The Impact of the Efficiency of Rubber Production

by Paper Pak Kuswanto 7

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2019, 9(2), 80-86.

The Impact of the Efficiency of Rubber Production on the Welfare of Rubber Farmers in Jambi Province

Kuswanto Kuswanto*, Zulkifli Alamsyah, Armandelis Armandelis, Zulfanetty Zulfanetty

Universitas Jambi, Jambi, Indonesia. *Email: kuswanto.fkip@Unja.ac.id

Received: 27 November 2018 **Accepted:** 08 February 2019 **DOI:** https://doi.org/10.32479/ijefi.7503

ABSTRACT

This study aims to analyse the level of technical efficiency of rubber production and its impact on the welfare of rubber farmers in Jambi Province. The research was conducted in central area of rubber plantation in Jambi Province, namely Batanghari, Sarolangun, Tebo and Muaro Jambi. To explain the determinants of productivity and to analyse the efficiency of rubber production and the factors that influence it, the Cobb-Douglas production function model using the stochastic frozen production function approach is used. Measuring the welfare of farmers using the farmers' household income rate (FHIR) approach. The results showed that the average rubber farmers in the study area have not been efficient in allocating inputs and not yet prosperous production. Improving the technical efficiency of rubber production through increasing the number of young farmers up to 23% and increasing the farming experience by 5% can increase the FHIR of 1.33.

Keywords: Household Welfare, Rubber Farmers, Technical Efficiency of Rubber Productio

JEL Classifications: Q12, Q13

1. INTRODUCTION

Jambi Province is one of the largest rubber producing regions in Indonesia, the third largest after South Sumatra and North Sumatra. The area of Jambi rubber plantations reached 379,011 hectares or about 10.19% of the total national rubber plantation area. But the rubber plantation area is not accompanied by high productivity. The productivity of Jambi rubber only reaches 842 kg/ha/year (DIRJENBUN, 2017). According to Tasman (2008), the level of productivity is determined by (1) the application of technology, (2) the amount and type of resources allocated to the production process, and (3) efficient use of resources.

The problem of production efficiency is the most important problem in the development of rubber agriculture in Jambi Province. The inability of farmers to allocate production inputs will have an impact on low production (Tajerin and Noor, 2005). According to Adar (2011), the factors that led to the low ability of farmers to allocate production inputs were social factors, such as farmer's age, formal education, agricultural experience, and the number of family members. In the long term, the impact will determine the sustainability of the development of rubber agriculture. According to Weersink et al. (1990), farmers who are able to allocate resources efficiently, technically, allocatively, and economically will get maximum benefits.

Previous research on the efficiency of rubber production has been carried out (Adebayo and Giroh, 2009; Poungchompu and Chantanop, 2015; Kittilertpaisan et al., 2016), limited to the level of reduction in technical efficiency. The suggested agricultural improvements from the analysis have implications for increasing productivity. In rubber farming, production is one of the factors that determines the level of income of farmers.

Revenue is the main motive of farmers in developing rubber farming. In various studies (BPS, 2015; Simatupang and Maulana, 2008; Sugiarto, 2008), income is a measure of farmers' purchasing power towards family needs. Meeting family needs for food, clothing, housing, and family needs reflects family welfare (Sunarti, 2006). Based on records (BPS, 2015) farmers in the plantation sector in Jambi Province from 2008-2013 were not yet prosperous.

This paper discusses the level of efficiency of rubber production and its impact on the welfare of farmers in Jambi Province. There are three questions that will be answered from this study, namely; First, how is the efficiency of rubber production in Jambi Province. Second, what factors influence the inefficiency of rubber production. Third, how rubber efficiency affects the welfare of farmers.

2. LITERATURE REVIEWS

Production technical efficiency analysis aims to improve the production system that is run by farmers so that it can increase the production produced. With increased production, farmers will get higher income and will increase their exchange rates for household expenses. Thus the analysis of production efficiency will be meaningful if it is associated with its impact on the socio-economic conditions of farmers as subjects and agricultural objects. According to Weersink et al. (1990), production efficiency is very important in determining the existence of opportunities in the agricultural sector and its potential contribution to economic growth and improving the welfare of farmers.

