Available online at http://ijasc.pasca.unand.ac.id

International Journal of Agricultural Sciences

ISSN: 2598 – 1145 (online)

Analysis of Factors Affecting the Productivity of Smallholder Tea Farming in Solok Regency, West Sumatra

Uci Sarly Riani[a], H. Hasnah[b], Ira Wahyuni Syarfi[b]

[a] *Magister of Agricultural Economics, Faculty of Agriculture, Universitas Andalas, Kampus UNAND Limau Manis Padang, West Sumatra, 25163 Indonesia*
[b] *Faculty of Agriculture, Universitas Andalas, Kampus UNAND Limau Manis Padang, West Sumatra, 25163 Indonesia*

ARTICLE INFORMATION

Article history:

Received: 30 August 2022
Revised: 01 December 2022
Available online: 30 December 2022

Keywords:

Cobb-Douglas, productivity, tea farming

Correspondence:
E-mail: hasnah@agr.unand.ac.id

A B T R A C T

This study aims to analyze the factors affecting the productivity of smallholder tea farming in Solok Regency. Sixty-five tea farmers, selected using a simple random sampling approach, were involved in this study. The study reveals that urea fertilizer, SP-36 fertilizer, insecticides, labor, plant age, and seedling varieties significantly affect tea yield at the level of α = 0.10. Farmers can increase the yield of tea farming by increasing fertilizer and labor and intensive pest and disease control. Gambung variety produces a higher yield than TRI, and the yield increases with the age of the plant.

1. INTRODUCTION

Tea has a strategic role in the Indonesian economy. It contributes to the Gross Domestic Product of approximately Rp 1.2 trillion. This commodity also contributes as foreign exchange and absorb large quantity of labor. In 2016-2020, about 80% of Indonesian tea was exported as black tea. In 2020 volume of black tea exports reached 37,339 tons, while Indonesia's green tea export volume reached 7,926 tons in 2020 (Central Statistics Agency, 2021). However, tea production fluctuated in the last five years (2016-2020). The lowest level of production occurred in 2020 at 128,016 tons.

Tea plantations spread in some provinces in Indonesia. West Sumatra Province is ranked third in Indonesia, with a total production of 1,287 tons. Solok Regency is the center of tea production in West Sumatra for smallholder tea farming. Solok's total area of smallholder tea farming reached 1,348 ha in 2020. In 2016-2020, the area of smallholder tea farming in Solok Regency increased from 522 ha to 524 ha. However, tea production decreased from 917 to 900 tons. This figure indicates a decrease in the productivity of tea farming. Tea productivity in Solok Regency is considered low at 1.66 tons of dried leaves/ha in 2020, which is still far from the potential productivity of 5.8 tons/ha. The Solok Regency Government carried out several programs for tea farmers in 2020, namely tea plant rehabilitation to increase tea production. The state budget funding provides 500,000 tea seeds, 43.50 ton of organic fertilizer, and 100 units of hand sprayers. In addition, technical guidance activities for millennial farmers were provided to support farmer groups who received tea seed assistance.

A study by Hosen (2017) found that factors affecting the decline in production were partly due to inappropriate cultivation practices. Climate change has been proven to have a negative impact on tea production in mainland China (Zhao, Xu, Zhang, Zhao, & Wang, 2022). The climate is also predicted to harm tea farming in Kenya, Sri Lanka, and China by 2050 and 2070 (Jayasinghe & Kumar, 2020). (Anjani, 2019; Dalimoenthe, Wulansari, & Rezamela, 2016) found that low rainfall leads to low tea productivity.

DOI: 10.25077/ijasc.6.2.75-79.2022

Smallholder tea farming has low production because farmers do not use superior seeds and have limited knowledge of technology, leading to low product quality (Ministry of Agriculture, 2014). It is supported by research (Hosen, 2017) that inappropriate farming practices cause low production. Farmers' application of Good Agriculture Practice (GAP) is still weak in Solok Regency. Many farmers used local seeds suspected to be factors that cause suboptimal production. Two varieties of seed commonly used by farmers are *Gambung* and TRI clones. According to Safitri., et al. (2018), *Gambung* clones are resistant to smallpox disease and yield higher than other clones.

Jayakody et al. (2019) found that factors of land production, labor, and fertilizer had a positive and significant effect on tea leaf production. Research by (Nepolean et al., 2012; Roychowdhury, Paul, & Banerjee, 2014) revealed that biofertilizers increase tea production.

The objective of this study was to analyze factors affecting the yield of tea farming. The result of this study may enable more effective decision-making and policy formulation to sustain and enhance future tea production in the competitive international market.

