Determinant Factors of the Agricultural Land Sustainability in Indonesia

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ABSTRACT
Land used for agriculture activities is recognized to have a low rental value compared to land used for industrial and trade sectors. As a result, agricultural land is increasingly under pressure to be converted to non-agricultural land, posing a danger to Indonesia's agricultural land sustainability. This study was conducted to determine the factors that affect agricultural land sustainability in Indonesia. The data used in this study was gathered from the World Bank, FAO, and PWT. The Ordinary Least Square (OLS) model was used to analyze the data. The findings reveal that the agricultural land sustainability in Indonesia is influenced by agriculture, forestry, and fishing value-added, real consumption of households and government, rural population growth, and human capital index.

Keywords: *Agricultural land sustainability, value-added, real consumption, rural population growth, human capital index.*

1. INTRODUCTION

Agriculture is one of the most significant sectors in the Indonesian economy. According to the Indonesian Central Statistics Agency, the agricultural sector would contribute 12.85% of the country's Gross Domestic Product (GDP) in 2020 [1]. This statistic comes in third after the manufacturing and the trade sectors. The agriculture sector's significant contribution to the Indonesian economy demonstrates the importance of the sector's long-term sustainability.

The most critical factor that must be met to increase the agricultural sector's performance and long- term sustainability is the availability of agricultural land. Agricultural land is the essential resource that must be met for various agricultural commodities to be produced. Agricultural commodities support people's lives, ensure food security, and maintain the population's nutritional and energy needs. In addition, agricultural land plays a vital role in tackling pollution and maintaining biodiversity [2–4].

For decades, land resources have been a hotly debated issue. Trade-offs in the usage of land resources lead to the conversion of land uses with low rents to higher rents. Agricultural land is likewise subject to this trade-off. Land used for agricultural purposes has a lower rent value than land used for industrial and trade activities, making converting agricultural land to non-agricultural land more difficult to avoid. This can threaten agricultural land sustainability.

In Indonesia, agricultural land is frequently converted to non-agricultural land quite often occurs in several areas, especially in urban and suburban areas. In Pekalongan City, the conversion of agricultural land to non-agricultural land increased by 1.26% per year on average from 1989 to 2017 [5]. In addition, a study in the Special Region of Yogyakarta found that the agricultural land decreased by 0.48% every year [6]. Furthermore, agricultural land conversion happens in the Sukoharjo Regency at a rate of 0.014% each year on average [7]. Studies conducted on the outskirts of Surakarta City also show that the conversion of agricultural land into residential land (2,916.63 ha), agricultural land into industrial land (450.43 ha), and agricultural land into business and trade areas (31.75 ha) [8]. However, the area of agricultural land outside of Java tends to increase [9–11].

Several studies have been done related to the conversion of agricultural land or agricultural land sustainability. A study in Henan Province, China, showed that agricultural land conversion has a positive relationship with the variables of urban land rent and urban wages [12]. Then, based on research conducted in 25 European Union (EU) countries, it is concluded that the conversion of agricultural land in each EU country will be determined by the soil, climate, and socioeconomic community characteristics [13]. Another study conducted in the Special Region of Yogyakarta showed that the sustainability of agricultural land could be influenced by social factors, including the interest of the younger generation to participate in the agricultural sector [14]. Furthermore, the level of farmers' welfare is also a determining factor for the sustainability of agricultural land [5]. Research in Pekalongan City even shows that the sustainability of agricultural land will depend on environmental conditions, including irrigation channel conditions and irrigation water quality [15].

This research has a high urgency because the sustainability of agricultural land is the main key to maintaining the population's food security. The population tends to increase yearly; if the sustainability of agricultural land cannot be appropriately guaranteed, it can increase the potential for hunger and malnutrition [12] In addition, farmers' welfare tends to be improved if farmers can manage wider agricultural land, so farming activities' economic scale can be fulfilled [16]. Based on that, our study tries to map the causes of agricultural land sustainability at the macro level. The majority of previous research was done at the farmer or micro level. We also use social and economic variables that researchers rarely consider when determining the factors that influence a country's agricultural land sustainability.

