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Original Article

The synergy of farming competitiveness and efficiency to boost local soybean production

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Abstract

This study strived to analyze the substitution efforts made for soybean commodities on the basis of farming competitiveness and efficiency using Stochastic Frontier Analysis, Policy Analysis Matrix, and Analytical Networking Process. The efficiency was calculated using stochastic frontier regression. Primary and secondary data were used in this study. Primary data were obtained from interviews with key persons, while secondary data were obtained from the Central Java Statistics Agency. The findings showed that soybean farming was not yet efficient, with an efficiency value of 0.65. However, it exhibited competitive and comparative features, as indicated by the PCR of 0.37 and DRC of 0.30, both of which were less than one. Based on these findings, alternative policies were prioritized to enhance domestic soybean substitution. These included issuing price subsidies to increase producer surplus, providing assistance to farmers to improve productivity (such as distributing seeds, fertilizers, pesticides/planting area), and implementing timing policies for soybean import permits outside the harvest period.

Keywords: ANP, competitiveness, efficiency, soybean, PAM

1. Introduction

Independent food availability and the high demand for food commodities worldwide are becoming hot issues. Therefore, food supply self-sufficiency is considered a benchmark of a country's success in regulating its agricultural sector. Soybean is a protein-rich food widely consumed by the people of Indonesia, and is used as a primary ingredient in making various processed food products, so the demand for soybeans is increasing occasionally. However, domestic soybean producers' ability is insufficient to meet such demands. This is an irony in that a fertile and vast agricultural country like Indonesia cannot be self-sufficient. Soybean cannot be separated from imported commodities that flood the domestic market.

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From 2015 to 2019, the national soybean production seemed concerning due to its significant decline (Tables 1 and 2). Indonesia has depended on imported soybeans. This is due to the fluctuating production by the regional soybean producers, while the market demands have been increasing. The balance of export and import volumes of Indonesia in 2015-2019 had an average deficit increase of 6.74% per year, or 6.86 million tons. By referring to the Import Dependency Ratio (IDR) in Table 3, the Indonesian ratio has reached 78.44% per year and tended to increase year by year. Indonesia has been one of the biggest soybean importers (Saptana & Saliem, 2015).

In addition, Indonesia's soybean productivity is relatively lower than the world's. This condition indicates the inability of domestic soybean producers to meet domestic soybean needs coupled with domestic fluctuations. This raises a question related to the production and productivity of local soybean. A previous study concluded that food crop commodities, including rice, corn, and soybean, are not

Table 1. The development of Indonesian soybean production in 2015-2019

Year	Harvest		Production	
	(Ha)	Growth (%)	(Ton)	Growth (%)
2015	614.10	-0.26	963.18	0.86
2016	576.99	-6.04	859.65	-10.75
2017	355.80	-38.34	538.73	-37.33
2018	493.55	38.71	650.00	20.65
2019	285.27	-42.20	424.19	-34.74

efficient (Fafurida, Setiawan & Oktavilia, 2019; Mango, Makate, Hanyani-Mlambo, Siziba, & Lundy, 2019; Musaba & Banda, 2020; Nuraini, Noor, & Isyanto, 2020).

Unresolved import dependence eroded domestic producers. If we did not make real breakthroughs to increase the soybean harvested area in the short term, it was probable that we would become a net importer of fresh soybeans. This study strived to analyze the substitution efforts made for soybean commodities based on farming competitiveness and efficiency. Therefore, the present study sought to examine the efficiency of soybean farming. It was urged to do this, given the decline in the primary soybean centre productivity. Then, data were analyzed regarding commodity competitiveness amid Indonesia's high volume of soybean imports. The next step was to formulate strategies to increase local competitiveness and efficiency.

2. Literature Review

2.1 The competitiveness theory

Ricardo's law of comparative advantage states that even if a country does not have an absolute advantage in producing two types of commodities compared to other countries, mutually beneficial trade can still take place. Economic competitiveness or comparative advantage is the theoretical basis used in this research. According to Wang and Shi (2020), the principle of comparative advantage in Ricardo's theory regarding international trade stems from the division of labour and specialization in the field of activity. The comparative cost principle states that a country tends to export its commodities with lower production costs than other countries.

2.2 Production efficiency

Efficiency generally refers to accomplishing a task or producing an output with minimum resources or effort without sacrificing quality or effectiveness. In other words, efficiency is about doing things best, using the available resources optimally to achieve the desired outcome.

