Economic dimension of the sustainable rice availability in Indonesia

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Abstract. Rice is a staple food and a source of income for some Indonesians living in rural areas as farmers. The disturbance of rice availability, caused by crop and distribution failure, can result in significant shortages and increased rice prices in a short time. This often leads to social problems developing into multidimensional crisis which can threaten the national stability and disturb the unity of Indonesia’s territory. This research was conducted in West Kalimantan, with the aims to analyse sustainability of rice availability in West Kalimantan based on sustainability index of economic dimension and any dominant leveraging attributes which support the sustainability with Rap-Rice method using Multidimensional Scaling (MDS). Data used primary and secondary data. The results of the analysis indicate that the index of sustainability of rice in West Kalimantan category is relatively sustainable with a value of 50.57%. The attributes that become factor of continuous leverage are farmers’ accepted grain prices (2.85%), availability of production facilities (2.57%), government subsidy (2.45%) and farmers’ bargaining position in crop sales.

1. Introduction
Rice is one of staple foods which is particularly important for Indonesian people [1][2][3]. According to FAO [4] more than 90% of people in Asia region have rice as staple food, and 140 million people have it as the main livelihood source. The dependence on rice of Indonesian people makes Indonesia the largest rice producer and consumer in the world. Rice is not only the main food for most of the people, but it is also a commodity with economic, cultural, environmental, social and political strategic values [5][6], as the country source of income farmer’s [7][8] and foreign exchange [9][10]. The considerable amount of rice produced through time influences the national sustainability of food security. Rice self-sufficiency is essential to the sustainability of food security [11]. The volatile rice prices are potentially triggering national riot. For regions in Indonesia-Malaysia border area such as West Kalimantan, food security is highly crucial and sensitive. The decreased rice production, caused by crop and distribution failure, can result in significant shortages and increased rice prices in a short time. The high price of food indicated the scarcity of food [12]. This often leads to social problems.
developing into multidimensional crisis which can threaten the national stability and disturb the unity of Indonesia’s territory.

The livelihood of most of the people living in the border area still depends on the agricultural sector. Consequently, the sector remains essential and strategic for the economic development in West Kalimantan. Based on the Central Bureau of Statistics of West Kalimantan, in 2017 agricultural sector contributed 20.30% in Gross Regional Domestic Product (GRDP) of the province which provides employment for 1,112,674 people and produces rice for 4,861,738 people.

In the recent years, the fulfillment of rice production in West Kalimantan can be supported by domestic product despite the increasing number of imported rice from outside areas every year. The limited sources of land and water, land conversion, decreased rice production, and decreasing farmer availability become a challenge to reach independence and sustainable food security. This is reflected in the period of 2011-2015 on which the rice production tended to decrease by 9.35%, from 1,372,989 tons in 2011 to 1,244,484 tons in 2015.

From the economic point of view, the decreased rice production will lead to the decreased income and welfare of poor farmer; it will also reduce the farmers’ interest to grow rice. The farmers’ income and welfare are influenced by the production, price, rice sales, credit access, stock, trade, and price policy [4][8], infrastructure and government policy supporting the rice production dynamics in Indonesia [1]; expected output price and wage rate influence the width of paddy land [9][13].

The result of agricultural censuses of the Central Bureau of Statistics of West Kalimantan in 2013 shows that total input cost per growing period per hectare of land was 7.6 million rupiahs while its production value was 8.2 million rupiahs. The gap, 600,000 rupiahs, is the farmers’ income. The amount is considered low, compared to the regional minimum wage rate of West Kalimantan which was 1.56 million rupiahs per month. This made the farmers switch to other fields of work. For about a decade, from 2003 to 2013, there was a decrease of 1.26% of people cultivating paddy. Many farmers switched to either rubber or palm oil plantation which offers higher income sources; small farmers and farm operators preferred to have another work which enables them to earn more money. The poor condition which lasts for a long term can reduce the national rice production and the sustainable food security level [14]. The willingness of the farmers to convert their farming land to plantation land was caused by the promising high income of plantation sector. If the problem is not immediately solved, it will be worse in the future; it can influence the sustainability of independent rice production in West Kalimantan.

This research aims to study the status of sustainable rice production based on the economic dimension and any dominant leveraging attributes which support the sustainability of rice production in West Kalimantan. The result is expected to contribute to the regional government for the policy arrangement in the future by considering sensitive factors to keep the independent rice production in the province.