2. METHODS

In this study, the sustainability of agricultural land is approached by data on the availability of agricultural land. Therefore, the larger the available agricultural land for farming activities, the higher the level of sustainability. The approach using land availability variables to determine the level of sustainability of agricultural land is motivated by the physical form of agricultural land. It is easy to monitor and detect the dynamics of land-use changes [17]. In addition, agricultural activities are currently dependent on the availability of agricultural land, meaning that if agricultural land is not available, the agricultural sector cannot develop, so its sustainability will be threatened [18].

This study used secondary data from 1983 to 2018. The types and sources of data used in this study are presented in Table 1.

The multiple regression analysis (Equation 1) is used to ascertain the determinant factors of agricultural land sustainability in Indonesia.

Table 1. Types and sources of data in this study

Type	Source
Agricultural land	World Bank
Agriculture, forestry, and fishing value-added	World Bank
Producer rice price	FAO
Real consumption of households and government, at current PPPs	PWT
Rural population growth	PWT
Human capital index	PWT

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu \quad (1)$$

where:

Y = Agricultural land (km2)
X_1 = Agriculture, forestry, and fishing value added (% of GDP)
X_2 = Producer rice price (LCU/tonne)
X_3 = Real consumption of households and government, at current PPPs (in mil. 2017 US$)
X_4 = Rural population growth (%)
X_5 = Human capital index
$\beta_{0\text{-}5}$ = intercept value of variable
μ = error

Several aspects of regression analysis must be considered, including [19]:

1. Adjusted R^2 is a function of the number of explanatory variables or regressors in the model (Equation 2); as the number of regressors increases.

$$R^2 = 1 - \frac{\sum \mu_i^2/(n-k)}{\sum Y_i^2/(n-1)} \quad (2)$$

where:
n = samples
k = parameters

2. Testing the overall significance of the multiple regression (Equation 3): The f-test to test the hypothesis:

   H_0: $\beta_1=\beta_2=\beta_n=0$, all slope coefficients are simultaneously zero.

   H_1: $\beta_1 \neq \beta_2 \neq \beta_n \neq 0$, not all slope coefficients are simultaneously zero.

   Compute:

$$F = \frac{ESS/df}{RSS/df} = \frac{ESS/(k-1)}{RSS/(n-k)} = \frac{R^2/(k-1)}{(1-R^2)/(n-k)} \quad (3)$$

The result of the f-test is rejecting H_0: if fstat < fcalc or p-value < 0.10; the interpretation that all independent variables have a significant impact on the dependent variable.

3. Testing the individual regression coefficients (Equation 4): The t-test to test the hypothesis:

   H_0: β_n=0, the coefficient is simultaneously zero. H_1: $\beta_n \neq 0$, the coefficient is not simultaneously zero.

   Compute:

   $$t = \frac{\beta_n}{se(\beta_n)} \quad (4)$$

   The result of the t-test is rejecting H_0: if tstat < tcalc or p-value < 0.10; the interpretation is the independent variable has a significant impact on the dependent variable.

4. The assumption that the data is normally distributed can be determined by using the Shapiro-Wilk test (Equation 5). The Shapiro-Wilk test hypothesis is as follows:

   H_0: Data is normally distributed.
   H_1: Data is not normally distributed.

   Compute:

   $$W = \frac{(\sum_{i=1}^{n} a_i x_{(i)})^2}{\sum_{i=1}^{n} (x_1 - \bar{x})^2} \quad (5)$$

   The result of the Shapiro-Wilk test is rejecting H_0: if p-value < 0.10; the interpretation is data is not normally distributed, vice versa.

5. The assumption of no collinearity or no multicollinearity if more than one exact linear relationship is involved. Formally, no collinearity means that there exists no set of numbers, λ_1 and λ_2, not both zero such that (Equation 6):

   $$\lambda_1 X_{1i} + \lambda_2 X_{2i} = 0 \quad (6)$$

   The independent variable has a multicollinearity relationship if it has VIF value more than 10.