3. Research Methodology

3.1 Study area

This study was carried out in Grobogan and Blora Regencies. Grobogan was chosen because it became the largest soybean producer in 2019 in Central Java Province, which amounted to 13.96 thousand tons. Meanwhile, Blora Regency was selected for its highest soybean productivity in Central Java in 2019, with 23.26 quintals/ha.

3.2 Data collection

The types of data used in research are primary and secondary. Primary data were obtained from direct interviews with key persons using questionnaires and interview guidelines. Meanwhile, secondary data were obtained from the records of the Central Java Statistics Agency and the agricultural report records of Central Java Province.

Table 2. Soybean centers in Indonesia. 2015 – 2019

No.	Province	2015	2016	2017	2018	2019	Average	Contribution (%)	Cumulative (%)	Average growth (%)
1	East Java	344.99	274.31	200.91	148.24	106.69	215.03	31.29	31.29	-25.37
2	Central Java	129.79	112.15	105.55	113.67	69.26	106.08	15.44	46.73	-12.71
3	West Java	98.93	92.07	49.26	102.05	67.96	82.06	11.94	58.67	5.08
4	West Nusa Tenggara	125.03	109.48	56.097	50.063	43.527	76.841	11.18	69.86	-21.25
5	South Sulawesi	67.19	62.05	16.10	14.49	10.77	34.12	4.97	74.82	-29.34
6	Aceh	47.91	22.18	6.93	9.54	772	17.46	2.54	77.37	-44.16
7	Lampung	9.81	9.96	8.02	47.99	14.17	17.99	2.62	79.98	102.38
	Others	139.50	177.42	95.84	163.92	111.01	137.53	20.02	100.00	4.99
	Indonesia	963.18	859.65	538.72	650.00	424.18	687.15	100.00		-15.54

Table 3. The import dependency ratio (IDR) and self sufficiency ratio (SSR) of Indonesian soybeans, 2015-2019

Unit	Year					Average
	2015	2016	2017	2018	2019	
Production (Ton)	963,183	859,653	538,728	650,000	424,189	687,151
Export (Ton)	1,188	1,345	1,473	2,055	3,682	1,949
Import (Ton)	2,256,932	2,261,803	2,671,914	2,585,809	2,670,086	2,489,309
IDR (%)	70.11	72.49	83.26	79.96	86.36	78.44
SSR (%)	29.91	27.54	16.78	20.09	13.71	21.61

The sampled population in this study was soybean farmers spread across Grobogan and Blora Regencies. The number of farmers in Blora Regency in 2021 is 20.96 thousand people; the population aged 15 years and over working in the agricultural sector in Grobogan Regency was 269.73 thousand people. The number of sampled farmers who became respondents in this study was 100 farmers.

The 100 farmers who were respondents were divided proportionally into Grobogan and Blora districts. Furthermore, each respondent was from the largest soybean-producing district in each regency. In this study, 80 respondents were analyzed for efficiency and competitiveness in Grobogan Regency, while in the Blora district, there were 20 respondents.

3.3 Methods of analysis

The stochastic frontier analysis is a method to estimate the production limit and examine the production efficiency level. Coelli (1998) proposes two components of efficiency calculation. The frontier stochastic production function is as follows:

$$y_i = x_i^b e^{\epsilon i} \qquad (1)$$

Furthermore, the random error in the above equation is divided into two parts: *v* represents the error component, and *u* is the non-negative technical inefficiency component.

$$y_i = x_i^b e^{vi-ui} \qquad (2)$$

$$\ln y_i = \beta \ln x_i + v_i - u_i \qquad (3)$$

$$\ln y_i = x_i\beta + v_i - u_i \qquad (4)$$

Here i = 1, 2, . . . , N represents the first cross-sectional unit; y_i denotes the natural logarithm of the observed output. The variable x_i is a row vector of size k+1 where each element corresponds to the natural logarithm of a specific input. β is the k+1 column vector of the parameters to be estimated; e^i is a composed error; v_i is the random error component; and u_i is the non-negative random variable related to the technical inefficiency of production.