Analysis of the impact of production efficiency on the welfare of farmers will be easily understood by simultaneously analysing the variables associated with it. Through the measurement of technical efficiency, production costs can be reduced so that producers will be more competitive in generating profits (Alvarez and Arias, 2004). Various measures of the efficiency of the techniques carried out by Farrell (1957); Aigner et al. (1977); Battese and Coelli (1995) produce the ratio of actual production to potential production estimated through the frontier production function. Where, the frontier production function is a function that states the maximum possible production achieved at maximum feasibility productivity conditions in farming conditions. This function is used to measure the actual production function of the frontier position.

Based on the literacy study conducted by Adar (2011), there are several factors that can influence the level of technical inefficiency of annual crop farming (citrus), namely farmers "formal education, farmers" experience in running farming, contact with field officers (PPL and PPHT), age of farmers, other income sources and sales system results. More specifically, research conducted by Poungchompu and Chantanop (2015), as well as research conducted by Kittilertpaisan et al. (2016) using farmer's age factor, education level, farming experience, family size, sex, and plant age in analysing technical inefficiency in rubber production. Mustapha and Hashim (2011) in their research added several factors that were used to analyze the technical inefficiency of rubber production, namely farmers' practices, skills, motivation and experience of officers, supervisory management competencies, soil fertility, rubber tree types and weather conditions

Analysis of the factors that lead to production inefficiencies can be used to increase the capacity of farmers in running farms so that they are more efficient in allocating production inputs to produce maximum output and reduce the costs or risks of using these inputs. Thus farming run by farmers will produce maximum profits (Alvarez and Arias, 2004).

Some researchers like Sugiarto (2008); Simatupang and Maulana (2007); Sadikin and Subagyono (2008); Burhansyah (2010) makes income a benchmark for farmers' ability to meet family needs. The ratio between income and farmer household expenditure is used as an approach to analyse the welfare of farmers. The approach was carried out based on the need to analyse the ability of farmer households in meeting their subsistence needs.

3. METHODOLOGY

This research was conducted in the central area of rubber plantations in Jambi Province. The research sample was taken using a cluster sampling technique, namely from the District, Sub-district and Village levels. Respondents were randomly selected based on the status of farmers as owners and managers of agriculture, making rubber farming the main source of income for families and applying rubber cultivation technology, such as seed use, maintenance, tapping, fertilization, and weed control in rubber farming. Respondents were taken from each village as many as 20 farmers, as explained in Table 1.

In explaining the determinants of productivity and analysing the efficiency of rubber production and the factors that influence it, we use Cobb-Douglas production function analysis with stochastic fungus production function approach. The original model of this function as defined by (Lovell and Shcmidt, 1980; Meunsen and Broeck, 1997) uses cross-data that have error term as a result of random effects and technical inefficiency, as the equation (1):

$$Q_i = \beta_0 L_i^{\beta_1} F_i^{\beta_2} A_i^{\beta_3} N_i^{\beta_4} M_i^{\beta_5} H_i^{\beta_6} \exp(v_i - u_i) \quad (1)$$

Where; Q is the amount of rubber production (kg); L is the amount of labour equivalent to the man's working day (WD); F is the area of productive plantation (hectare); A is the age of the plant (year); N is the number of plants (trees); M is the amount of fertilizer used (kg); H is the amount of herbicide (L) which is calculated in 1 year; v-u is an error term (v is the effect of external factors that are not modelled and u is the effect of technical inefficiency (internal) in the model); i is the sample rubber farm (i = 1, 2, 3....., N); and β is the parameter to be estimated.

