Analysis of Soybean Production Trends in Indonesia

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Abstract. Climate change since 2012 has had a real influence on the uncertainty of soybean production which has resulted in fluctuating soybean production in Indonesia. The study purposed to: (i) analyze the fluctuation of soybean production before and during climate change, (ii) analyzing the factors that affect soybean production fluctuations covering land area (X1), soybean prices (X2), consumption (X3). The type of data used is secondary data, a time series data of soybean production in 1994 to 2019. The data was obtained from the Central Statistics Agency. The analytical method used is trend analysis to analyze production fluctuations. Multiple linear regression analysis to analyze the factors that influence production fluctuations. The results showed that before climate change production trends decrease, during climate change production trends increase slightly. Factors that influence soybean production are land area (positive influence on fluctuations in soybean production by α 5 % means an increase in land area results in an increase in production), price has positive effect on soybean production fluctuations with α 5 % means an increase in price motivates farmers to produce, and consumption has positive effect on soybean production fluctuations with α 5 % means an increase in consumption motivates farmers to produce.

Keywords: Climate change, *Glycine max* (L.) Merr, tempeh.

1 Introduction

Soybean (*Glycine max* (L.) Merr.) is one of the multipurpose leguminous plants, that can be used as food, feed, and industrial raw materials is non-end-product consumer [1–3]. Particularly, in Indonesia, soybean is basic ingredients of food such as soy sauce, tofu, and "tempeh". Soybean contain of 35 % to 38 % protein, the highest of other legumes [4, 5]. In terms of price, soybean is a cheap source of vegetable protein. Tempeh is a traditional fermented food that made from soybeans with the help of *Rhizopus oligosporus* mushroom, with white characteristics, compact texture, and specific flavor [6–8]. The existence of the fermentation process makes tempeh easily to be digested, absorbed and utilized in the body

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than in the form of soy [9]. Tempeh also has potential to be used to against free radicals, thus inhibiting the aging process and preventing degeneration because tempeh contains of isoflavones as antioxidants such as atherosclerosis, coronary heart disease, diabetes mellitus, cancer, menopausal symptoms and others [10–13]. Tempeh can be processed into various products such as tempeh chips [14].

Indonesia is the largest tempeh producing country in the world and is the largest soybean market in Asia. As much as 50 % of Indonesian soybean consumption in the form of tempeh, 40 % in the form of tofu and 10 % in the form of other products, such as tauco, tofu, oncom, and soy sauce [15]. Based on the Ministry of National Development Planning [16], the average of tempeh consumption per person per year in Indonesia is 6.95 kg and tofu 7.07 kg. The need for soybeans as the main raw material for tempeh and tofu, 67.28 % is met in Indonesia, while the rest is imported. Domestic soybean demand that cannot be fulfilled is caused by insufficient soybean production.

Soybean is a commodity that is most sensitive to climate change. One of the problems in the soybean production process in Indonesia is climate change [17, 18]. Global warming changes the characteristics of the global, regional and local climate, and impacts various aspects of life and the ecobiology of the agricultural sector. Climate change also causes high rainfall [19]. Based on the above background explanation, it is necessary to do further research on the development trend of soybean production in Indonesia for 25 yr (1994 to 2019) and what factors influence soybean production in Indonesia during this period.

2 Material and methods

2.1 Soybean production trends in Indonesia

Soybean is one of the high value of food commodities after rice and corn. This commodity has a variety of uses, including as a raw material for the food industry that is rich in sources of vegetable protein and as a raw material for the animal feed industry. The food industry made from soybeans and animal feed industry that is growing rapidly has an impact on soybean demand which is always increasing from year to year. According to Roessali *et al.* [20], the food industry made from soybeans that are developing very rapidly in Indonesia includes tempeh, tauco, soy sauce, tofu, and milk craftsmen.

