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Stochastic Frontier Economic Efficiency Analysis of Soybean Seed Breederin Southeast Sulawesi, Indonesia

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Abstract:
Background*: Increasing soybean production in Indonesia was being developed to improve the quality of seeds with involving soybean seed breeders that regulated by the government. The relationship between the government and seed breeders was implemented through an institutional program that through the concept of contract farming. The government has budgeted a lot of costs to support the fulfillment of resources in the seed breeder program. Even though the government budget was not unlimited for a budget post. The amount of the budget for one post is a trade-off for the other post so that the budget allocation for seed breeding is expected to reach a level of economic efficiency.*
Materials and Methods*: This research was a case study within the scope of the study of production economics with the research main indicator regarding the estimation of the economic efficiency index based on the cost function. Estimation of the cost function could show the most responsive input factor to increase production costs. Estimation of the economic efficiency index provides information on the distribution of the economic efficiency index among farmers.*
Results*: Previous studies had only measured efficiency in producing seed production but had not measured efficiency in managing budget allocations in producing seed products at minimum cost. Our findings show that the minimum level of economic efficiency achieved by breeder farmers is 65 percent level from the maximum economic efficiency level and around 60 percent of breeder farmers have achieved an economically efficient level above the 90 percent level. Significantly at a minimum error rate of 5 percent, economic efficiency could be encouragement in several ways, which were (1) reducing costs in using labor, (2) efficiency in land use or leasing costs, (3) increasing income incentives for soybean seed-breeding farmers.*
Conclusion:*Generally, the findings in this study indicate that seed breeding requires an increase in agricultural mechanization technology to reduce the use of labor in order to minimize costs. Other findings provide insight that seed breeders increase their capabilities to farm with a minimum cost per product with an income motive so that the government can develop a pattern of providing incentives based on economic efficiency.*
Key Words*: Seed Breeders, Economic Efficiency, Efficiency Determinants.*

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I. Introduction

One of Indonesia's efforts to increase soybean production comes from increasing the quality of seeds that have high productivity. The problem in the field is a scarcity of seeds when the planting season has arrived so that soybean farmers use usual seeds or shift their farming to grow other crops. Under these conditions, a program is needed that supports the availability of soybean seeds with good varieties, quality, quantities available on demand, at the right time, in almost all locations of soybean farming, and prices that are affordable to farmers. For this reason, the current government has developed a soybean seed program evenly throughout Indonesia. The development of the seed program is conducted in the form of development of the Soybean Seed Breeder Group. This group is fostered by the government to ensure there is integration between soybean farmers and the soybean seed breeders.[1,2,3].

Seed cultivators are a group of farmers who periodically produce high-quality seeds, within the scope of an area covering certain sub-districts or villages in accordance with the directives of the relevant regional government. According to Nurbaeti[3] since 2015 farmers can participate to become soybean seed breeders where this program is supported by the ministry in accordance with the Decree of the Director General of Food Crops No. 11/KPA/SK.310/C/1/2015 concerning Technical Guidelines for Empowering Seed Breeders. The spread of soybean seed breeders in Indonesia began with the recruitment of farmers who had never produced seeds or informally raised seeds. Then the farmers who have been recruited have their abilities increased through mentoring and training, namely:

a. In the 1st period, seeding technical training in terms of cultivating the ability to produce SS seeds
b. In the 2nd period, seeding technical guidance and training was carried out in the form of producing ES seeds, which were sourced from SS seeds originating from the 1st period.
c. In the 3rd period, prospective panangkar farmers are assisted and facilitated in the seed certification process

Besides to providing cultivation training to farmers, the government also plays a role in several matters that directly support the seed breeding program. The government support to farmers in providing production resources, cultivation techniques, postharvest equipment, and seed marketing. Production resource support was provided by the government for seed breeders in the form of: (1) provision of superior seeds with the types of seeds developed, namely Anjasmoro and Argomulyo, (2) provision of urea and SP36/NPK fertilizers. From a technical perspective, the government provides support of technical guidance and monitoring in on-farm implementation in order to ensure that the cultivation of soybean seeds is in line with established technical procedures. In terms of on-farm, the government also provides mechanical equipment to support various related activities. Government support for soybean seed breeders is not only in supporting production factors but also in terms of post-harvest and seed marketing. The government provides (warehouse building) and and soybean seed cleaner. Whereas in terms of seed marketing, the government markets all the seeds produced by breeders because the seeds that have been produced are adjusted to the demand by soybean farmers, so that all seeds can be sold[4].