Table 1: Number of respondents based on rubber plantation at district, sub-district and village level in Jambi Province in 2017

No	District	Sub-district	Village	Number of samples
1	Sarolangun	Singkut	Batu Putih	20
		Batin VIII	Pulau Buayo	20
2	Tebo	Rimbo Ulu	Sumber Sari	20
		Rimbo Ilir	Karang Dadi	20
3	Batang Hari	Batin XXIV	Bulian Baru	20
4	Muaro Jambi	Jaluko	Muhajirin	20
	Total			120

Source: Secondary data, 2017 (processed)

The parameter estimation is used maximum likelihood estimation (MLE) method. Expected coefficient values $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 > 0$. The positive coefficient indicates an increase in the production factor used will increase rubber production.

To analyse the technical efficiency level of rubber production, the equation (2) is used:

$$TE_i = \frac{Q_i}{Q_i^*} = \frac{\beta_0 L_i^{\beta_1} F_i^{\beta_2} A_i^{\beta_3} N_i^{\beta_4} M_i^{\beta_5} H_i^{\beta_6} \exp(v_i - u_i)}{\beta_0 L_i^{\beta_1} F_i^{\beta_2} A_i^{\beta_3} N_i^{\beta_4} M_i^{\beta_5} H_i^{\beta_6} \exp(v_i)} = \exp(-u_i) \quad (2)$$

Where, is the technical efficiency of the i farm; Qi is the amount of output (output) to $-i$; is the potential production/frontier of the i-th rubber farm; is the mean expectation value of ui, thus $TE_i \leq 1$.

Decision:

H_0: TE = 1; rubber farming by farmers has been technically efficient

H_1: TE <1; rubber farming by farmers has not been technically efficient

The measurement of technical inefficiency used in this study refers to the effect model in technical efficiency of (Battese and Coelli, 1995; Coelli et al., 1998). vi variable is random variable assumed *iid* (identically independently distributed), $N(0, \sigma v2)$ and independent from ui. The u_i variable as a measure of the technical efficiency effect is assumed to be free (but not identically non-negative and has a half-truncated distribution with mean μ and variance $\sigma u2$ or $N(\mu, \sigma u2)$.

In this research, several factors that will be used to estimate the effect of technical inefficiency of rubber production are age of farmer, farmer formal education, farmer's experience and number of family farmer's responsibility. Mathematically can be written as in equation (3):

$$\mu_i = \alpha_0 + \alpha_1 Ag_i + \alpha_2 Ed_i + \alpha_3 + \alpha_4 Df_i + \varepsilon_i \quad (3)$$

Where,

u_i is the technical inefficiency value automatically obtained from the Frontier 4.1 program; Ag is the age of the farmer (year); Ed is a formal education of farmers (year); *Ex* is farmer's experience in rubber farming (year); *Df* is the number of dependents of the family (persons); and i is the sample farm (i = 1, 2......,N).

To analyse the impact of rubber production efficiency on farmer's welfare simulation techniques are simultaneously used to increase production efficiency, production, income, expenditure and farmer welfare level.

The welfare of rubber farmers' families is analysed using the concept of farmers' household income rate (FHIR), which is the ratio between total household income and total household expenditures (Sugiarto, 2008).

$$FHIR = \frac{Y_{pk}}{E_{pk} + E_{kon}} \quad (4)$$

Where, *Ypk* is the income of rubber farming; *Epk* is the expenditure of rubber farming; and *Ekon* family consumption expenditure which is calculated in 1 year.

If *FHIR* > 1, shows farmers' households have prosperous. *FHIR* < 1, shows that farmers' households are not prosperous.

Mathematically, the mechanism of efficiency impact of rubber production on the welfare of farmers as formulated by the following equation:

1. The inefficiency and efficiency of rubber production. The level of efficiency and inefficiency of production is derived from the simultaneous equations resulting from Program Frontier 4.1, which explains if the inefficiency rate increases then the level of production efficiency decreases:
$$TE_i = \delta_0 - \delta_i \mu_i \quad (5)$$
2. The function of the relationship between efficiency with production:
$$Q_i = TE_i Q_i^*$$
3. The function of the relationship between production efficiency and income:
$$Y = \left(P_{Q_{pk}} TEQ_{pk}^*\right) \quad (7)$$

