Analysis of Factors Affecting Soybean Production and Price Efficiency in Banten Province

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Abstract. The soybean harvested area in Banten Province in 2018 was 23,594 ha with a production of 18,093.6 tons with productivity 0.77 ton/ha [1]. Based on the area harvested in 2018, soybeans are the third-largest crops in Banten Province, namely 23,594 ha after rice (334.83 ha) and corn (66,356 ha) [1]. While based on the administration, the biggest soybean producer in Pandeglang Regency with a harvested area of 18,925 ha with a production of 14,115 tons or productivity of 0.66 ton/ha. The second-largest producer is Lebak Regency with a harvested area of 4,001 ha with a production of 3,375 tons or productivity of 0.84 ton/ha [1]. This soybean plant mostly grows on dry land and is generally planted in the Dry Season (DS). Soybean is one of the strategic commodities of food crops besides rice and maize [2].
One of the factors that support the increase in soybean production in Banten is to increase productivity per planted area. This is supported by the use of various inputs for farming, ranging from land, seeds, fertilizers, growth stimulants, pesticides, herbicides, labor, etc. The quantity and combination of the various inputs (factors of production) above will determine the amount of production (productivity) of soybeans. According to [3], support resources of production are land, capital, labor, and management, and to analyze the relationship between production factors and production, the production function is used. Production function analysis is important because it is used to find out how limited resources can produce maximum production. It is also necessary to know the efficiency of prices or allocative so that the shortage or excess of factors of production can be identified.

To find out the production factors that affect soybean production in Banten and price efficiency, it is necessary to conduct a study so that it is known what factors have a significant effect on production and to know the allocative (price) efficiency. Then it is necessary to know how the actual farming system and farming analysis, and also to know the level of price efficiency.

2. Method

2.1 Data Collection Method, Location and Time of Study

The data collected in this study are primary and secondary data. Primary data is collected through surveys, while secondary data is collected by visiting the offices of the relevant agencies like the Agriculture Office of Pandeglang Regency and Banten Province. Also from the Central Bureau of Statistics of Banten Province, and other agencies related to this study.

The method used in this study is the survey method. The survey method was carried out for primary data collection by conducting interviews using structured questionnaires at the farmer level.

The sample location was chosen purposively, namely, Pandeglang Regency is based on the results of discussions with the local Food Crops Office, where this regency is the largest producer of soybeans in Banten, and at that time the government was incessantly implementing the soybean Special Effort (Upsus) program. Primary data collection at the farmer level was carried out by simple random sampling because the respondents were relatively homogeneous, namely soybean farmers [4]. The selected districts are Cimanuk District and villages from surrounding areas that cultivate soybeans. The number of respondents selected from the sample villages in Pandeglang Regency was as many as 29 respondents. The data obtained in this study is the result of the author's dissertation entitled "Model optimization of land use and sustainable food crop inputs in Banten Province" [5].

2.2 Analysis Method

The data analysis used consisted of qualitative and quantitative analysis. Qualitative analysis using descriptive statistics and quantitative analysis using multiple linear regression analysis. This analysis is used to look at the production factors that affect soybean production in the Dry Season (DS) of 2018 [3]. This means that there is a relationship between the independent variables or explanatory variables and the dependent variable [6].

The equation for the estimated soybean production is presented below.

\[
\text{PRODKS} = a_0 + a_1J_{BES} + a_2J_{URE} + a_3J_{SP36} + a_4J_{NPK} + a_5J_{KCL} + a_6J_{POP}
+ a_7J_{PUDP} + a_8J_{PUDC} + a_9J_{KD} + a_{10}J_{ZPTP} + a_{11}J_{PTC}
+ a_{12}J_{PESP} + a_{13}J_{PESC} + a_{14}J_{HERBP} + a_{15}J_{HERBC}
+ a_{16}J_{TKMDK} + a_{17}J_{KMSW} + a_{18}LGRP + e
\]  