2. METHODS

2.1. Research Method

This study was carried in July to September 2022 in Solok Regency, West Sumatra. Solok Regency was selected due to the center of tea production in West Sumatra. The survey method was applied in data collection using a questionnaire. Sixty-five sample farmers were involved in this study and selected using simple random sampling.

2.2. Data Analysis

Cobb-Douglas production function was employed to identify factors influencing the tea productivity of smallholder farming. Eight explanatory variables are involved in the model: the use of urea, SP-36 fertilizer, herbicide, insecticide, fungicide, labor, the age of the plant, and seed variety. The Cobb-Douglas production function is as follows:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + \beta_8 D_1 + \varepsilon$$

Where:
Y = productivity (kg/ha/yr)
X_1 = amount of urea fertilizer (kg/ha/yr)
X_2 = amount of fertilizer SP-36 (kg/ha/yr)
X_3 = herbicide (liter/ha/yr)
X_4 = insecticide (liter/ha/yr)
X_5 = fungicide (liter of water/ha/yr)
X_6 = number of workers (HOK/ha/yr)
X_7 = plant age (yrs)
D_1 = dummy clone varieties (1 = Gambung clone, 0 = TRI clone)
β_0 = intercept
β_i = estimator coefficient
ε = error term

3. RESULTS AND DISCUSSION

As presented in Table 1, the average age of farmers is 49 years old, categorized as productive age. The average years of farmers' formal education are ten years (high school). Famers have extensive tea farming experience, with an average of 23 years of experience.

Table 1. Farmers Profile

Description	Average
Age of farmer (years)	49
Education (years of schooling)	10
Farming experience (years)	23
Land size (ha)	1.6
Attending training on GAP	
• Yes	34%
• No	66%
Picking technology	
• Manual	66%
• Machinery	34%
Variety	
• Gambung	32%
• TRI	68%

The average size of landholding is 1.6 ha. Most farmers (66%) did not attend training on good agricultural practices and picked tea leaves manually. This condition can hinder them from increasing tea yield. About 68% of farmers grew TRI variety.

The average tea yield was 9.9 tonnes of wet leaves per hectare per year (Table 2). The maximum yield farmers obtained was 15 tons.

 DOI: 10.25077/ijasc.6.2.75-79.2022

Table 2. Descriptive Statistics of Variables

Variable	Mean	Deviation Std	Minimum	Maximum
Yield (Y)	9866.15	2524.27	4800	15000
Urea (X_1)	846.37	343.28	0	1500
SP-36 (X_2)	36.77	58.84	0	150
Herbicide (X_3)	5.74	0.73	4	7
Insecticide (X_4)	2.74	2.94	0	7
Fungicide (X_5)	121.54	185.61	0	500
Labour (X_6)	150.59	64.69	44.86	429.50
Plant Age (X_7)	22.68	76.85	7	33
Dummy Variety (D_1)	0.32	0.47	0	1

Farmers used two kinds of fertilizers, Urea and SP-36, with an average use of 846 kg and 37 kg per hectare, respectively. Fungicide was the main chemical used at an average of 122 liter/ha. The use of labor per hectare was 151 man-days. The age of plants ranges from 7 to 33 years.

Table 3 presents the estimation results using OLS Method. The results show that seven of eight independent variables are significant, with an R^2 value of 0.613. It means that 61.3% of the variations in tea yield can be explained by independent variables used in the production function. The rest, 38.7%, is defined by other variables outside the model. Variables of urea fertilizer (X1), SP-36 fertilizer (X2), insecticides (X4), fungicides (X5), labor (X6), plant age (X7), plant varieties (X8) significantly affect the yield of tea.

Table 3. OLS Estimate for Cobb-Douglas Production Function

Variables	**Coefficient**	**t**	**Pr>|t|**
Constant	5.973*	11.03	0.000
ln Urea Fertilizer	0.031*	2.63	0.011
ln Fertilizer SP-36	0.037*	3.43	0.001
ln Herbicide	-0.176	-0.91	0.366
ln Insecticides	0.120*	3.20	0.002
ln Fungicide	0.025*	2.02	0.048
ln Labor	0.383*	5.94	0.000
ln Plant Age	0.372*	4.52	0.000
Dummy-Varieties	0.203*	3.22	0.002
R-Square	0.613		
Adj R-Square	0.557		

*significant at $\alpha = 0.10$

The estimation result of the production function using the MLE (*Maximum Likelihood Estimation*) method is presented in Table 4.