Function of impact of rubber production efficiency on farmer's welfare:

$$FHIR = \frac{\left(P_{Q_{pk}} TEQ_{pk}^*\right)}{E_{pk} + E_{kon}} \quad (8)$$

4. RESULTS AND DISCUSSION

This research was conducted in the central area of rubber plantations in Jambi Province. The selection of rubber farmers who were respondents was based on the existence of rubber farming as the main source of family income. The average rubber farmer in the research area in Jambi province is 49 years old, the average farmer education at the elementary school level. The experience of farmers in running rubber farming on average is 19 years. The number of dependents of farmer households is an average of 3 people. The average education of farmer families depends on the elementary and high school levels.

The average production of rubber produced by farmers for 1 year in the study area was 3.876 kg. The use of the average workforce is 267 WD. The use of an average workforce for 1 year of tapping is 200 WD. The use of labor to collect results in an average year of 62 WD. Use of labor for fertilization in an average year of 1 WD. The average labor use for weeding land in 1 year is 2 WD. While the use of labor for weed control on average in 1 year is 2 WD.

The area of rubber plantations owned by farmers in the study area is an average of 2.5 hectares (he). The average age of rubber plants is 18 years. The average rubber tree tapped by farmers is 1,010 trees. The average use of urea fertilizer in 1 year is 85 kg. The average use of herbicides in 1 year is 4 L.

The stochastic frontier model used in this study is the estimation method of MLE. This method is carried out in two stages, first using the ordinary least square (OLS) method as an estimate of technological parameters and production inputs (βn). The second stage uses the MLE method to estimate the overall factors of production (βn), intercept (β_0) and the variance of the two error components vi and ui ($\sigma v2$ and $\sigma u2$). The estimated parameters of the production function of stochastic fungicides and the effect model of technical inefficiency with MLE are carried out simultaneously using the border program version 4.1 of Coelli. The results of the analysis are explained in Table 2.

In Table 2 the log-likelihood value with MLE (−29.36) method is greater than log-likelihood value by OLS method (−38.47), thus the production function with MLE method is better and in accordance with the conditions in the field. The value of γ which is closer to 1 than 0, i.e. 0.72 indicates that the term error is derived only from the result of inefficiency (*ui*) and not from noise (*vi*). Whereas γ approaches zero it is interpreted that the entire error term is as a result of noise (*vi*) such as weather, pests, etc., and not the result of inefficiency. The ratio of generalizalized-likelihood ratio of 18.17 is greater than Chi-square table at α = 5% and df = 6, which is 7.84, so there is technical inefficiency in the model.

Table 2: Estimation of the parameter and t ratio of stochastic frothier production function model using MLE

Variables	Parameter	coefficient	t-ratio
Intercept	β_0	7.79	0.68
Labor	β_1	0.32	2.65***
Land area	β_2	0.34	3.66***
Plant age	β_3	−0.33	−4.20***
Number of productive plants	β_4	0.01	0.10
Fertilizer	β_5	0.13	1.95*
Herbicide	β_6	0.03	0.70
Inefficiency factors			
Intercept	α_0	−0.34	−0.03
Farmer's age	α_1	0.71	3.84***
Farmer education	α_2	0.03	0.30
Farmer's experience	α_3	−0.37	−4.44***
Number of family counts	α_4	0.03	0.44
Variant parameters			
σ2		0.10	7.85
γ		0.72	0.31
Log-likelihood MLE		−38.47	
Log-likelihood MLE		−29.39	
Likelihood ratio		18.17	
Average TE		0.85	

Information - ***: Real at α=1%; **: Real at α=5%; *: Real at α=10%.
MLE: Maximum likelihood estimation

Based on the estimation of stochastic frontier production function, there are four factors that influence to rubber production, that is labour, land area, age of plant and fertilizer. The use of labour, land area and plant age have a significant effect on the 99% confidence level, while the use of urea fertilizer has a significant effect on the 90% confidence level on rubber production. This means the addition of input will have an impact on the addition of production. The mathematical model of the stochastic frontier production function is described in the following equation:

$$\text{Ln Q} = 7.79+0.32\ln L+0.34\ln F-0.33\ln Ca+0.01\ln Pc+0.13\ln Ur+0.03\ln He+vi-u_i$$