The stochastic frontier model in this study follows:

$$LnPd = b0 + b1LnLh + b2LnPu + b3LnPes + b4LnOb + b4LnPt + b4LnBi + \mu \qquad (5)$$

LnPd is Production, LnLh is Land Area, LnPu is Fertilizer, LnPes is Pesticides, LnOb is Drugs, LnPT is Labor, and LnBi is Seeds.

The second method applied is Policy Analysis Matrix. It was used to analyze the competitiveness of soybean farming. Monke and Pearson (1989) state that PAM aims to determine the economic efficiency and incentives obtained from government interventions and those effects on farming activities. This study used the Policy Analysis Matrix (PAM) to determine the DRC ratio.

Production costs are differentiated according to tradable inputs and domestic inputs. Tradable inputs are inputs traded on international markets, while inputs not traded on international markets are included in the domestic input group. The private price of inputs is the price paid by soybean farmers for the 2021 planting season. Meanwhile, an undistorted economic condition forms the social price of inputs. For tradable inputs, the social prices are determined based on the price at the port (border price). This includes the FOB (free on board) price for exported inputs and the CIF (cost insurance and freight) prices for imported inputs.

Analytic Network Process (ANP) in this study was done in three steps. First, interview key persons to comprehend the problems related to the risks and resilience of soybean farming. Second, the first step outputs were used as the basis for designing a questionnaire to collect data from respondents. Third, ANP analysis was performed to analyze problems, solutions and strategies for soybean farming resilience. The stages of ANP included the following.

3.3.1 Model construction

The construction of the ANP model in the form of a network hierarchy is based on theoretical and empirical references through focused interviews.

3.3.2 Model quantification

The quantification phase of the model uses questions in the ANP questionnaire in the form of pairwise comparisons between elements. It is used to find out which of the two is dominant and how large the difference is on a numerical scale of 1-9.

3.3.3 Analysis results

In phase three, the results or synthesis of the ANP network in the super decisions software for each respondent can be generated.

3.4 Analytical framework

In determining the criteria and alternative policy priorities, an in-depth interview was carried out, combined with the use of criteria and alternative policy priorities from previous studies. Determining alternative policies was also prepared before conducting the analysis using the Analytic Networking Process to ensure that the selected alternative is the best policy priority. This preparation was based on the results of frontier stochastic regression analysis and matrix policy analysis conducted beforehand.

4. Results and Discussion

The results of the frontier stochastic production function of soybean farming in the Grobogan and Blora Regencies can be seen from the elasticity coefficient. In detail, the results are presented in Table 4. The researchers formulated the following equation:

$$LnPd = 6.56 - 0.08\ LnLh + 0.23\ LnPu + 0.01\ LnPes - 1.16\ LnOb + 2.6\ LnPT + 0.03\ LnBi \qquad (6)$$

Table 4. The estimation of frontier stochastic production functions

Unit	Coefficient	*t-ratio*
Constant	6.56	4.96
LnX1 (Land Area)	-0.08	-0.9
LnX2 (Fertilizer)	0.23	1.31
LnX3 (Pesticide)	0.01	0.27
LnX4 (Medication)	-1.16	-0.49
LnX5 (Workforce)	2.6	3.83
LnX6 (Seed)	0.03	0.26
Mean of Technical Efficiency	1.17	-
N	100	-

The coefficient of elasticity of each input used in soybean farming in the Grobogan and Blora Regencies can be explained by increased fertilizer, pesticide, labor, and seed significantly increasing soybean production. Furthermore, excessive land area and medication usage decrease soybean production in Blora and Grobogan Regencies.

Table 5 shows that the mean efficiency was 0.65, indicating that the use of production factors in soybean production has not been efficient. This is because the farmers have not yet been able to combine the production factors of land area, fertilizer, pesticides, medication, workforce, and seeds to obtain optimum soybean production. An excessive utilization of production factors would undoubtedly reduce productivity and outputs.

The differences in demographic conditions, as well as internal and external factors, contribute to the variation in rising farming problems. The results of previous studies also show mixed conclusions. Previous research shows that certain combinations of inputs such as land, fertilizer, seeds, labour, and level of education have a significant effect on the efficiency of the use of factors of production (Ainsworth, Yendrek, Skoneczka, & Long, 2012; Edison, 2021; Ndlovu, Mazvimavi, & Murendo, 2014; Setiawan, 2013; Orewa & Izekor, 2012; Ugbabe, Abdoulaye, Kamara, Mbaval, & Oyinbo, 2017).