Indonesia's population in 2020 is projected to reach 271.1×10^6. Based on these projections the availability of good quality food is needed in large enough quantities, not to mention the availability of soybeans as one of the raw materials for food sources of the Indonesian people. In 2019, the target of soybean production in Indonesia is 1.92×10^6 t. The main objective of domestic soybean production is to secure the supply of craftsmen and consumption needs for tofu and tempeh [21].

According to data compiled by the Ministry of Agriculture [22], from 1980 to 2016 the national soybean production trend fluctuated and tended to increase with an average growth of 2.35 % yr^{-1}. During this period, trends in soybean production in Java and outside of Java were also in tune, but outside of Java was higher at 6.00 % yr^{-1} than Java, which only increased by 1.36 %. Nationally, the increase in soybean production was only realized in 2014 amounted to 22.44 % and in 2015 amounted to 0.86 %, while the previous 3 yr decreased by 6.15 % (2011), 0.96 % (2012), and 7.49 % (2013).

During the 2014 to 2018 period, national soybean production grew by an average of 10.97 % yr^{-1} but there was a significant decline in production in 2016 and 2017, amounting to 10.75 % and 37.33 %. Soybean production is expected to increase sharply in 2018 at 79.66 %, from the previous year's total production of 583.73×10^3 t to 967.87×10^3 t [23]. Increasing

soybean production both in terms of quantity and quality continues to be pursued by the government through extensification and intensification.

Soybean demand continues to reach a high level of demand, the average growth rate of soybean demand during 2011 to 2015 was 1.79 %. The increasing demand for soybeans includes a high population, economic growth, changes in tastes, and high levels of expenditure [24]. Population and demand for food are two things that are closely related to each other. The higher the level of population in a country, the higher the level of food needs including demand for soybeans [25].

2.2 Soybean consumption level in Indonesia

Indonesia's human consumption of soybean is expected to increase following population growth trends. Soybean consumption in Indonesia is generally used to meet domestic food needs, the soybean-based food industry, and the animal feed industry. However, soybean consumption in Indonesia is still dominated to meet domestic food needs. The level of soybean consumption in Indonesia is higher than the amount of domestic availability [26]. During the period of 2002 to 2015, domestic soybean consumption fluctuated and tended to decline, with an average decline rate of 2.15 % yr^{-1}. The highest soybean consumption of 8.63 kg $capita^{-1}$ yr^{-1} occurred in 2007 [27].

In 2015 Indonesia's population reached 255×10^6 people with an average level of soybean consumption of 10 kg $capita^{-1}$ yr^{-1}. The need for soybeans is used for the production of tofu and tempeh by 80 %, 10 % is used for processed food, and 2 % for seeding [24]. Demand for soybeans continues to experience a high increase, the average growth rate of soybean demand during 2011 to 2015 was 1.79 %. The increasing demand for soybeans includes a high population, economic growth, changes in tastes, and high levels of expenditure [28].

The higher the level of population in a country, the higher the level of food needs including demand for soybeans [28]. According to Ningrum *et al.* [23], soybean use for feed sector is expected to reach 1.7×10^6 t in 2018, post expects the consumption of soybean reach 3.14×10^6 t in 2018. Population and demand for food are two things that are closely related to each other.

2.3 Soybean import

The low level of soybean production in Indonesia which is only able to meet domestic needs by 35 %, makes the government import to meet the shortfall [12]. Dependence on imports of soybeans in Indonesia has continued to increase since 1978. In 2006, the level of dependence on soybean imports reached 54.66 % and after 2006 it reached more than 60 %.
The main factor causing the high soybean imports is the low domestic soybean production. The low domestic soybean production is caused by the soybean planting land which has undergone a lot of transformation over functions and competing with other staple crops such as rice and corn [29]. Therefore, increasing productivity is one of the strategies that can be done to improve import dependence on this commodity

According to Roessali *et al.* [20], the import quantity of soybean in Indonesia during 1986 to 2015 is affected by exchange rate, soybean consumption level, and import tariff. Soybean demand in the domestic market is dominated by imported soybean. Therefore, the higher import tariff, which means the increase price of soybean will make the total demand of soybean in Indonesia become decrease.

