Towards sustainable Salak Pondoh Sleman (*Salacca edulis* cv Reinw) farming system: a socio-economic perspective

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**Abstract.** Salak Pondoh Sleman (*Salacca edulis* cv Reinw) is a product that has been certified as a geographical indication product. Therefore, maintaining its sustainability is importantly required. This study aims to determine the sustainability status of Salak Pondoh Sleman farming system based on its sustainability index, specifically in a socio-economic perspective. To achieve the goal, the socio-economic factor that influences the sustainability status of Salak Pondoh Sleman farming system was determined. Economic sustainability was assessed based on income, selling price, and farming costs, while social sustainability was reviewed based on the participation of farmers in their group. A structured questionnaire was developed and distributed through a survey in three subdistricts area within Sleman subdistrict, namely Tempel, Turi, and Pakem in 2019. A multi-dimensional scaling for Rapid Assessment Techniques for Salacca (RAP/Salacca) test, a test developed for determining sustainability index based on an influential factor, was performed and revealed that selected attributes contribute to sustainable farming of Salak Pondoh Sleman. The sustainability of Salak Pondoh Sleman farming system is further explained in this study.

1. Introduction

Sleman is one of the potential agricultural regencies in the Special Region of Yogyakarta, with an area of 39,109 hectares [1]. A number of 451,861 (22.00%) people working in the agriculture sector was the second highest percentage compared to other sectors [2]. Production of horticultural crops in Sleman is dominated by Salak Pondoh (*Salacca edulis* cv Reinw), with an average of 98.60% from the total crop’s yield in Sleman [2,3].

Salak Pondoh Sleman (*Salacca edulis* cv Reinw) is a superior variety developed by Sleman Regency as well as the horticultural product with the highest yield in the area [2]. Salak Pondoh Sleman has a dominant role as a source of income and job, especially for its production center area. Moreover, Salak Pondoh Sleman is also claimed to have a distinctive quality characteristic that distinguishes it from similar cultivar in other regions [4]. A related study mentioned that Salak Pondoh Sleman has a sweet-tasted and crunchy texture as well as yellowish fruit, indicated by the high value of notation b* [5]. Therefore, Directorate General of Intellectual Property (DJKI) has granted the Geographical Indication (GI) certificate to the product. The Certificate also indicates that Salak Pondoh Sleman was impossibly found in other regions.

Since GIs certificate has no specific validity period, it will remain active if the certified product can maintain its unique characteristics. In addition, the local government of Sleman Regency has registered Salak Pondoh Sleman as a superior variety. These conditions urge the implementation of its sustainable agricultural practices as an effort to ensure the quality and quantity of Salak Pondoh Sleman, both as a
geographical indication product and a superior agricultural product in Sleman Regency. Indicators that influence the sustainability of Salak Pondoh Sleman plantation, therefore, should be identified as a basis for determining agricultural policy in the future. Therefore, this study aims to determine the sustainability status of Salak Pondoh Sleman farming system based on its sustainability index, specifically in a socio-economic perspective.

2. Methodology
2.1. Respondent
A hundred farmers of Salak Pondoh Sleman was selected and interviewed in May to June 2019 based on the simple random sampling method to obtain their socio-economic profiles. The respondents were located in three subdistricts in Sleman, i.e., Tempel, Turi, and Pakem (figure 1). Considering the registered geographical indication area, as listed in the Geographical Indication Requirement Book of Salak Pondoh Sleman [4], these selected subdistricts were chosen. In addition, the selected three subdistricts were also the cultivation area with the highest yield of Salak Pondoh Sleman [2]. A proportionate random sampling technique was used to determine the number of respondents based on the observed locations (30 respondents from Tempel, 55 respondents from Turi, and 15 respondents from Pakem).