Table 4. Maximum Likelihood Estimate for Cobb-Douglas Production Function

Input Variables	**Coefficient**	**Z**	**Pr>|z|**
Constant	7.030	13.37	0.000
ln Urea Fertilizer	0.034*	3.32	0.001
ln Fertilizer SP-36	0.021*	2.54	0.011
ln Herbicide	-0.127	-0.82	0.412
ln Insecticides	0.082*	2.62	0.009
ln Fungicide	0.016	1.61	0.108
ln Labor	0.263*	3.99	0.000
ln Plant Age	0.259*	3.05	0.002
Dummy Varieties	0.118*	2.31	0.021

*α level = 0.10

Estimation using the MLE method reveals that six variables influence tea production: urea fertilizer, SP-36 fertilizer, insecticides, labor, plant age, and plant varieties. The urea fertilizer variable has a coefficient value of 0.034. It indicates that one percent increase in the use of urea, tea production increases by 0.034 percent. Farmers found the price of fertilizer expensive. It is why most farmers only used one type of fertilizer for their tea farming. Our results are different from the findings by (Welda, Hasnah, & Khairati, 2020) where the variable urea fertilizer negatively affects palm oil production.

The coefficient value of 0.021 for SP-36 indicates that a one percent increase in SP-36 fertilizer used can increase tea production by 0.021 percent. The amount of SP-36 used by farmers (37 kg/ha) is lower than recommended (standard) amount (60 – 300 kg/ha).

Herbicide variables have a negative but insignificant effect on tea production. According to the results of interviews in the field, the continuous use of herbicides in large doses causes the soil in the tea farm to become hardened and reduces tea production. In line with his research, Pratama (2021) found that herbicide variables negatively affect rubber production. The farmers prefer to cut weeds manually using machetes instead of herbicides, which can increase the cost of production from rubber farming.

The Insecticide variable significantly affects tea production, with a coefficient value of 0.082. It means that an increase in the amount of insecticide used by 1 percent can increase tea production by 0.082 percent. It is suspected that the use of insecticides has not been on target. Farmers used insecticides to control pests, especially Helopelthis and Caterpillars.

Using labor contributes to increasing tea production (coefficient value of 0.263). Every 1 percent increase in labor can increase tea production by 0.263 percent. The use of labor is mostly on harvesting and post-harvest

activities. Fertilizing, weeding, pest, and disease control activities are mainly carried out by the family member. The research by Jayakody et al. (2019) also found that labor positively and significantly affects tea production in Ratnapura District, Sri Lanka.

The estimation results that tea production increases with age. A similar condition occurs at the gambir tree, where the tree's age positively and significantly affects gambir production, as found by Fauziah, Hasnah, and Khairati (2020). Adimulya (2006) stated that tea plants can be up to 100 years old but reach optimum production up to 40 years. As the age of tea ranges from 7 to 33 years, the tea plant of our respondents is still at the optimal production age.

The plant varieties significantly affected tea production in a positive sign. It means the *Gambung* variety has a higher yield than TRI. The result reveals that the use of the *Gambung* variety can increase tea production by 11.8% compared to the TRI variety. According to Suprihatini et al. (2021), the main factor behind the low productivity of Indonesian tea farming (85%) is tea farming derived from Dutch heritage, and tea comes from old clones originating from Sri Lanka (TRI), whose low yield. Gambung clones (GMB) can produce dry tea of more than 5 tons/hectare/year. These findings are supported by (Basnayake & Gunaratne, 2002) who found that farmers using TRI clones were inefficient.

4. CONCLUSIONS

The estimation of Cobb Douglas production function results, showed that using urea fertilizer, SP-36 fertilizer, insecticides, labor, plant age, and plant varieties significantly influenced tea production in Solok Regency. Labor use, plant age, and plant variety greatly affected tea production more than other variables. *The gambung* variety has 11.8% higher tea production than the TRI variety.

Farmers should be encouraged to use the *Gambung* variety to obtain higher yields. More training on good agricultural practices should be provided for farmers to improve their knowledge to apply optimal input to increase tea production.

REFERENCES

Adimulya, V. 2006. Analysis of Tea Production (Camellia sinensis (L.) O. Kunte) in Jolotigo Gardens, PTPN IX, Pekalongan, Central Java. Bogor Agricultural Institute.

Anjani, G. Z. (2019). Dampak Perubahan Iklim Terhadap Produktivitas Tanaman Teh (Camellia sinensis L.) di Kebun Teh Pasirmalang, Jawa Barat. Universitas Brawijaya,

Basnayake, B., & Gunaratne, L. (2002). Estimation of technical efficiency and it's determinants in the tea small holding sector in the Mid Country Wet Zone of Sri Lanka. Sri Lankan Journal of Agricultural Economics, 4(1381-2016-115740), 137-150.

Central Statistics Agency of the Republic of Indonesia. (2021). Indonesian Tea Statistics 2021 (p. 114). Central Statistics Agency of the Republic of Indonesia.