Equation (1) is converted into the form of the Cobb Douglas production function by converting it into logarithmic form, namely:
\[
\log PRODKS = \log a_0 + a_1 \log JBES + a_2 \log JURE + a_3 \log JSP36 + a_4 \log JNPK + a_5 \log JKCL \\
+ a_6 \log JPOP + a_7 \log JPUDP + a_8 \log JPUDC + a_9 \log JKDG + a_{10} \log JZPTPP \\
+ a_{11} \log JZPTC + a_{12} \log JPESC + a_{13} \log JHERBP + a_{14} \log JHERBC \\
+ a_{15} \log JHERBP + a_{16} \log JTKMDK + a_{17} \log JTKMSW1 + a_{18} LGRP + e
\]  

(2)

Where:

- PRODKS = Soybean commodity production in 2018 DS (kg)
- JBES = Total use of certified seeds (kg)
- JURE = Total use of Urea fertilizer (kg)
- JSP36 = Total use of SP36 fertilizer (kg)
- JNPK = Total use of NPK fertilizer (kg)
- JKCL = Total use of KCL fertilizer (kg)
- JPOP = Total use of solid organic fertilizer (kg)
- JPUDP = Total use of solid foliar fertilizer (kg)
- JPUDC = Total use of liquid fertilizer (kg/ha)
- JKDG = Total use of manure (kg/ha)
- JZPTP = Total use of solid growth stimulants (kg/ha)
- JZPTC = Total use of liquid growth stimulants (ltr/ha)
- JPESC = Total use of liquid pesticides (ltr/ha)
- JHERBP = Total use of solid herbicide (kg/ha)
- JHERBC = Total use of liquid growth stimulants (ltr/ha)
- JTKMDK = Total use of human labor in the family (HOK/ha)
- JTKMSW = Total use of hired human labor (HOK)
- LGRP = Cultivated area (ha)
- e = Random error.

Expected parameter sign:

\(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}, a_{11}, a_{12}, a_{13}, a_{14} > 0\)

Price efficiency/allocative analysis was conducted on all production factors of soybean farming to determine whether it is efficient or not, where price efficiency occurs when:

\[NPMx = P_x \quad \text{or} \quad \frac{NPMx}{P_x} = 1\]  

(3)

Where:

- \(NPMx\) = Marginal Product Value of commodity x (example: soybean)
- \(P_x\) = Price of commodity x.

In farming analysis, to find out the benefits of each cost incurred, Benefit-Cost (B/C) ratio analysis is used. The value of the B/C ratio must be > 1 so that the farm is profitable [7][8][9]. The equation is as follows:

\[\frac{B}{C} = \frac{\Pi}{TC}\]  

(4)

Where:

- \(\Pi\) = Soybean farming income or benefit (IDR)
- \(TC\) = Total Cost / Total Cost of Soybean Farming (IDR)
Existing data is processed computerized, for tabular analysis and B/C ratio processed by Excel program, while for multiple linear regression analysis processed by SAS version 9.1 program and SPSS21.

### 2.3. Classical Regression Assumption Test

Based on the multicollinearity test, it is known from the Pearson correlation test that the correlation coefficient value that exceeds 0.85 is only on the independent variable of cultivated land area while the other variables have coefficient values below 0.85 exists so it can be concluded that there is no multicollinearity. Based on figure 1, it is known that the residual data is distributed relatively normally where the curve line is curved upwards and the legs are symmetrical, i.e. not skewed to the left or skewed to the right.

The normality test was carried out using the graphic method (histogram) which is shown in figure 1. Based on the figure, the residual data is distributed relatively normally where the curve line is curved upwards and the legs are symmetrical, i.e. not skewed to the left or skewed to the right. This means that the data is normally distributed. The normality test with the probability plot graph method was also carried out as shown in figure 2. In figure 2, the results of the normal probability plots test where the data points are still around the diagonal line from the zero point, which means that the residuals (data) are relatively normally distributed.