4.1. Labour

The results of the stochastic frontier production function model analysts show that a 1% increase in labour usage will boost production by 0.32%. Land area. The result of the estimation as shown in Table 3 explains that the level of production responsiveness to land expansion efforts is inelastic, as indicated by the resulting coefficient value of 0.34. That is, from every 1% increase in land area will increase production by 0.34%. Age Rubber Plant. Based on the results of analysis as shown in Table 3 obtained value of coefficient variable aged rubber plant of −0.33. This illustrates that the older age of the rubber plant, the level of production decreases. Facts in the field illustrate the condition of rubber plants owned by the average farmer has been aged 18 years, and there are 26.67% of farmers whose aged rubber plants above 21 years. Use of urea fertilizer. Based on the results of the analysis as shown in Table 2, the variable coefficient of urea fertilizer is 0.13, meaning that if the use of fertilizer increases by 1% it will increase production by 0.13%.

The result of stochastic production function analysis using MLE was obtained mean technical efficiency of 0.85. The technical efficiency level is the ratio between actual production and potential production obtained from the Frontier production function using the Frontier 4.1 program. This condition illustrates that the average farmer has reached 85% of the potential production he gets through the use of a combination of production factors, and there is still a 15% chance of increasing rubber production.

Table 3: Impact of efficiency improvement (age of younger farmers 23% or 37 years) to household welfare of rubber farmers

Components of technical efficiency	Average/farmer	FHIR component	Average/farmer
Farmer's age (Years)↘	37	Revenue (Rp)↗	36,050,515
Farming experience (Year)*	20	Production cost (Rp)↗	2,337,449
TE↗	0.873	Consumption (Rp)↗	24,983,350
Production (kg)	4,766	Total spending (Rp)↗	27,320,799
Labor (HOK)↗	466	Revenue exchange rate↗	
Land area (hectares)↗	4	Against total spending↗	1.32
Plant age (year)↘	9	On production costs↘	15.42
Urea fertilizer (kg)↗	567	Against total consumption↗	1.44

Source: Primary data. 2017 (processed), Description: ↗increases, ↘decreased, *permanent. FHIR: Farmers' household income rate

From the estimation model of the effect of technical inefficiency of rubber production as shown in Table 2, there are two variables that have real effect on 99% confidence level, that is farmer's age and farmer's experience in running rubber farming, while other variables, such as the education of farmers and the number of family dependents have no significant effect on either 95% or 90% confidence level.

4.2. Farmer's Age

Farmers 'age describes the farmers' physical ability in running rubber farming. In Table 1 the coefficient value of farmer age variable is 0.71, meaning that if farming is managed by farmers with age 1% older than the average age of farmers, it will increase the inefficiency of production by 71%.

4.3. Farmer's Experience

The variable coefficient of farmer experience as shown in Table 2 is −0.37. This means that if the farmers experience in managing rubber farms increased 1%, it will reduce technical inefficiency by 0.37%. The increasing experience of farmers in running rubber farming will further improve the pattern and technology used, so it will be more efficient farming.

The family welfare rate of rubber farmers is measured using FHIR Approach. Where FHIR is the ratio between income and household expenditure of rubber farmers for 1 year. Based on the results of the analysis that has been done, the average of FHIR to total expenditure is smaller than one, which is equal to 0.97. This explains that the average household of rubber farmers is not yet prosperous.

Increasing the technical efficiency of rubber production can be done by increasing the role of the younger generation of farmers to manage rubber farming and providing sufficient experience of rubber farming, through training and education. According to Susilowati (2016), who is considered a younger generation is a farmer <30 years old, while peasants aged >55 are considered as old farmers. While Mantra (2004), classifies the age of farmers into three groups, namely unproductive group aged between 0 and 14 years, productive group aged between 15 and 64 years and unproductive group aged >65 years. Based on the farmer's classification, if the farming experience begins at the age of 16 years, then at 37 years old farmers will have greater physical capability and have a higher experience than the current condition of farmers.