![Figure 1](image_url). Surveyed area of the Salak Pondoh Sleman farmers. The specific location at the village level is shown in the yellow area

2.2. Socio-economic attributes
The attributes of socio-economic dimension of Salak Pondoh Sleman were developed as a results of an in-depth interviews with the Salak Pondoh Sleman stakeholders and local regulator, i.e. officer from Department of Agriculture, Food, and Fisheries Sleman, two extension agents from Agricultural, Food, and Fisheries Extension Unit, as well as the Society for GI Protection Salak Pondoh Sleman (Masyarakat Perlindungan Indikasi Geografis). This study used a closed questionnaire consisting of 16 attributes, eight of which measure the economic dimension, while eight other attributes cover the social dimension. The scoring in the questionnaire was based on the results of field observations, farmers' opinions, as well as literature studies. This study used various score-scales according to the attributes of each dimension, as shown in Table 1. The higher the score, the better the assessed attributes.
Table 1. The semi-quantitative attribute of Salak Pondoh Sleman’s sustainability index

| Code | Attribute | Description |
|------|-----------|-------------|
| **Economic dimension** | | |
| E1   | Revenue   | Based on the percentage of revenue earned from Salak Pondoh Sleman farming system against the total revenue: (0) < 10%; (1) 11 to 25%; (2) 26 to 50%; (3) 51 to 75%; (4) > 75% |
| E2   | Average annual yield | Based on the comparison of farmer yield to the average yield in the district: (0) smaller than; (1) same as; (2) greater than |
| E3   | Production cost | Based on production cost trend in the period of 2015 to 2018: (0) increase; (1) fluctuating with an increasing trend; (2) same as; (3) fluctuating with a decreasing trend; (4) decrease |
| E4   | Selling price | Based on the selling price trend at farmers level in 2015 – 2018: (0) decrease; (1) fluctuating with a decreasing trend; (2) same as; (3) fluctuating with an increasing trend; (4) increase |
| E5   | Farmer exchange rate | Based on the capability and purchasing power of farmers in funding their household lives: (0) Deficit; (1) Break-even; (2) Surplus |
| E6   | Debt to income ratio | Based on the percentage of debt in revenue: (0) > 75%; (1) 51 to 75%; (2) 26 to 50%; (3) 11 to 25%; (4) < 10% |
| E7   | Loan utilization\(^{\dagger}\) | Based on debt utilization for: (0) food; (1) Transportation; (2) Education; (3) Production |
| E8   | Agricultural marketing | Based on the agricultural market system carried out by (0) traders; (1) direct selling; (2) farmers group; (3) cooperatives |
| **Social dimension** | | |
| S1   | Land ownership status | Based on the land ownership status: (0) assets of others; (1) rent/profit sharing; (2) government assets; (3) own assets |
| S2   | Total population | Based on population trend in the last five years: (0) increase; (1) fluctuating with an increasing trend; (2) same as; (3) fluctuating with a decreasing trend; (4) decrease |
| S3   | Education level | Based on farmers’ formal education: (0) not completed in primary school; (1) graduated from elementary school; (2) graduating from junior high school; (3) graduated from high school |
| S4   | Number of agricultural households | Based on the number of farmers’ households relative to the district average: (0) below average; (1) Same as; (2) above average |
| S5   | Conflict | Based on the number of conflicts occurring within a year related to land issues: (0) > 10 times; (1) 6 to 10 times; (2) 1 to 5 times; (3) never |
| S6   | Intensity to follow agricultural counseling/training | Based on the intensity of following agricultural counseling: (0) never; (1) sometimes; (2) always |
| S7   | Farmer’s perception related to GI certification in Salak Pondoh Sleman | Based on farmers’ perceptions related to the importance of GIs certification on Salak Pondoh Sleman: (0) not important; (1) neutral; (2) important |
| S8   | Knowledge and experience of climate change | Based on the knowledge and experience of farmers on the effects of climate change on land: (0) positive effect; (1) neutral/unaffected; (2) negative effect |