Heteroscedasticity test in the case of soybean production equations using the Scatterplot method, namely by graphs by looking at the spread of the data displayed through the points around the zero point on the X-axis and Y-axis. Based on figure 3, scatter graph, dots (residual data) spread with an irregular pattern at point 0 which is on the X and Y axes. So it can be concluded that there are no symptoms of heteroscedasticity.

### 3. Results and Discussion

#### 3.1. Characteristics of Farmers Sample and Farming System in Banten Province

Based on the survey results, the average age of the head of the family (HF) is 42.8 years with a range of 20-77 years. The average length of education for the head of the family is 7.5 years with the lowest education being 6 years (graduated from elementary school) and the highest being 15 years or equivalent to graduating from a college academy. The average number of family members (including the head of the household) is 3.6 people with a range of 1-7 people. From the survey results, it is known that the average area of agricultural land in the survey location is 0.98 ha per household with a range of 0.25 - 5.0 ha. This arable land consists of owned land with an area of 0.37 ha/household with a range of 0-5 ha, and non-owned land with an area of 0.61 ha/family with a range of 0-3.0 ha. The area of paddy fields cultivated in the 2018 dry season is 0.48 ha per household (HH). Compared to the area cultivated for soybeans in Guinea Savanna-Nigeria (see Fatoba et al. 2010 and 2011), which is 1.2 ha/family, this area is 150% smaller. In general, the cropping pattern in the survey area is soybean-rice-fallow. The cultivated varieties are Anjasmoro (51.7%), Grobogan (44.8%), and Detap (3.5%)[10].
3.2. Soybean Farming Analysis

Based on the results of the survey, the average productivity of soybeans at the survey site in the 2018 Dry Season (DS) was 987.9 kg of dry shells per ha. With an average harvest price of Rp. 5,965.5/kg dry shells, the revenue is IDR. 5,893,317.5/ha. The total cost of production is IDR. 1,854,336.4/ha so that the income obtained is IDR. 4,038,981.1/ha. Soybean productivity is 28.3% higher than the average productivity of Banten Province, which is 0.77 ton/ha.

Based on the analysis of the B/C ratio, it is known that the value is 3.2 based on financial prices. This means that soybean farming is financially profitable. Details of the analysis of soybean farming in the 2018 Constitutional Court are presented in Table 1. The largest component of farming costs is labor, which is Rp. 943,527.1/ha or 51.8%. The second is the cost of fertilizer, which is IDR. 424,530.6/ha or 22.9% and the smallest is the cost of drugs (pesticides and herbicides) which is IDR. 357,307.4/ha or 19.3%.

3.3. Soybean Production Function Analysis

The results of the guess soybean production equation in 2018 (PRODKS) are described in detail in Table 2. The explanatory variables that significantly affect soybean production in 2018 are the amount of use of NPK fertilizer (JNPK), the amount of use of other fertilizers (JPUL), the amount of use of...
liquid pesticides (JPESC), Total use of hired human labor (JTKMSW), and area of land under cultivation (LGRP).

Table 1. Analysis of Soybean Farming per Ha in Dry Season (DS) 2018 in Banten Province.