2.4 Type and data source

This study used secondary data in the form of time series data for 25 yr, that was for 1994 to 2019. Secondary data were obtained from the Food and Agriculture Organization (FAO) and Central Statistics Agency (*Badan Pusat Statistik* - BPS).

2.5 Data analysis methods

Data analysis methods used in this study consisted of two formula. First**,** to analyze the development of soybean production using trend analysis calculated by computer programme, mathematically formulated as in Equation (1) [30].

$$Y = a + bX \quad (1)$$

Second, to analyze the factors that influence soybean production using multiple regression models, mathematically formulated as in Equation (2) [31].

$$Y = \alpha + \beta 1\ X2 + \beta 2\ X2 + \beta n\ Xn + e \quad (2)$$

3 Results and discussion

3.1 The development (trends) of soybean production in Indonesia

Indonesian soybean production in the period of 1994 to 2019 (Table 1) fluctuated and tended to decrease from 1995 to 1998 with an average decline of 6.77 % yr^{-1}. Then it increased by an average of 26.4 % (1999), decreased again by an average of 11.32 % (2000 to 2003), increased again by 9.76 % (2004 to 2005), decreased again by 25.53 % (2005 to 2007), increased by 16.28 % (2007 to 2009), decreased by 4.87 % (2010 to 2013), increased by 13.9 % (2014 to 2016), decreased by 4.42 % (2017). Finally, there was a rapid increase in soybean production in 2018, the amount was up to 146.07 %, indicated by the total national soybean production of 1 333.744 t and continued to increase in 2019 by 5.34 %.

Increased soybean production in terms of quantity and quality continues to occur through extensification and intensification. So far, fertilization is one of the cultivation techniques that contribute significantly to increasing soybean production. In terms of land productivity during 1994 to 2010, it averaged 1.25 t ha^{-1} and increased by 2.05 t ha^{-1} in 2011 to 2019. Land area in 2011 until 2019 declined drastically, but productivity increased. That was caused by the government's efforts through the intensification program. According to Roessali *et. al.* [20], the relationship between land area and productivity has a dominant effect on the amount of production. The expansion of the area has a greater contribution to the amount of crop production, this result was in line with Liu *et al.*; Purwanto and Weliana [13, 14] that increasing corps yields will increase production corps. Another effort to get high production is by intensification.

Soybean crop productivity can be increased through the introduction of technological innovations. One of the easiest and fastest-spreading technology components is new high yielding varieties (VUB) that have high yields because the contribution of new improved varieties that increase productivity is more easily seen and understood by farmers. One example of soybeans released in 2001 is the Anjasmoro cultivar, which has a large seed size that can grow in rice fields and its production reaches up to 2.5 t ha^{-1}. This cultivar is most often used as raw material for making tofu, tempeh, soy sauce, tauco, and soy milk.

Table 1. Land area, production, and soybean productivity in Indonesia.

Year	Land area (ha)	Production (t)	Production growth (%)	Productivity (t ha^{-1})
1994	1 406.92	1 564 847	7.35	1.11
1995	1 477.432	1 680 010	9.72	1.13
1996	1 273.290	1 517 180	10.59	1.19
1997	1 119.079	1 356 891	3.77	1.21
1998	1 095 070	1 305.640	5.97	1.19
1999	1 151.079	1 382.848	26.4	1.20
2000	825	1 017.634	18.74	1.23
2001	678.848	826.932	18.6	1.22
2002	544.522	673.056	0.22	1.23
2003	526.796	671.6	7.73	1.28
2004	565.155	723.483	11.75	1.28
2005	621.541	808.353	7.65	1.30
2006	580.534	747.611	20.74	1.29
2007	459.116	592.634	30.31	1.29
2008	591.899	776.491	25.63	1.31
2009	722.791	974.512	6.92	1.35
2010	660.823	907.031	6.15	1.37
2011	622.254	851.286	0.96	1.37
2012	567.624	843.153	7.49	1.49
2013	550.793	779.992	22.44	1.42
2014	615.685	954.997	0.86	1.55
2015	613.885	963.183	26.93	1.57
2016	577	860	4.01	1.49
2017	357	542	4.83	1.52
2018	339.92	1 333.744	146.07	3.92
2019	338.84	1 405.660	5.34	4.15

Source: Data center and agricultural information system of ministry of agriculture, 2019

In this study, the trends of soybean production in Indonesia for 1994 to 2019 were divided into two, namely before and since 2010. Analysis of trends before 2010 can be seen in Figure 1.