\(^{\dagger}\)Applied if the farmer has debt/loan

2.3. **RAPSalacca**

The sustainability analysis of Salak Pondoh Sleman farming system was done by multidimensional scaling (MDS) approach, named as RAPSalacca (Rapid Appraisal for Salacca zalacca cv Reinw). RAPSalacca was a modified RAPfish (Rapid assessment Techniques for fisheries) test, a test for analyzing the fisheries sustainability, developed by Fisheries Center, University of British Columbia \([6,7]\). MDS was used to determine the sustainability status of Salak Pondoh Sleman, both at uni- and multi-dimensional levels, which were stated in the scale of sustainability index (Table 2).
Table 2. Sustainability status category of Salak Pondoh Sleman based on MDS analysis
(RAPSalacca)

| Index Value       | Category               |
|-------------------|------------------------|
| 0.00 to 25.00     | Poor (unsustainable)   |
| 25.01 to 50.00    | Less (less sustainable)|
| 50.01 to 75.00    | Fair (fairly sustainable) |
| 75.01 to 100      | Good (sustainable)     |

2.4. Performance and evaluation

Leverage analysis, Monte Carlo analysis, stress value determination, and coefficient of determination (R²) were statistically used in the performance and evaluation stage [7]. Leverage illustrates the sensitivity to determine the sensitive contributed attributes. Considering the priority order in the leverage analysis, a determined sensitive attribute was done by its root mean square (RMS). The greater the change in the value of RMS, the greater the role of the attribute in improving sustainability status.

Data consistency was checked by comparing the value of each dimension to the averaged Monte Carlo value, an analysis tool to evaluate the effects of random errors in the estimated ordination of each attributes in each dimension at a 95% confidence interval. The stability of these values can be determined from the difference between the average iteration value of Monte Carlo with MDS value, which is indicated stable if > 1 [6]. In addition, stress value and R² shows the performance level analyses. The stress value below 0.25 indicates a good analysis, while the R² value of 1 (100%) indicates that the selected attribute can represent the current state until close to 100% [7]. Analysis in this study showed excellent performance (Table 3).

3. Results and Discussion

RAPSalacca and leverage analysis, in this research, was conducted for measuring the sustainability index of each dimension and determine the sensitive attributes that affect the sustainability of Salak Pondoh farming system.

Table 3. Performance and analysis of MDS in determining the sustainability index of Salak Pondoh Sleman

| Economic Dimension | Social Dimension | Sustainability Index of Salak Pondoh Sleman |
|--------------------|------------------|---------------------------------------------|
| Sleman             | Tempel           | Turi                                        |
| Pakem              | Sleman           | Tempel                                     |
| Pakem              | Pakem            |                                             |
| Mds                | 65.25            | 70.74                                      |
| Stress             | 0.14             | 0.14                                       |
| R²                 | 0.95             | 0.95                                       |
|                      |                  |                                             |
| Average            | 63.88            | 69.12                                      |
| Difference with MDS| 1.37             | 1.62                                       |

*) Calculated by selected sensitive attributes from the economic and social dimension

3.1. Economic dimension

The result of economic dimension analysis to the sustainability index of Salak Pondoh Sleman farming system has shown an index of 65.25. The results of the analysis at the sub-district level showed that Pakem had the smallest sustainability index (61.69), while Tempel and Turi had the sustainability index of 70.74 and 69.65, respectively. The figures illustrated that the economic dimension in the farm of Salak Pondoh Sleman fell to a fairly sustainable category. Results also showed that Pakem was economically unsustainable, indicated by the smallest sustainability index in Sleman Regency.

The results of leverage analysis (figure 2) denote E4, the selling price, as the most sensitive attribute that influenced Salak Pondoh Sleman farming system. Selling price at farmer level is influenced...
by supply (product availability) and demand (market demand) [8]. Product availability is very dependent on the harvest season. In a year, Salak Pondoh Sleman was harvested three times, i.e., main harvest (November to January), small harvest (February to April), and moderate harvest periods (May to July). The lowest price will generally occur during the main harvest period, reached less than IDR 3,000 per kg in December 2018. Low levels of consumption (demand) on a product will impact the low price of the product [8], [9]. The price will be lower during harvest season due to high supply in the market. The characteristic of Salak Pondoh Sleman as an agricultural product, which is perishable, weakens the farmer's bargaining position. Farmers will be urged to sell the product for a certain period [10], [11] to avoid the risk of deterioration.