The age of the farmer and the experience of the farmer in running a rubber farming business are very significant factors affecting the technical inefficiency of rubber production. The age of farmers has a positive influence on the technical inefficiency of rubber production, which means that when the age of farmers increases, rubber production becomes increasingly inefficient. The experience of farmers in running rubber farming has a negative effect on the inefficiency of rubber production, which means that if the experience of farmers in carrying out farming increases, rubber production becomes more efficient. So, to improve the efficiency of rubber production it is necessary to regenerate rubber farmers by encouraging young people aged 16-37 years to develop rubber farming and improve their experience in managing rubber farming.

Simultaneously, increasing efficiency increases rubber production, namely by improving the use of production factors, such as labour, land area, rubber plant rejuvenation and fertilizer use. With the increase in rubber production, the exchange rate of farmers' income towards home expenditure has increased. This condition illustrates that farmer households are increasingly prosperous, as simulated in the following discussion

4.4. Simulation I (Age of Younger Farmers 23% or 37 Years)

It is assumed that if rubber farming is more managed by young farmers (23%) or 37 years old, the ability of farmers is physically higher than the previous farmers who have aged 49 years.

In Table 3, when rubber farming is managed by farmers who are 23% younger or an average age of 37 years and have experience of rubber farming for 20 years, the level of technical efficiency of production increases to 0.873 and increases production by 4.766 kg. Simultaneously, the exchange rate of farmer income towards household expenditure increased by 1.32. This condition illustrates that farmers' households are increasingly prosperous.

4.5. Simulation II (Rubber Farming Experience is Higher 5% or 21 Years)

In Table 4 it is assumed that rubber farming is managed by a farmer with a higher experience (5%) or 21 years, then the use of input is more efficient (0.853), thus increasing production to 3,956 kg. With the increase of rubber production, household income exchange rate of farmers to expenditure becomes increasing, that is equal to 1.14. It means that the condition of farmers changes to prosper.

Table 4: Impact of efficiency improvement (rubber farming experience is higher 5% or 21 years) to household welfare of rubber farmers

Components of technical efficiency	Average/farmer	FHIR component	Average/farmer
Farmer's age (Years)*	49	Revenue (Rp)↗	29,918,979
Farming experience (Year)↗	21	Production cost (Rp)↗	1,159,915
TE↗	0.853	Consumption (Rp)*	24,983,350
Production (kg)	3,956	Total spending (Rp)↗	26,143,265
Labor (HOK)↗	282	Revenue exchange rate	
Land Area (hectares)↗	2.6	Against total spending↗	1.14
Plant age (year)↘	17	On production costs↗	25.79
Urea fertilizer (kg)↗	101	Against total consumption↗	1.20

Source: Primary data. 2017 (processed), Description: ↗increases, ↘decreased; *permanent

Table 5: Impact of efficiency improvement (younger age of 23% or 37 years old and rubber experience 5% or 21 years) to household welfare of rubber farmers

Components of technical efficiency	Average/farmer	FHIR component	Average/farmer
Farmer's age (Years)↗	37	Revenue (Rp)↗	36,793,093
Farming experience (Year)↗	21	Production cost (Rp)↗	2,635,123
TE↗	0.875	Consumption (Rp)*	24,983,350
Production (kg)↗	4,864	Total spending (Rp)↗	27,618,473
Labor (HOK)↗	493	Revenue exchange rate	
Land area (hectares)↗	4.2	Against total spending↗	1.33
Plant age (Year)↘	9	On production costs↗	13.96
Urea fertilizer (kg)↗	684	Against total consumption↗	1.47

Source: Primary data. 2017 (processed), Description: ↗increases, ↘decreased, *permanent

4.6. Simulation III (Age of Younger Farmers 23% or 37 Years and Experience of Longer Rubber Farming 5% or 21 Years)

In Table 5, an increase in the number of young farmers aged 37 years and an increase in farming experience for 21 years makes the use of input production more efficient, which is equal to 0.875. At this level of efficiency, the production produced increases to 4.864 kg. With the increase in rubber production, there is an increase in the exchange rate of farmer income against household expenditure, which is equal to 1.33. This condition illustrates that rubber farmer households are increasingly prosperous.