The government spends a lot of resources to produce seeds with good varieties, good quality, quantities available on demand at the right time, in almost all locations of soybean farming, and prices that are affordable for farmers. As is well known, the government budget allocation for seed breeding programs is not unlimited because an increase in the government budget in one budget post is a trade-off against another budget post so that the budget allocation for seed breeding is expected to reach a level of economic efficiency in order to increase the impact of fiscal policy on Indonesia's economic growth.

The concept of economic efficiency which is used as a reference from Farrell[5] who argued that economic efficiency is a combination of technical efficiency and allocative efficiency. Where technical efficiency shows an assessment of the ability to produce output with the minimum amount of resources possible while allocative efficiency shows an assessment of the ability to produce output at the lowest possible cost. Although seed breeding is a program capable of having an impact on increasing soybean productivity in Indonesia, this program also consumes a number of resources that must be assessed and its efficiency measured.

Efficiency measurement aims to assess the success of program implementation as material for evaluation and improvement in the context of program sustainability. The measurement of economic efficiency will provide material for comparison between similar programs so that the government can eliminate programs that consume more resources. Efficient farm will encourage the maximization of benefits for both the government and the breeder farmers themselves. The government will get greater benefits even though the amount of the budget spent tends to be constant, while for breeder farmers economic efficiency will have an impact in the form of increasing farm income. Based on this, the study specifically aims to (1) determine the factors that significantly determine the cost of soybean seed production, (2) measure the level of economic efficiency achieved by breeder farmers, (3) determine the factors that affect economic efficiency achieved by breeder farmers.

II. Material And Methods

This research is a case study within the scope of production economics with the main research indicator is estimation of the economic efficiency index based on the cost function. Estimation of the cost function can show the most responsive input factor to increase production costs. Estimation of the economic efficiency index provides information on the distribution of the economic efficiency index among farmers.To get the results of the analysis, certain types of data are needed, so this study uses cross-sectional quantitative data. The data was obtained from respondents of soybean breeders in Konawe District, South Konawe Regency and Kolaka Regency, Southeast Sulawesi who used the census method, which means that every seed breeder in that research regency found during this research.

Collecting Data Method: Quantitative cross-sectional data were collected by observation, interviews and documentation. The observation method was conducted by visiting directly where the respondent in farm so that an overview of the conditions of the soybean seed farming was obtained. The interview method was conducted direct discussions with the respondents, in this case the soybean seed breeders. To get the efficient of time, the interview was conducted using a closed-ended question with instrument in the form of a questionnaire in order the questions can be directed according to the desired data. The documentation is done by taking data on farming records that have been conducted.

Data Analysis Method: Data analysis was carried out in several stages, namely:

1. Estimating parameters in the cost function equation using the Ordinary Least Square (OLS) estimation method

   Determination of the factors that influence the cost function aims to examine the factors that are thought to directly affect costs in the production process. The approach to analyze this is done by the Ordinary Least Square (OLS) estimation method. The mathematical formula in this multiple regression analysis is as follows:

   $\ln C_i = \beta_o + \beta_1 \ln(w_{i1}) + \beta_2 \ln(w_{i2}) + \beta_3 \ln(w_{i3}) + \beta_4 \ln(w_{i4}) + \beta_5 \ln(w_{i\,5}) + \beta_6 \ln(Y) + \varepsilon$

   Where :
   C = Soybean Seed Production Cost in one period (Rp)
   w_1 = Price of Land in one period (Rp/head)
   w_2 = Price of Seed per kilogram in one period (Rp/kg)
   w_3 = Price of Urea Fertilizer per kilogram in one period (Rp/kg)
   w_4 = Price of SP36 Fertilizer or NPK per kilogram in one period (Rp/kg)
   w_5 = Price of Pesticide per liter in one period (Rp/l)
   w_6 = Labor price per person in one period (Rp/person)
   Y = Soybean Seed Production in one period (Kg)
   β_o = Constant
   β_i = Parameters Estimated input
   ε = Residual elements

2. Estimating and describing the distribution of economic efficiency levels using the Maximum Likelihood Estimator (MLE) method.

   To measure economic efficiency, it is done by estimating the homogeneous Cobb-Douglas cost function[6]. Economic efficiency (EE) is defined as the ratio between the actual total production cost (C) and the minimum observed total production cost (C*), as shown in the equation below.

$$\mathrm{EE}_i = \frac{Ci}{C^*} = \frac{\exp[C_i(y_i, p_i, \beta) + v_i + u_i]}{\exp[C_i(y_i, p_i, \beta) + v_i]} = exp(u_i)$$

   The efficiency measure is based on the stochastic frontier approach, carried out by first setting a dual stochastic frontier cost function. Parameter estimation of this function uses the Maximum likelihood estimation (MLE) method with the TE Effect Model option, and uses FRONTIER software version 4.1.