6. There is no autocorrelation in the disturbances.

   $$cov(u_i, u_j|X_i, X_j) = E\{[u_i - E(u_i)]|X_i\}\{[u_j - E(u_j)]|X_j\}$$
   $$= E(u_i|X_i)(u_j|X_j)$$
   $$= 0 \quad (7)$$

   The Durbin-Watson test (Equation 7) can detect the presence of autocorrelation.

The selection of the model used in this study considers all indicators to determine the best model and the classical assumptions required in using multiple linear regression of the Ordinary Least Square (OLS) model. The analysis results show that the adjusted R2 value has a high value, and the F test has a significant value at the 1 percent alpha level (see Table 2). In addition, the normality, multicollinearity, and autocorrelation tests show that the model meets the classical assumptions, indicating that it can produce a robust estimate (Table 2). Therefore, all of these indicators show that the model used in this study is the best.

3. RESULTS AND DISCUSSION

The standard deviation of agricultural land area in Indonesia is 71,957.59 km^2, with the largest agricultural land area in 2018 and the smallest agricultural land area in 1984. Then agricultural value- added was recorded to have the best performance in 1986, which reached 24.25% of total Indonesian GDP. However, this value had fallen year after year, reaching its lowest point in 2018, when it only accounted for 12.81 percent of the total Indonesian GDP. Furthermore, the price of rice producers in Indonesia highly fluctuates as indicated by the standard deviation value, which reaches 2,989,029.00 LCU/ton. Other variables, namely real consumption of households and government significantly fluctuate. In addition, the rural population growth variable tends to decrease, with the highest population in 1998, then decline to the lowest point of 30.06% in 2016. On the other hand, the human capital index (HCI) variable has relatively increased. The lowest HCI ever reported was in 1983, while the highest was 2.42 in 2010. This indicates that the quality of Indonesia's human resources has improved from 1983 to 2018.

On a macro level, the area of agricultural land in Indonesia tends to increase from year to year. Figure 1 shows the area of agricultural land in Indonesia increases by 6,576.20 km^2 per year. These results can illustrate that agricultural land sustainability in Indonesia can be maintained at a macro level. This increase in agricultural

Table 2. Variables Description

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Agricultural land	36.00	488,118.90	71,957.59	370,520.00	623,000.00
Agriculture, forestry, and fishing value-added	36.00	17.15	3.96	12.81	24.25
Producer rice price	36.00	2,445,092.00	2,989,029.00	145,060.00	9,359,030.00
Real consumption of households and government, at current PPPs	36.00	912,360.60	532,130.60	327,131.40	1,955,348.00
Rural population growth	36.00	45.35	11.13	30.06	89.74
Human capital index	36.00	2.13	0.24	1.64	2.42

land area is supported by implementing the agricultural land extensification program in Indonesia. Agricultural extensification programs are mainly carried out in provinces outside Java Island by implementing various policies, for example, the MIFEE (Merauke Integrated Food and Energy Estate) policy. This policy aims to increase the availability of agricultural land by clearing unproductive land and converting it into agriculturally productive land [9].

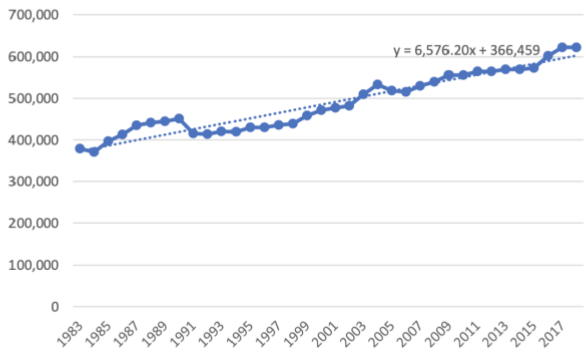

Figure 1. The Development of Agricultural Land in Indonesia (in km^2)