| No. | Type of Input/Output | Volume | Price/unit (IDR) | Value (IDR) |
|-----|----------------------|--------|------------------|-------------|
| 1   | Seed (kg)            |        |                  |             |
|     | a. labeled           | 40.9   | 8,924.8          | 365,024.3   |
| 2   | Fertilizer (kg):     |        |                  |             |
|     | a. Urea              | 83.2   | 1,769.1          | 147,189.1   |
|     | b. SP-36             | 28.8   | 1,713.1          | 49,337.3    |
|     | c. KCL               | 12.9   | 2,611.1          | 33,683.2    |
|     | d. NPK Ponska        | 4.3    | 4,583.3          | 19,708.2    |
|     | e. Manure fertilizer (kg) | 228.6 | 68.9           | 15,750.5    |
|     | f. Other fertilizer (ltr) | 1.1  | 23,333.3        | 25,666.6    |
|     | g. Solid leaf fertilizer (kg) | 0.5  | 26,285.7       | 13,142.8    |
|     | h. Liquid leaf fertilizer (ltr) | 1.6  | 75,033        | 120,052.8   |
| 3   | Pesticide:           |        |                  |             |
|     | a. Solid (kg)        | 0.4    | 15,000           | 6,000       |
|     | b. Liquid (ltr)      | 0.5    | 168,728.8       | 84,364.4    |
| 4   | Herbicide:           |        |                  |             |
|     | a. Solid (kg)        | 1.5    | 41,428.6         | 62,142.9    |
|     | b. Liquid (ltr)      | 3      | 68,266.7         | 204,800.1   |
| 6   | Cost of labor:       |        |                  |             |
|     | a. Hired labour (Mand Day Work) | 16  | 51,804        | 828,864     |
|     | b. Family Labour (MDW) | 15.3 | 18,621.5     | 284,909     |
|     | c. Wage of tractor service | 1.3 | 88,194.4     | 114,652.7   |
|     | d. Cost of Family tractor. | 5   | 61,416.7     | 307,083.5   |
| 7   | Total Cost           |        |                  | 1,854,336.4 |
| 8   | Return               | 987.9  | 5,965.5        | 5,893,317.5 |
| 10  | Income               |        |                  | 4,038,981.1 |
| 11  | R/C                  |        |                  | 3.2         |
| 12  | B/C                  |        |                  | 2.2         |

Source: primary data processed, 2019. Explanation: n = 29 respondents.

The coefficient of elasticity of soybean production on the amount of NPK fertilizer (EPRODKS, JNPK) is 0.01681 (inelastic), which means that every 1% increase in NPK will increase soybean production by 0.017%, meaning that soybean production is not responsive to changes in the amount of NPK fertilizer. The coefficient of elasticity of soybean production against the number of other fertilizers (EPRODKS, JPUL) is 0.01376 (inelastic) meaning that every 1% increase in the JPUL will increase PRODKS by 0.014% at a confidence level of 85%, meaning that soybean production is not responsive to changes in the number of other fertilizers.

The elasticity value of soybean production to the amount of liquid pesticide (EPRODKS, JPESC) is 0.01482 (inelastic) which means that every 1% increase in the JPESC will increase PRODKS by 0.015%, meaning that soybean production is not responsive to changes in the amount liquid pesticides.
Table 2. Predicted Results of Soybean Production Equation in 2018 Dry Season in Banten Province.

| Variable                                      | Symbol     | Elasticity (%) | t-counted | Level of Significant |
|-----------------------------------------------|------------|----------------|-----------|---------------------|
| Intercept                                     | $d_1$      | 7.42460        | 8.08      | <.0001              |
| Total use of certified seeds                  | JBES       | -0.05361       | -0.22     | 0.8309              |
| Total use of Urea fertilizer                 | JURE       | 0.00337        | 0.04      | 0.9651              |
| Total use of SP36 fertilizer                 | JSP36      | -0.02313       | -3.51     | 0.0031              |
| Total use of NPK fertilizer                  | JNPK       | 0.01681        | 1.81      | 0.0902**            |
| Total use of other fertilizer                | JPUL       | 0.01376        | 1.58      | 0.1358*             |
| Total Use of Solid leaf Fertilizer           | JPUDP      | 0.01173        | 1.07      | 0.3025              |
| Total Use of Liquid leaf Fertilizer          | JPUDC      | -0.01657       | -2.04     | 0.0591              |
| Total Use of Liquid Pesticide                | JPESC      | 0.01482        | 2.08      | 0.0549**            |
| Total Use of Liquid Herbicide                | JHERBC     | -0.00492       | -0.92     | 0.3741              |
| Total Use Number of Family Tractor           | JTRDK      | -0.01630       | -2.94     | 0.0102              |
| Tractor                                       |            |                |           |                     |
| Total Use of Family Labour                   | JTKMDK     | -0.00414       | -0.68     | 0.5080              |
| Total Use of Hired Human Labour              | JTKMSW     | 0.01552        | 1.87      | 0.0812**            |
| Land Are Cultivated                          | LGRP       | 1.22417        | 4.01      | 0.0011***           |
| $R^2$                                         |            | 0.9372         |           |                     |
| F Counted                                     |            | 17.23          |           |                     |

Source: Processed primary data, 2019. Explanation n = 29 respondents.