   According to Coelli, et al[7]the efficiency value of the above equation is termed overall economic efficiency (EEi) for each observation unit i. C* is the cost under ideal conditions where efficiency (full efficient) is achieved, while C is the actual cost based on observations, the balance of these two measures will determine the inefficiency coefficient. If Ci* = Ci then there is no inefficiency effect (ui=0) on the unit of observation, or in other words the lowest relative cost (full efficient) is achieved and has an index EEi = 1, if Ci*<Ci then there is inefficiency (ui> 0), and the EEi index >1. The value of the inefficiency coefficient ranges from one to infinity.

3. Estimating the parameters of the determinants of economic efficiency.

   The diversity of economic efficiency indices/values is thought to be influenced by several factors which can become determinant factors affecting economic efficiency. The factors that influence economic efficiency are applied as follows:

   $u_{iEE} = \delta_0 + \varphi_1 DCF + \delta_2 EDU + \delta_3 EXP + \delta_4 \mathrm{PUK} + \varepsilon$

ui_{EE} = Economic Inefficiency
DCF = Dummy Contract Farming (0= Non-Contract, Contract=1)
EDU = Breeder Education Level
EXP = Breeder Experience
PUK = Revenue received by Breeders
δ_i = Estimated Parameter of variable input
φ = Dummy variable parameters
ε = Residual elements

III. Result andDiscussion

Part of economic efficiency starts from determining the most influential cost factors in the soybean seed breeding business. In this study, the determination of these factors was conducted by estimating the parameters of the cost function using the OLS and MLE estimation methods. The cost function reflects the factors that influence the condition of breeders who minimize costs in a certain production level. The modeling in this study uses a model which shows that the cost of seed production is affected by the prices of various inputs and the amount of seed production

As described in Table 1, it can be seen that cumulatively the factors included in the cost function model show the suitability of the model which is at a very good level. Where this is indicated by theF_{Value} and Adjusted R^2 value which each shows a value of 95,334 and 0,892. Cumulatively the variables included in the model have a very significant effect (at an error level of 1 percent) in determining the ups and downs of the production cost variable for soybean seed farming. The resulting Adjusted R^2 value also shows that 89.2 percent of the explained variation of the farming cost variable originates from this cost function model, and 10.8 percent of the unexplained variation from the model.

Table 1 : Cost Function Parameter Estimation Results.

Variabel	OLS		MLE	
	Estimated Parameters	t-ratio	Estimated Parameters	t-ratio
Konstanta	-18.659	-1.1389	-18.741	-18.742
Price of Land in	0.27127***	3.66827	0.27127***	3.66827
Price of Seed	1.26488*	1.62431	1.26488*	1.62431
Price of Urea	0.04443	0.32748	0.04443	0.32748
Price of SP36	-0.36313	-1.41102	-0.36313	-1.41102
Price of Pesticide	0.87817	1.50023	0.87817	1.50023
Price of Labor	0.42462***	3.13923	0.42462***	3.13923
Soybean Seed Production	0.78204***	12.73533	0.78204***	12.73533
F_{Value}	95.334			
Adj R^2	0.892			
σ^2			0.01079	4.16702
γ			68.517728	2.89657
LR *test*	24.33984 (restrictions = 6)			

The results of the estimation of the factors that affect costs as in Table 11 show that the variable land prices, labor prices and total production are factors that have a very significant effect at the 1 percent error level. These findings indicate that the total cost of soybean seed farming is dominantly influenced by the price of land, the price of labor and the amount of production. Based on Table 1, it shows the parameter estimation of the variable Land price of 0.27127 which means that the direction of increasing land prices will be in line of increasing the cost of soybean seed production. Then, the calculated magnitude of the parameter estimation of 0.27127 results in a prediction that a 1 percent increase in land prices will increase production costs by 27 percent. Land prices are important because they are costs that must be financed by farmers in each period and have a large share in the total cost component of farming. Land prices also show a greater magnitude of the estimation parameter compared to the land price variable, which is equal to 0.42462, which means that if there is an increase in the price of labor by 1 percent, it will increase production costs by 42.4 percent. Labor is the which one main factor in soybean seed farming because the required labor in this farm is good level practice one in farm cultivation activities. The need for a trained workforce is caused by activities in farming that are very specific in seed breeding so that the wages of this kind of labor are more expensive than the wages of other workers.