Coelli, T. J., Prasada Rao, D. S., O'Donnell, C. J., & Battese, G. E. (2005). An Introduction to Efficiency and Productivity Analysis. Second Edition. New York: Springer Science and Business Media, Inc.

Dalimoenthe, S. L., Wulansari, R., & Rezamela, E. (2016). Dampak Perubahan Iklim Terhadap Produktivitas Pucuk Teh Pada Berbagai Ketinggian Tempat. [Impact of Climate Changes on Leaves Productivity in Various Elevation Levels]. Jurnal Littri, 22(3), 135 - 141. doi:http://dx.doi.org/10.21082/littri.v22n3.2016.135-141

Fauziah, Hasnah, R. Khairati.(2020). Technical Efficiency of Gambir Farming in Fifty Regency Cities, West Sumatra, Indonesia. International Journal of Agricultural Science Vol. 4 No. 1 (2020) 19-27.

Hardiyanti, F. (2011). Technical Efficiency Analysis of Tea Plant Production Factors (Camellia sinensis) In Afdeling Wonosari PT. Nusantara Plantation XII (Persero) Wonosari Garden, Malang Regency. Faculty of Agriculture, Department of Agricultural Socioeconomics, Universitas Brawijaya.

Hosen, N. (2017). Profile Of Agribusiness Of Smallholder Gambier Plantation In West Sumatra. Center for the Study of Agricultural Technology, Balitbangtan West Sumatra. Journal of Applied Agricultural Research Vol. 17 (2): 124-131.

Jayakody, Sandunika., Sajitha, Dishanka. (2019). An Estimation of Technical Efficiency of Tea Smallholdings in Ratnapura District of Sri Lanka. Journal of Social and Development Sciences Vol. 10, No. 4, pp 1-11, December 2019. Univitersity of Colombo: Sri Lanka.

Jayasinghe, S. L., & Kumar, L. (2020). Climate change may imperil tea production in the four major tea producers according to climate prediction models. Agronomy, 10(10), 1536.

Kothari, C.R. (2004). Research Methodology, Methods, and Techniques (Second Revised Edition). New Age International Publisher.

Ministry of Agriculture. (2014). Regulation of the Minister of Agriculture of the Republic of Indonesia Number 50/ permentan/OT.140/4/2014 concerning Technical Guidelines for Good Agriculture Practices (GAP on Tea).

Nepolean, P., Jayanthi, R., Pallavi, R. V., Balamurugan, A., Kuberan, T., Beulah, T., & Premkumar, R.

DOI: 10.25077/ijasc.6.2.75-79.2022

(2012). Role of biofertilizers in increasing tea productivity. Asian Pacific Journal of Tropical Biomedicine, 2(3), S1443-S1445.

Pratama, A. (2021). Technical Efficiency Analysis of Rubber Plantation of Smallholders in Banyuasin Regency, South Sumatra Province. SEA Volume 09, No. 02, December 2020, 10–27.

Roychowdhury, D., Paul, M., & Banerjee, S. K. (2014). A review on the effects of biofertilizers and biopesticides on rice and tea cultivation and productivity. International Journal of Science, Engineering and Technology, 2(8), 96-105.

Safitri., I. Ari., A. Junaedi. Management of Tea Plant Pruning (Camellia sinensis (L.)O. Kuntze) in the Tambi Plantation Unit of Central Java. Bul. Agrohorti 6(3): 344-353 (2018).

Suprihatini, Rohayati., V. Sokoastri. A. Srimulyatni. Doni S. A. D. Mawardhi. 2021. Tea Commodity Policy Priorities for The Rescue of National Tea Plantations. Plantation Analysis and Opinion Volume 2: February 20, 2021. Nusantara Plantation Research.

Usman, H., and Akbar. 2006. Social Research Methodology. PT. Script Earth. Jakarta.

Welda, W., Hasnah, H., & Khairati, R. (2020). Technical Efficiency of Smallholder Oil Palm Farmers: An Application of Stochastic Frontier Analysis. SSRG International Journal of Agriculture & Environmental Science 7(1), 43 - 47. doi: 10.14445/23942568/IJAES-V7I1P109

Welda. Hasnah. R. Khairati. (2020). Technical Efficiency of Smallholder Oil Palm Farmers: An Application of Stochastic Frontier Analysis. Ssrg International Journal of Agriculture & Environmental Science (SSRG-IJAES) Vol. 7 Issue 1-Jun-Feb 2020

Zhao, Y., Xu, Y., Zhang, L., Zhao, M., & Wang, C. (2022). Adapting Tea Production to Climate Change under Rapid Economic Development in China from 1987 to 2017. Agronomy, 12(12), 3192.