5. CONCLUSION AND RECOMMENDATION

Based on the results and discussion above, it can be concluded that the average rubber farmer has not been able to manage rubber plantations efficiently because most of the farmers' physical abilities have declined and the experience of farmers is not representative of the knowledge of good rubber cultivation technology. The increasing number of young farmers aged 37 years and the experience of farmers in running rubber farming for 21 years increased production efficiency by 88%. Simultaneously, rubber production increased by 4,864 kg per year, thereby increasing the exchange rate of farmers' income to family expenses by 1.4 above the category of prosperous families.

Efforts to increase rubber production are: (1) Optimizing the use of labour both in the context of tapping, weeding, fertilizing, controlling pests and weeds and other businesses that support the success of rubber products, (2) improving agricultural technology, such as using superior seeds (3) rejuvenating less productive crops through business partnerships with private companies and the state, (4) significant government support in providing fertilizers and encouraging farmers to increase their use.

6. REFERENCES

Adar, D. (2011), Keragaan Usahatani dan Efisiensi Produksi Jeruk Keprok Soe Berdasarkan Zona Agroklimat di Provinsi Nusa Tenggara Timur. [Farming Performance and Efficiency of Tangerine Soe Production Based on Agroclimate Zone in East Nusa Tenggara Province] (Doctoral Disertation). Bogor-Indonesia: Bogor Agricultural Institute.

Adebayo, E.F., Giroh, D.Y. (2009), Analysis of the technical inefficiency of rubber tapping in rubber research institute of Nigeria, Benin City, Nigeria. Journal of Human Ecology, 27(3), 171-174.

Aigner, D.J., Lovell, C.A.K., Schmidt, P. (1977), Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, 21-37.

Alvarez, A., Arias, C. (2004), Technical efficiency and farm size: A conditional analysis. Agricultural Economics, 30, 241-250.

Badan Pusat Statistik (BPS) Provinsi Jambi. (2015), Jambi Dalam Angka. [Central Bureau of Statistics (CBS) of Jambi Province. Jambi in the Numbers]. BPS of Jambi Province, Indonesia. Available from: https://www.jambi.bps.go.id/publication.html?Publikasi%5BtahunJudul%5D=&Publikasi%5B kataKunci%5D=nilai+tukar+petani.

Battese, G.E., Coelli, T.J. (1995), A model for technical efficiency effects in a stochastic frontier production function for panel data. Empirical Economics, 20, 325-332.

Burhansyah, R. (2010), Dinamika Indikator Kesejahteraan Petani di Kabupaten Kubu Raya dan Sanggau Provinsi Kalimantan Barat. Balai Pengkajian Teknologi Pertanian Kalimantan Barat. [Dynamics of Indicators of Farmer Welfare in Kubu Raya and Sanggau Districts, West Kalimantan Province. West Kalimantan Agricultural Technology Assessment Center] hlm.494-506. Available from: https://www.pse.litbang.pertanian.go.id/ind/pdffiles/Pros_2012_02D_MP_ Rusli.pdf.

Coelli, T.J., Rao, D.S.P., Battese, G.E. (1998), An Introduction to Efficiency and Productivity Analysis. Boston: Kluwer Academic Publishers.

Direktorat Jenderal Perkebunan (DIRJENBUN). (2017), Statistik Perkebunan Karet Indonesia [Directorate General of Plantation (DGP). Statistics of Indonesian rubber plantations]. Jakarta, Indonesia. Available from: http://www.ditjenbun. pertanian.go.id/tinymcpuk/gambar/file/statistik/2017/Karet-2015-2017.pdf.

Farrel, M.J. (1957), The measurement of productive efficiency. Journal of the Royal Statistical Society, 120(3), 253-290.