Chakuri, Asem, and Ebo Onumah (2022) examine, more specifically, soybean farming, where the results show that soybean farming is also not efficient, meaning that farmers have not been able to optimize inputs to get maximum output. This study also emphasizes the importance of production inputs in supporting productivity.

Interestingly, this study found that an increase in the land area would reduce the level of soybean production. The result differed from Toleikiene *et al.* (2021), who stated that land planted would affect the number of plants, which would affect the amount of vegetable production.

Table 5. The results of calculation of soybean technical efficiency in Grobogan and Blora Regencies

Farmer	Technical efficiency
Average (100 Farmers)	0.65

Table 7. Transfer output value and nominal protection coefficient on output (NPCO)

Information	Estimation Result
TO (Rp/Ha)	-1,785,000
NPCO	0.92

Furthermore, this study found that the use of stimulants to stimulate plants had a detrimental effect on soybean production. This finding aligns with the research results presented by Kharisma (2018), which stated that excessive usage of soybean growth stimulus drugs increases the likelihood of plant mortality. Badarch (2017) added that several types of plant medicines also contain chemicals that can be dangerous if used excessively. However, according to Khai and Yabe (2011), the use of agricultural drugs can also increase the technical efficiency of soybeans, but it is necessary to pay attention to the dose used so that it is not in excess, thus endangering soybean plants.

However, to obtain more empirical results, this study used the estimated policy analysis matrix (PAM) to analyze the impacts of government policies on the performance and efficiency of soybean farming in Blora and Grobogan Regencies, the estimation results of which are summarized in Table 6.

The private profit value of soybean was IDR 12.67 million per hectare per year, indicating that the farming condition was profitable. Meanwhile, the comparative advantage can be seen from the social profit (KS) and domestic resources ratio (DRC). The KS was IDR 15.12 million per hectare per year. This meant that the soybean had a positive social profit and could give some profit without any interference from the government. The DRC was 0.30, indicating that soybean production required domestic resources amounting to 30.5% of the import cost. Since the DRC was less than one, soybean farming achieved a comparative advantage. This research also aligns with previous research that finds that soybeans have competitiveness. (Krisdiana *et al*., 2021; Sarwono & Pratama, 2014).

Table 6. The analysis matrix of soybean policy in Grobogan and Blora Regencies

	Income	Cost		Profit
		Tradable	Non-Tradable	
Private price	21,000,000	728,572	7,598,228	12,673,200
Social price	22,785,000	1,006,912	6,650,080	15,128,008
Divergence effect	-1,785,000	-278,340	948,148	-2,454,808
PCR	0.37			
DRC	0.30			
Private Profit	12,673,200			
Social Profit	15,128,008			

Government policies apply not only to output prices but also to input prices. Subsidies or trade barriers were regulated to enable producers to utilize resources and ensure their protection optimally. A classical trade theory emphasizes the importance of a perfectly competitive market and avoids government roles. However, the more modern theory underlines that the government needs to intervene in market failure. By referring to the findings of this study, it was known that soybean farming appeared to compete with imported soybeans in terms of price, whether competitively or comparatively. Table 8 explains the result of the priority elements of soybean import substitution policies in Grobogan and Blora Regencies, and government policy is known to be the highest priority element in this model within 0.52 weight.

Table 9 shows that the highest priority for agro-input elements is opening new planting areas, rice fields, and irrigated rice fields (A2), with a weight of 0.65. Land provision is still the main priority to encourage soybean production for import substitution and agro-input elements. According to Kariyasa (2003), neither national nor provincial levels will equally distribute the locations of soybean production in every region. Furthermore, the most prioritized in cultivation is to encourage productivity (B3) with a weight of 0.69. This implies that soybean farming has not yet been technically efficient. Therefore, the selected alternative is the provision of price subsidy for increasing producers' surplus (C1) with a weight of 0.59. Though it needs further investigation, an effort made to provide a price subsidy would be directly taken by the farmers as an incentive. Meanwhile, concerning alternative marketing, the suggested policy establishes purchase contracts with associations of tofu and tempeh craftsmen, cooperatives, or logistic departments (D2) (Yunus, 2020).