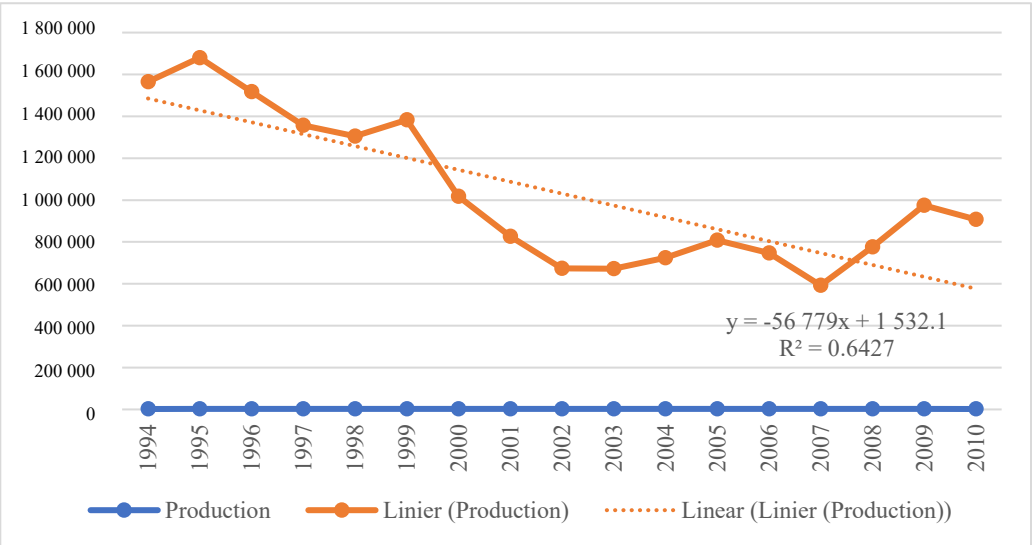

Fig. 1. Indonesian soybean's production trends for 1994 to 2010.

Figure 1 shows that soybean production in Indonesia tends to decrease from year to year, although in certain years some have increased. Nevertheless, the movement of the curve shows a decrease in soybean production. Based on the graph above it can be seen that the total trend of soybean production in Indonesia in 1994 to 2010 has a negative slope which described in the Equation (3).

$$Y = 1\,532.1 - 56\,779x \quad (3)$$

This result means the decline in soybean production during the period of 1994 to 2010 amounted to 56 779 t. This is due to the decreasing area of land for soybean commodities and the lack of government involvement in the process of soybean farming, in this case, there have been no directives from the government to use new improved varieties (VUB) that can increase productivity. The decrease in the soybean area is caused by land conversion from soybeans to horticulture.