Soybean Seed Production variable shows that the estimated parameter is the largest compared to other variables, that is 0.78204, it indicates that the production amount is the main component in determining the production costs. These findings explain that the amount of production produced in soybean seed farming is determined by the fulfillment of a number of inputs that are explicitly paid for in each farm period so that they are reflected in the total production costs. As a result, any effort to increase production will increase the amount of production costs. In soybean seed farming, it can be predicted that every 1 percent increase will increase production costs by 78.2 percent.

To obtain the estimated value of economic efficiency in soybean seed farming, the parameter estimates are generated using the Maximum Likelihood Estimators (MLE) method. This method capables to describe the ratio between the i-th actual total production costs (Ci) and the total potential production costs from the estimation results (Ci*) so that it gives an exponent ui (Exp_{ui}) value as an index of economic efficiency that is on a score of 0–1[8]. The results of parameter estimation using the MLE estimation method can be seen in Table 1 which shows the values of γ and σ_2.

The value of σ2 or sigma-squared has a t-ratio value of 4.16702 which means that the indicator value of σ2 has a significant effect at an error level of 1 percent. This value illustrates that there are variations in production between seed breeder which are determined by the variation of a number of factors in the cost function being modelled. The magnitude of the σ2 value of 0.01079 indicates that the influence of external variations from the model can significantly determine 1.08 percent of fluctuations in the production costs of soybean seed farming. Meanwhile, the value of γ determines the percentage of variation originating from economic inefficiency. Table 1 shows that the γ value is 68.51 and has a very significant effect at an error level of 1 percent, which means that the effect of economic inefficiency on external variations of farming is 68.51 percent. From the two stochastic frontier efficiency indicator values, it can be seen that there is a significant economic inefficiency effect that also determines the amount of production costs apart from input prices and production quantities. By also calculating the value of the effect of economic inefficiency, it can produce a comparison of the value between the i-th actual production costs (ci) and the potential total production costs from the estimation results (ci*) which are tabulated in Table 2.

Table 2. Result Tabulation of of Economic Efficiency Level Distribution in Soybean Seed Farming

Economics Efficiency Classifications Index	Amount of Seeder (Farm)	Percentage of Seeder (Farm)
0.650-0.699	1	1.24
0,700-0,749	5	6.17
0,750-0,799	5	6.17
0,800-0,849	8	9.88
0,850-0,899	14	17.28
0,900-0,949	19	23.46
0,950-0,999	29	35.80
Total	81	100
Mean	0.901	
Minimum	0.668	1.24
Maximum	0.992	35.80

The level of economic efficiency describes the level of ability of farm performance to transform various inputs into combined outputs with minimum possible costs. Based on the results of the analysis presented in Table 2, it shows that not all breeder farmers are able to achieve the proper level of economic efficiency. From the results of the stochastic frontier analysis on the cost function, it shows that the level of economic efficiency in farming ranges from 0.668-0.992 and on average the level of economic efficiency is at a value of 0.901 which means that overall the level of success of soybean seed breeders is able to minimize production costs in farming around 93, 7 percent from the frontier which is the potential cost level that should be achieved by efficiently allocating resources.

The distribution of the economic efficiency index of seed breeder is described as concentrated in the range of 0.950–0.999, which are 29 people or around 35.80 percent of the total seedling farmers. In addition, based on these indicators it can be seen that all seed breeder have achieved an efficiency level above 0.650 percent and 59.2 percent of breeder farmers have achieved an efficiency level above 0.900, which means that more than half of the breeder farmers have approached the maximum economic efficiency level. The difference in the achievement of the level of economic efficiency between farmers shows that each farmer commits economic inefficiency which is influenced by a number of factors and in this study these factors are thought to originate from the Farm Pattern, The level of seed-breeder education, The experience in seed breeders management and seed breeders income shown in Table 3.

Table 3. Estimation of Factors Affecting Economic Inefficiency

Variables	Estimated Parameters	Standar Error	t-ratio
Dummy Contract Farming (0= Non Contract, Contract=1)	-0.14374	0.09726	-1.47784
Seed Breeder Education Level (EDU)	-0.00119	0.00840	-0.14119
Seed Breeder Experience (EXP)	0.05707	0.02886	1.97748
Profit Received by Seed Breeders (PUK)	-0.02725***	0.00733	-3.71916