The production cost, E3, was the second sensitive attribute that affects Salak Pondoh Sleman farming system. Other attributes, Farmer's exchange rate (E5), loan Amount (E6), and loan utilization were the other sensitive attributes that affect the sustainability of Salak Pondoh Sleman farming (Figure 2a).

3.2. Social dimension

A high index value was obtained (90.38) as a result of the social dimension analysis in Sleman Regency. The analysis results at the sub-district level showed that Tempel had the highest sustainability index (90.54), while Turi and Pakem had the sustainability index of 90.31 and 90.32, respectively. The value denoted that Salak Pondoh Sleman farming was categorized as very sustainable in the social dimension.

The results of the leverage analysis (Figure 2b) indicated that knowledge and experience to climate change (S8) was the most sensitive attribute that influences the sustainability of Salak Pondoh Sleman farming system. Agricultural sustainability was inherently associated with humans and climate, particularly in human response to climate change as well as the impact of climate change on crops [12]. Climate change has also impacted the success of agricultural cultivation, especially in the growth, development, and production of horticultural commodities [13]. Lack of knowledge about climate change and its impact on agriculture, including Salak Pondoh Sleman, was an opposite effort to implement the long-term agricultural sustainability strategy [14].

The land ownership status (S1) was the second sensitive attribute that affects Salak Pondoh Sleman farming system. Furthermore, the intensity to follow agricultural counseling/training (S6), the number of agricultural households (S4), and the education level (S3) were observed as another sensitive attribute that affects the sustainability of Salak Pondoh Sleman farming system (Figure 2b).

Figure 2. Leverage analysis on the sustainability index of Salak Pondoh Sleman: (a) Economic dimension; (b) Social dimension
3.3. The Salak Pondoh Sleman farming system sustainability

The sustainability index of Salak Pondoh Sleman farming system was determined by a combination of attributes on both social and economic dimensions, which were sorted based on the leverage value. Eight sensitive attributes (six economic dimension attributes and two social dimension attributes) were selected based on leverage analysis results (Figure 2), with a value exceeding 0.69 (Figure 3). Results showed that the socio-economic sustainability index of the Salak Pondoh Sleman farming system was 72.78, indicates a fairly sustainable category. In order to improve its sustainability index, economic aspects, therefore, need to be prioritized, particularly on the sensitive attributes mentioned in this study. The existing condition shows a trend of the declined selling price at the farmers level, mostly during the main harvest season.

![Figure 3. Leverage analysis on the sustainability index of Salak Pondoh Sleman](image)

As an effort to increase the welfare, the Government of Sleman Regency seeks to expand the market to the international level. One of the activities was carried out by the Asosiasi Petani Salak Pondoh Sleman, a farmer groups association consisting of farmers originating from Tempel, Turi, and Pakem, which accommodates and connects farmers to exporters. To attain the international market, farmers are required to register their land to the Department of Agriculture, Food, and Fisheries Sleman. The policy was carried out to elicit the traceability requirement along with various inherent quality attributes of imported products. After being registered, farmers are entitled to a special certificate. However, only around 20% of the farmer groups in the observed area had the certificate. The low number is caused not only by the high standard of export quality but also due to the reluctance of farmers to fulfill administrative requirements. Current conditions indicate the low awareness of farmers to fulfill the requirements, for instance, recording management information on the preparation, cultivation, to harvest stages.

4. Conclusion

The sustainability level of Salak Pondoh Sleman farming system based on the sustainability index of the socio-economy dimension in Sleman Regency was categorized fairly sustainable. This result indicates that the current farming system was economically profitable and socially acceptable to the community. The results also show that the economy was the dominant dimension in determining the sustainability of Pondoh Sleman Salak farming system compared to the social dimension. However, the economic sustainability index in this study has a lower value than the social dimension. The combined analysis of the socio-economy dimension resulted in five sensitive factors influencing the sustainability of farming including selling price (E4), production cost (E3), debt to income ratio (E6), the farmer exchange rate (E5), and debt utilization (E7).
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