Based on Figure 1, the alternative of price subsidy to increase the producers' surplus became the priority for soybean import substitution. Three priorities of soybean import substitution were found, namely giving price subsidies to increase the producers' surplus (C1), assisting farmers to encourage productivity (B3), and the timing of soybean import permission policy outside the harvest time (C2). One can be done by increasing the soybean commodity's import tariff and procurement price (Dewi & Yulianti, 2021).

Table 8. The priority elements of soybean import substitution policies in Grobogan and Blora Regencies

Element	Weight
Agro-input	0.07
Cultivation	0.30
Policy	0.52
Marketing	0.08

5. Conclusions

Empirical results show that the use of input factors for soybean production has a positive effect on that production. The stochastic frontier regression result above shows that the mean efficiency was 0.65. The analysis highlights that the utilization of production factors in soybean production is inefficient. This occurs because farmers have not yet been able to combine the production factors to achieve optimal production effectively.

Furthermore, based on the Policy Analysis Matrix, the results indicate that the PCR is 0.30, and a DRC of 0.30 signifies that soybean possesses a comparative and competitive advantage. This research used an analytical networking process approach to compile effective and appropriate soybean import substitution efforts. Based on the results, it is known that government policy is a priority in preparing soybean import substitution efforts. Overall, the ANP results explain that three priority policy alternatives are obtained to increase the competitiveness of soybean commodities. First, providing price subsidies to increase producer surplus, second assisting farmers to boost productivity, and third granting soybean import permits outside the primary harvest season. This study only proves soybean's technical efficiency, competitiveness, and import substitution policy in Grobogan and Blora Regencies. This limitation is inherent in this study, suggesting that future

Table 9. The soybean import substitution priority in Grobogan and Blora Regencies in all policy elements

No	Element	Alternative	Weight	Inconsistency value
1	Agro-input	Local seed development through crossing strains to increase productivity (A1).	0.26	0.03
2		Opening of new planting areas in forests. dry fields. irrigated rice fields (A2).	0.65	
3		Accelerating subsidized fertilizer distribution to match the timing of the planting period (A3).	0.07	
4	Cultivation	Encouraging efficiency through technical counseling on the use of production factors (B1)	0.22	0.07
5		Conducting research and demonstration on the need for technically efficient factors of production (B2).	0.07	
6		Giving assistance to farmers to encourage productivity (distribution of seeds. fertilizers. pesticides/planting area) (B3)	0.69	
7	Government policies	Price subsidy to increase producers' surplus (C1).	0.59	0.07
8		Timing policy for soybean import permits outside the main harvest period (C2).	0.19	
9		Commitment to supply farming equipment and marketing guarantees at competitive prices (C3).	0.14	
10		Incentives for new land clearing (C4)	0.07	
11	Marketing	Group marketing to avoid *ijon* system (D1).	0.14	0.00
12		Purchase contract with association of tofu and tempe craftsmen. cooperative or logistic department (D2).	0.85	

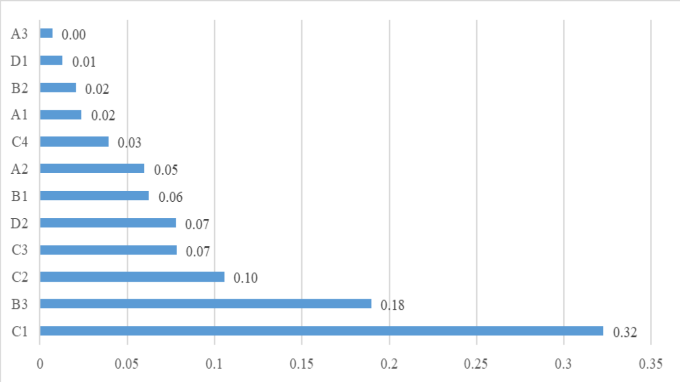

Figure 1. Priority of soybean import substitution in Grobogan and Blora Regencies according to the alternative synchronization of each element

research on this topic should be conducted on a larger scale, encompassing different variables and employing a more advanced research approach.

6. Suggestions

Soybean farming has great potential due to its comparative and competitive advantages. However, this commodity has not yet been efficient. To deal with this issue, the government can provide optimal assistance for soybean farmers, intensification of subsidies for fertilizers. Government interventions are needed to support import substitution. Some policies can be issued: giving price subsidies to increase the producers' surplus, issuing soybean import permission outside the harvest time, committing more to provide farming tools and guaranteeing competitive marketing prices, and giving incentives for land clearing.

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