The Farm Pattern referred to here is the participation of farmers in Contract Farming of soybean seeds. Where in Table 3 it shows that Dummy Contract Farming has a less significant effect at an error level of 10 percent, and shows the estimated parameter magnitude of -0.14374 which indicates that the level of economic inefficiency is greater in independent business patterns. These findings indicate that the design and implementation of contract farming carried out by the government on breeders in producing soybean seeds encourages increased economic efficiency. Contract farming for seed breeders provides many benefits to farmers such as convenience not only in obtaining variable inputs such as soybean seeds, urea and fertilizers, as well as convenience in obtaining fixed input facilities such as Seed Cleaners, Storage Warehouses and seed cultivation technical guidance facilities. The existence of this facility will reduce transaction costs for each input and reduce various fixed costs because it has been provided by the Government acting as principal in Contract farming. Contract farming usually implemented in Indonesia is able to provide benefits such as assistance in supplying inputs, providing technical guidance, and increasing access to marketing. The benefits of this Contract farming are able to reduce costs borne by farmers/breeders so as to reduce the inefficiency of cost allocation incurred by farmers/breeders participating in Contract farming[9,10].

The findings presented in Table 3 show that even though the significance level is low, the sign of the effect of education level on economic inefficiency shows a negative sign, which means that the higher the education of the breeder, the lower the farmer's inefficiency. The role of education in farming is to make farmers more open in adopting information and technological changes. Where, this is an important factor in the management of modern farming that is always growing. Farmers with this ability will be able to act and make the right decisions in allocating inputs so as to reduce inefficiencies[11,12]. The ability to minimize costs will really need a strong adjustment because the economic environment around farming is always dynamic so that without the ability to manage modern farming, economic inefficiency will not be achieved.

In contrast to the influence of education, the influence of breeder experience on economic inefficiency shows signs that actually show the experience of farmers can increase inefficiency. The role of education and experience can complement each other's farming management because higher education will facilitate the adoption of technology and accelerate the increase in the absorption of farmer's knowledge to reach the expert level[13]. Therefore farmers who are supported by higher education can achieve a good level of management so as to minimize inefficiencies even though they have low experience. These findings indicate that in terms of economic efficiency the role of educational level is higher than the role of farming experience even though previous research on the same subject experience actually showed that the role of experience was very good in reducing technical inefficiencies[14]. This condition is due to the fact that economic efficiency indicators not only measure the ability of farmers to produce efficient products but also measure the ability to combine inputs that are capable of producing the lowest costs, in a certain amount of production. The ability to allocate inputs that minimize costs is a different capability from efficient technical production capabilities so that a farmer may be efficient in terms of technical capabilities but not efficient in minimizing costs.

One of the motives of someone trying to farm is to make a profit. In the seed breeding business, the prices obtained are almost uniform among breeders because the seeds are marketed and purchased by the relevant government to be marketed to farmers. Therefore, the method of maximizing profits carried out by seed breeders is through minimizing costs so that each farmer tries to allocate business resources with combinations that have minimal costs. Based on this description, it can be seen that an increase in income will go hand in hand with an increase in economic efficiency.

IV. Conclusion and Research Implication

Based on the description of the discussion, it can be concluded that:

1. Cost fluctuations in soybean seed production are determined by land costs, labor costs and the amount of production. The prediction from these findings is that the largest source of fluctuations in production costs

comes from changes in the amount of production which can increase production costs by 78.2 percent for every increase in production by 1 percent. Meanwhile, the impact of an increase in land prices and labor prices on production costs per 1 percent is 27 percent and 42.4 percent, respectively.

2. The effect of economic inefficiency on the difference in production costs in soybean seed farming reaches 68 percent. Even so, the level of economic efficiency in farming ranges from 0.668 to 0.992 and on average the level of economic efficiency is at a value of 0.901 which means that the overall level of success of soybean seed breeders is able to minimize production costs in farming around 93.7 percent of the level of costs. minimum that can be achieved.
3. The effect of economic inefficiency which contributes to differences in production costs among breeders is negatively and significantly affected by the income level of each breeder farmer. In this case the breeder farmer shows the side of economic motives so that the higher the level of income received by the farmer, the higher the farmer's effort to minimize economic inefficiency.

The findings in this study generally indicate that labor costs and farmer incentives determine the efficient allocation of resources. Efforts to increase production by farmers must be followed by government assistance to update various technologies that can minimize costs in the form of agricultural mechanization to reduce the need for labor.

Findings indicating that economic efficiency increases due to income encouragement are taken into consideration by the government regarding policies to increase incentives for farmers as rewards for good performance achievements in a production period. Providing additional incentives is a pull factor for breeder farmers to be able to carry out farming activities that are economically efficient. In this case the farming contract that is carried out between the government and seed growers must create a performance bonus mechanism in each period.

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