Kittilertpaisan, J., Kittilertpaisan, K., Khatiwat, P. (2016), Technical efficiency of rubber farmers' in Changwat Sakon Nakhon: Stochastic frontier analysis. International Journal of Economics and Financial Issues, 6(S6), 138-141.

Lovell, C.A.K., Schmidt, P. (1980), Estimating stochastic production and cost frontier when technical and allocative inefficiency are correlated. Journal of Econometrics, 13, 83-100.

Mantra, I.B. (2004), Demografi Umum [General Demography]. Yogyakarta, Indonesia: Student Library.

Meunsen, W., Broeek, V.D.J. (1997), Efficiency estimation form cobb-douglas production function with composed error. International Economic Review, 47, 142-444.

Mustapha, N., Hashim, N. (2011), Supervisory system using stochastic frontier analysis. Journal of Sustainability Science and Management, 6(1), 156-168.

Poungchompu, S., Chantanop, S. (2015), Factor affecting technical efficiency of smallholder rubber farming in Northeast Thailand. American Journal of Agricultural and Biological Sciences, 10(2), 83-90.

Sadikin, I., Subagyono, K. (2008), Kinerja Beberapa Indikator Kesejahteraan Petani Padi di Pedesaan Kabupaten Karawang 2008. Balai Pengkajian Teknologi Pertanian Jawa Barat [The Performance of Several Indicators of the Welfare of Rice Farmers in the Karawang Regency 2008. The Study Center for Agricultural Technology in West Java]. p74-98. Available from: https://www.pse.litbang.pertanian.go.id/ind/pdffiles/MP_Pros_A2_2009.pdf.

Simatupang, P., Maulana, M. (2007), Kaji Ulang Konsep Nilai Tukar Petani Tahun 2003-2006 [Review the Concepts and Developments of Farmer Exchange Rates in 2003-2006]. Journal of Economics and Development. LIPI. Jakarta, Indonesia. Available from: http://www.pse.litbang.pertanian.go.id/ind/pdffiles/Anjak_2007_IV_05.pdf.

Sugiarto. (2008), Analisis Tingkat Kesejahteraan Petani Menurut Pola Pendapatan dan Pengeluaran di Pedesaan [Analysis of Farmers' Welfare Level According to Rural Income and Expenditure Patterns]. Bogor, Indonesia: Center for Socio-Economic and Agricultural Welfare Analysis. p248-260. Available from: http://www.pse.litbang.pertanian.go.id/ind/pdffiles/MS_B1.pdf.

Sunarti, E. (2006), Indikator Kesejahteraan Keluarga: Sejarah Perkembangan, Evaluasi dan Keberlanjutan [Family Welfare Indicators: History of Development, Evaluation and Sustainability]. Bogor, Indonesia: IPB. Available from: http://www.dp2m.umm.ac.id/files/file/Dr_-Euis-Sunarti-Indikator-Keluarga-Sejahtera.pdf.

Susilowati, S.H. (2016), Fenomena penuaan petani dan berkurangnya tenaga kerja muda serta implikasinya bagi kebijakan pembangunan pertanian [The phenomenon of aging of farmers and the decline of young workers and their implications for agricultural development policy]. Agro Economic Research Forum, 34(1), 35-55.

Tajerin, T., Noor, M. (2005), Analisis efisiensi teknis budidaya pertambakan kerapu di keramba jaring apung di perairan teluk Lampung [Analysis of technical efficiency of grouper aquaculture farming in floating net cages in the waters of Lampung bay]. Journal of Development Economics, 10(1), 95-105.

Tasman, A. (2008), Ekonomi Produksi [Production Economics]. Jakarta, Indonesia: Chandra Pratama.

Weersink, A., Godah, A., Turvey, C.G. (1990), Decomposition measures of technical efficiency for dairy farms. Canadian Journal of Agricultural Economics, 38(3), 439-456.

The Impact of the Efficiency of Rubber Production

ORIGINALITY REPORT

18%	13%	5%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

5%

★ pdfs.semanticscholar.org

Internet Source

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		