The coefficient of elasticity of soybean production on the number of hired human labor (EPRODKS, JTKMSW) is 0.01552 which means that every 1% increase JTKMSW will increase PRODKS by 0.015%, which means that soybean production does not responsive to changes in the number of hired human labor (inelastic). The elasticity value of soybean production to the area of cultivated land (EPRODKS, LGRP) is 1.22417 which means that every 1% increase in LGRP will increase PRODKS by 1.22% (elastic), so that soybean production is responsive to changes in the area of the cultivated land. The cumulative elasticity of soybean production with respect to production factors is 1.18151 (elastic), which means that every 1% addition of the cumulative factor of production will increase soybean production by 1.18% or increase return to scale. So soybean farming is relatively efficient.

Based on Moses’s research (2017) on the technical efficiency of soybean production in Adamawa State, Nigeria, it was found that the factors that significantly affect soybean production are the area of land cultivated or cultivated, the number of seeds, and the number of workers [11]. According to [12] that has conducted a study on the economic analysis of soybean production, it was found that the factors that affect soybean production are the amount of use of seeds, the amount of fertilizer used, and the amount of use of agricultural chemicals. Based on the research of [13] in South Sulawesi Province, Indonesia, using the Cobb Douglass function, it is known that the factors that affect soybean production are length (experience) of farming, the number of the family labor force, distance from house to paddy field, distance from house to input market, amount of urea fertilizer, amount of KCl fertilizer, amount of organic fertilizer, dummy of land ownership status (profit sharing), dummy of soybean varieties, dummy of spacing, and the dummy of land type. Purnamasari et al. (2017) based on his research in Kulon Progo Regency, D.I. Yogyakarta, using the Cobb Douglas production function, found that the factors affecting soybean productivity were the number of seeds, the amount of NPK fertilizer, the amount of manure, the amount of Gandasil, the rate of adoption of GAP (Good Agriculture Practices) [14].

Mugabo et al. (2014) in their research in Rwanda, using the Cobb Douglas function found that the factors that affect soybean production are the area of land cultivated, the amount of fertilizer, and the number of pesticides. Likewise, with the results of the study of Aidoo et al. (2014) in Northern Ghana it is known that the factors that affect soybean production are the area of land cultivated, the number of
According to research by [17] regarding the analysis of the total factors of soybean production in China using the Cobb Douglas function, found that the factors that affect production are planting area and material costs, while the factors that affect the total factors of production are technical achievements, cultivation patterns, and policies. Kristanti et al. (2017) also conducted soybean research in Indonesia using the Cobb-Douglas function, from the results of his research it was found that the factors that significantly affect soybean production are land area, total seed use, total use of TSP/SP-36 fertilizer, and production operating costs. The technical value of the soybean farming efficiency of the Grobogan variety is 0.767, which means that the output can still be increased by 23.3% using the same input [18].

Based on research by [19] in Pangandaran Regency, West Java Province using the stochastic frontier production function it was found that the factors that influence soybean production are the number of seeds, the number of workers, the number of chemical fertilizers, and organic fertilizers. The efficiency model shows that age, farming experience, and household size significantly affect technical inefficiency. Dwiastuti and Ningsih (2016), conducted a study on the economic efficiency of soybean farming in Nganjuk Regency, East Java Province using the Cobb Douglas Frontier Cost Function, found that the factors that affect production costs are land rent, fertilizer prices, pesticide prices, prices bore well irrigation and the amount of output [20].