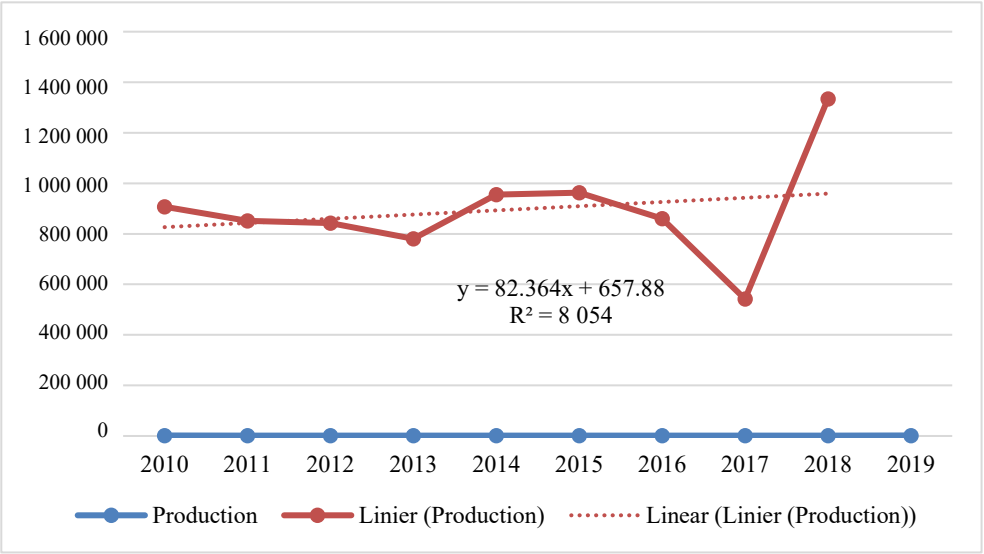

Fig. 2. Indonesian soybean production trends for 2010 to 2019.

Figure 2 shows that soybean production in Indonesia tends to increase from year to year, although in certain years some have decreased. Nevertheless, the movement of the curve shows an increase in soybean production. This is consistent with research Budiharti [32] that shows the production of soybeans would likely increase by 11.18 % annually from 2016 to 2020. Based on the graph above it can be seen that the total trend of soybean production in Indonesia in 2010 to 2019 has a negative slope which described in the Equation (4).

$$Y = 657.88 + 82.364x \quad (4)$$

This means an increase in soybean production during the period of 2010 to 2019 amounted to 82.364 t. This is caused by the application of soybean crop intensification through the introduction of technological innovations. One of the easiest and fastest-spreading technology components is new high yielding varieties (VUB) that can increase land productivity. In addition to the productivity of the land, according to Arnawa *et al.*; Khojely *et al.* [33, 2], adoption of soybean varieties, planting season, farmer age, farmer experience, and access to extension services all have a significant impact on yield.

3.2 Factors that influence soybean production development

Based on the analysis results obtained an R-square value of 0.710, it shows that the total soybean production in Indonesia since 1994 to 2019 is influenced by land area, price, and consumption level of 71 %. Land area, price, and level of consumption simultaneously affect total production with a calculated *F* value of 17.969. The details can be seen in Table 2.

Table 2. Factors that influence soybean production development.

Variable	Coefficient (B)	t	Sig.
Constant	-404.758	-1.773	0.090
X1 (Land area)	0.831	3.945	0.001
X2 (Price)	0.045	1.893	0.072
X3 (Consumption level)	67.417	2.859	0.009
R-square = 0.710			
F_{test} = 17.969	Sig. = 0.000		

Source: Processed primary data, 2020

Table 2 shows that the variables of land area (0.831), price (0.045), and consumption level (67.417) have a significant positive effect on the significance level (α) of 5 % on soybean production in Indonesia. The influence of land area on soybean production was 0.831, it means that if the land area is increased by 1 %, soybean production would increase by 0.83 %. The effect of prices on soybean production by 0.045, it means that if prices are increased by 1 %, production increased by 0.05 %. According to Zainuri *et al.*; Handayani *et al.* [34, 35] the effect on production has an effect on government policy. The effect of consumption levels on soybean production in Indonesia is 67.417, meaning that if the level of consumption is increased by 1 %, the production will increase by 67.42 %. According to Carlson and Garrett [36] the development of production, soybeans are not only studied, but only by price and exchange rates, the development of soybean production is also a negative impact on the environment with a forest burning system for soybean land clearing.

4 Conclusion

Based on the results of the analysis of soybean production trends in Indonesia shows that during 1994 to 2010 decreased and the period of 2010 to 2019 increased. Land area, price, and consumption level factors haves a significant positively effect on soybean production in Indonesia during 1994 to 2019 with a significance level (α) of 5 %. Government intervention is needed in increasing soybean productivity by motivating farmers to use new high yielding varieties (VUB).

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