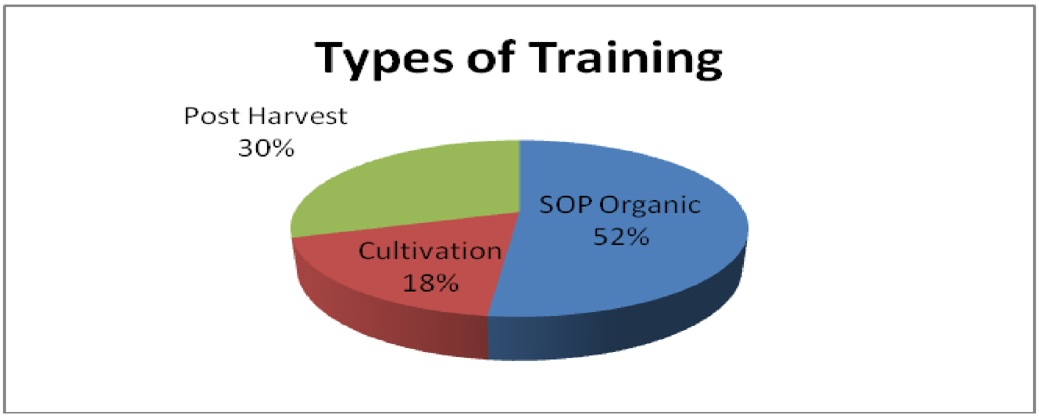


**Figure 4.** Percentage of Respondents Based on Trainings Ever Followed

**Technical Efficiency of Organic Vegetable Farming**

The analysis result of technical efficiency of organic vegetable farming in Batang Regency has not been efficient yet. The analysis result of technical efficiency using Stochastic Frontier Production Function in details can be seen in Table 3.

From Table 2 it can be seen that most parameters on the frontier production function of organic vegetable farming in Batang Regency indicates the average of efficiency level of 0.88. This result explains that organic vegetable farming in Batang Regency has not been wholly efficient. In Batang Regency, most are conducted in subsystem way, with relatively small industry land area so that the result is not maximum yet. It is in accordance with the research conducted by Sukiyono (2005) and Puspitasari (2009), Kusnadi et.al. (2011), which concluded that the farming industry conducted by the farmers have not wholly been efficiently conducted yet. The variables of land area, a number of seeds and labors are proved to be able to really affect the production of organic vegetables in Batang Regency, while the factors of manure and organic pesticide have no real effect on the production.

**Table 3.** Estimation Result of Frontier Production Function

| No | Variables | Coefficient | Std. error | t- ratio |
|---|---|---|---|---|
| 1 | Constanta | 105.98 | 32.702 | 3.240** |
| 2 | Land Area | 649.298 | 3.865 | 167.965** |
| 3 | Seeds | 0.709 | 0.335 | 2.113* |
| 4 | Labors | 17.961 | 7.792 | 2.304* |
| 5 | Manure | 0.043 | 0.096 | 0.454 |
| 6 | Organic Pesticide | 52.421 | 94.741 | 0.553 |
| 9 | γ | 0.039 | 0.187 | 0.210 |
| 10 | $\sigma^2$ | 125.140 | 1.000 | 125.126** |
| 11 | Mean Technical Efficiency | 0.889 | Explanation :<br>** significantin 1% ;<br>* significantin 5% | |

Source : Primary Data Processed (2017)

The factor of land area brings positive and significant effect on the organic vegetable production in Batang Regency. It means that the more the land area used for the farming industry is, the more increasing the organic vegetable production in Batang Regency will be. The extending of organic vegetable farming industry in Batang Regency can be conducted by extending the planting area so hopefully it can meet the increasing needs for organic vegetables in accordance with people's consciousness of living more healthy. For Batang Regency, the planting area extending can be done because there are still many areas that have not been utilized intensively, especially the dry land (house yard). However, the organic vegetable farming industry requires land condition with certain height. Therefore, the extending of planting area is also limited on the highland area.

The factor of seeds brings positive and significant effect on the production of organic vegetables. This indicates that the number of seeds used in the organic vegetable farming indutry in Batang Regenc is very important in increasing the production. To reach the optimum production result, the use of seeds needs to be conducted efficiently starting from the seed selection.

The factor of labors brings positive and significant effect on the production of organic vegetable in Batang Regency. This can be explained that the use of labors may afect the organic vegetable production especially during the time of plant maintainance that requires attention such as destroying the disturbing plants and knowing as soon as possible if there are pest attack or others that destroy the organic vegetable plants so any action can be conducted quickly.

The factor of manure brings no significant effect on the production of organic vegetable in Batang Regency, but it brings positive effect. It can be explained that the use of manure on organic vegetable farming industry in Batang Regency has not been in accordance with the needs. Although all the farmers of organic vegetables use the manure, only most of them utilize the fertilizer.

The factor of organic pesticide brings no significant effect on the production of organic vegetables in Batang Regency, but it brings positive value. It can be explained that the use of organic pesticide is still needed in the vegetable farming. The use of organic pesticide in organic vegetable farming has not been in accordance with the needs. Some use the organic pesticide in big amount and some use it in little amount.

## CONCLUSION

Based on the data analysis result found in this research, it can be concluded as follows :

1. The average value of Technical Efficiency of organic vegetable farming in Batang Regency is 0.88. Based on the efficiency value, all farmers of organic vegetables in Batang Regency have not conducted their activities efficiently.
2. Land area, seeds, and labors bring positive and significant effects on the production of organic vegetables.
3. Manure and organic pesticide bring no significant effect on the production of organic vegetables.

To increase the production of organic vegetabels in Deles Village, Bawang District, Batang Regency requires the following things to do :

1. It needs the role of stakeholders to give socialization, mentoring, and facilities in the organic vegetable farming
2. Extending the planting area
3. Increasing the use of seeds in quality and quantity.

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