### Table 3. Price Efficiency of Each Production Factor of Soybean Farming.

| Item            | a₁   | Y/X  | PM   | Px   | NPM  | NPM/Px |
|-----------------|------|------|------|------|------|--------|
| JBESk           | -0.0536 | 24.1767 | -1.2961129 | 8294.76 | -5380.9762 | -0.6487 |
| JUREk           | -0.00337 | 11.8719 | 0.0400827 | 1769.06 | 166.099377 | 0.09389 |
| JSP36k          | 0.02313 | 34.3365 | -0.79420236 | 1713.1 | -3297.2312 | -1.9247 |
| JNPKk           | 0.0168 | 230.2704 | 3.87084536 | 4583.33 | 23091.6054 | 5.03817 |
| JUPLk           | 0.1376 | 923.2336 | 12.7036949 | 23333.33 | 52740.9905 | 2.26033 |
| JUDPpk          | 0.01173 | 1975.72 | 23.1751956 | 26285.71 | 96214.745 | 3.66034 |
| JUDPck          | -0.0166 | 606.049 | -10.04223223 | 75033.0 | -41691.597 | -0.5556 |
| JESPck          | 0.0148 | 1863.887 | 27.6228023 | 168728.76 | 114679.545 | 0.67967 |
| JHERBCk         | -0.00492 | 334.8678 | -1.64754956 | 68266.67 | -6840.0096 | -0.1002 |
| JTRDKk          | -0.0163 | 198.7646 | -3.23986278 | 61416.67 | -13450.699 | -0.219 |
| JTKMDKk         | -0.00414 | 64.60824 | -0.26747812 | 18621.50 | -1110.4691 | -0.0596 |
| JTKMSWk         | 0.01552 | 61.58728 | 0.95583461 | 51804.01 | 3968.26785 | 0.0766 |
| LGRPk           | 122.417 | 987.86 | 120930.8576 | 176000 | 502059695 | 285.261 |

Source: Processed primary data, 2019.

Price efficiency/allocative analysis was carried out on all production factors of soybean farming to determine whether it was efficient or not, where price efficiency occurred when NPM = Px or NPMx/Px equals 1. The results are listed in table 3. Based on Table 3 it can be seen that the values of NPM/Px that are equal to 1 do not exist from any of the production factors or independent variables. This means that all factors of production are inefficient or need to be reduced in number (NPM/Px < 1) or need to be increased in number (NPM/Px > 1). For those whose NPM/Px < 1 value, are the number of uses: seeds, urea fertilizer, SP36 fertilizer, and others, all of which are inefficient and need to be reduced. The value of NPMx/Px >1 are the number of uses: NPK fertilizer, other fertilizers, and others, also inefficient and must be added in use in order to be efficient. Cumulatively the value of the average price efficiency,
namely the sum of the values of each production factor price efficiency divided by the number of production factors is 17.826, meaning that the overall use of production factors is not efficient, it still needs to be added to make it efficient.

4. Conclusion and suggestion

4.1. Conclusion

1. The cultivated varieties are Anjasmoro (51.7%), Grobogan (44.8%), and Detap (3.5%). Soybean farming income is IDR 4.038 million/planting season with a B/C ratio of 2.2, which means this farming is profitable.
2. The factors that significantly affect soybean production are the amount of use of NPK fertilizer, the number of other fertilizers used, the amount of liquid pesticide used, the amount of hired human labor, and the area of arable land.
3. Based on the price efficiency analysis, none of the production factors has a value of \( \frac{NPMx}{Px} = 1 \), meaning that each production factor does not price efficient. For production factors whose \( \frac{NPM}{Px} < 1 \) value like the number of uses: seeds, urea fertilizer, and others need to reduce their use. For those whose \( \frac{NPMx}{Px} > 1 \) value like the number of uses: NPK fertilizer, other fertilizers, and others must be added in used in order to be efficient.

4.2. Suggestion

The government needs to guarantee the selling price of soybeans is in line with the HPP price so that farmers are stimulated to plant soybeans.

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