The analysis results using the multiple linear regression method show that the factors that influence the agricultural land sustainability in Indonesia are agriculture, forestry, and fishing value-added, real consumption of households and government, rural population growth, and human capital index. The agriculture, forestry, and fishing value-added variable has a regression coefficient of 6,215,593, which means that increasing the value-added of the agriculture, forestry, and fisheries sectors by 1 percent of Indonesia's GDP can increase the agricultural land 6,215,593 km^2. Value-added is an essential aspect for the agricultural sector. An increase in value-added means that agricultural commodities have a higher economic value. This can benefit the economy and help maintain agricultural land sustainability in the future [20]. In addition, value-added can be increased by providing training that improves farmers' ability to process agricultural products. Furthermore, establishing collaborations between farmers and companies can help to enhance the quality of agricultural products.

The real consumption of households and government variable also shows a positive relationship to agricultural land. This means that the higher level of real consumption, the higher level of the agricultural land sustainability can be well maintained. Real consumption shows the level of demand for agricultural commodities. Higher demand for agricultural commodities can increase production and maintain agricultural land sustainability in Indonesia [21]. The level of real consumption is directly proportional to people's welfare. Therefore, raising real consumption can be accomplished by improving society's welfare in general and the welfare of farmers in particular.

The rural population growth variable has a negative relationship with agricultural land. The higher rural population growth, the lesser of agricultural land in Indonesia. The growing population in rural areas can increase the need for settlements, businesses, and other

Table 3. Determinant Factors of the Agricultural Land Sustainability in Indonesia

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Agriculture, forestry, and fishing value-added	6,215.593**	3,001.477	2.070	0.047
Producer rice price	-0.003	0.003	-0.890	0.382
Real consumption of households and government, at current PPPs	0.088***	0.025	3.480	0.002
Rural population growth	-733.034*	415.959	-1.760	0.088
Human capital index	234,136.900***	52,795.150	4.430	0.000
Cons	-156,614.200	153,128.600	-1.020	0.315
Adj. R^2				0.914
F-statistic				75.750
Prob. F-statistic				0.000
Prob. Shapiro-Wilk				0.925
Mean VIF				1.280
Durbin-Watson statistic				0.597

*** Significant at 1% alpha; ** Significant at 5% alpha; * Significant at 10% alpha activities, resulting in a higher land- use trade-off. Trade-offs force changes in land uses that are considered to have low economic value, such as agricultural land to other uses with high economic value [22,23]. This put more pressure on agricultural land and increases the conversion of agricultural land into non-agricultural land [12,24]. These results show the importance of maintaining the population growth rate in rural areas to maintain agricultural land sustainability. Policies to control population growth have been carried out in Indonesia, including Family Planning (Keluarga Berencana / KB) program.

Furthermore, the HCI variable has a positive relationship to agricultural land. This means that a better HCI value can encourage Indonesia to expand its agricultural land area. Therefore, the HCI has become a significant variable to manage the agricultural sector. The high value of the HCI can bring the agricultural sector into a more productive sector by implementing various innovations and new technologies [25]. This is because human capital refers to a person's level of ability and skill in developing a business, so that higher human capital will encourage higher levels of technology adoption by farmers and encourage farming efficiency [26]. In addition, increasing the HCI can encourage public awareness to maintain agricultural land sustainability and increase the implementation of environmentally friendly agriculture [27].

4. CONCLUSION AND RECOMMENDATION

The agriculture, forestry, and fishing value-added, real consumption of households and government, and human capital index variables have a positive effect on the area of agricultural land in Indonesia, while the rural population growth variable has an opposite effect. This study has produced several key recommendations, including; First, improving human resource competency, particularly among farmers, to increase value-added. Farmers must participate in a variety of training and internship to manage agricultural products. Another activity is to form partnerships between farmers and companies so that various attempts may be made to improve agricultural product quality. Second, controlling rural population growth. Counseling on family planning (KB) is a practical action that can help control the population. Third, promote the development of social welfare, especially for farmers. This will increase real Indonesian consumption. The most common method used by the government is to implement fiscal policy.

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