2. Materials and Methods

This research conducted in 4 districts of West Kalimantan Province comprising Kubu Raya, Ketapang, Bengkayang and Landak which are the center of rice farming area.

The data used in this study include primary and secondary data which represent 19 attributes of economic dimension supporting the sustainable rice production in West Kalimantan. The attributes involve: (1) rice production; (2) availability of capital; (3) profit from rice farming; (4) average farmers’ income compared to total household income; (5) average farmers’ income compared to regional minimum wage of the province; (6) farmers’ bargaining position in crop sales; (7) government subsidy / assistance; (8) farmers’ accepted grain prices; (9) retail rice prices; (10) rice seed prices; (11) fertilizer prices; (12) agricultural drug prices; (13) availability of production facilities; (14) land area mastery; (15) economic efficiency; (16) farmers exchange rate; (17) number of farm household; (18) Gross Regional Domestic Product (GRDP) of the province; and (19) poor population percentage. The primary data were obtained through questionnaires distribution to 144
farmers and interviews with merchants, consumers, related institutions, and practitioners including researchers and academicians. The secondary data, which are time series, were obtained from various reports and documents provided by the Central Bureau of Statistics, Department of Agriculture and Horticulture, Department of Industry and Trade, Food Security and Guidance Agency, and Logistics Bureau of West Kalimantan.

To find the condition and status of sustainable rice production in West Kalimantan, based on the economic dimension, MDS (Multidimensional Scaling) Rap-Rice Eco Kalbar, modified from RAPFISH, was used. This method is commonly used to determine the sustainability index and status of various dimensions of research objects.

The ordination analysis of Rap-Rice Eco Kalbar was performed through some stages which are: Determination of the economic dimension attributes on sustainable rice availability in West Kalimantan; Pairwise comparison using ordinal scale. It is from bad value to good value or vice versa, depending on its impact on the sustainability and its influence in determining the Anchor scores that functions as control cycle and element for calculating the MDS stress value of regression analysis.

Standardization of each variable score for homogenous weight and eliminated gap of each measurement scale [15], based on the following method:

\[
X_{ik}^{sd} = \frac{x_{ik} - x_k}{s_k}
\]  

Where \(X_{ik}^{sd}\) is standard score of areas, including the reference points to \(i = 1,2,..,n\), of each variable to \(k = 1,2,..,p\), \(x_{ik}\) is initial score of areas, including the reference points to \(i = 1,2,..,n\) of each variable to \(k = 1,2,..,p\), \(x_k\) is md score of each variable to \(k = 1,2,..,p\) and \(k\) is variable.

The distance of each area, including the reference points was calculated using Euclidian Distances method with dimension \(n\), formulated as follow:

\[
d^2_{ij} = \sum (X_{ik} - X_{jk})^2
\]  

Ordination creation for all variables based on the algorithm analysis of MDS for obtaining two variable dimensions which are X axis and Y axis resulting in \(V(n \times 2)\) matrix, on which \(n\) refers to number of observed areas including the reference points. The distance of each objects was recalculated using Euclidian Distances regression (\(d_{ij}\)) with initial point (\(d_{ij}\)) based on the following equation:

\[
\hat{d}_{ij} = a + \beta d_{ij} + \epsilon
\]  

Where \(\hat{d}_{ij}\) is expected value of \(d_{ij}\) on regression line.

Calculation of S-stress value [16] based the following equation:

\[
L\hat{d}_{ij} = \left(\frac{\sum_{i<j} \left(\hat{d}_{ij} - f(d_{ij})\right)^2}{\sum \hat{d}_{ij}^2}\right)^{\frac{1}{2}}
\]  

and the metric MDS minimizes \(L\hat{d}_{ij}\) over all \(\hat{d}_{ij}\) and \(a, \beta\).

The goodness of fit in MDS is seen from the value of S-Stress and R2, low S-Stress referring to good fit and vice versa in which \(S < 0.25\) indicates good model in RAPFISH approach, good value of \(R2\) close to 1.

Assessment of the sustainability index and status of rice production based on the economic dimension; the value of sustainability index of each dimension stated from bad (0%) to good (100%); the index and value categorized into four types: 00.00 % - 25.01% for bad or unsustainable, 25.01% -
50.00% for less sustainable, 50.01% - 75.00% for relatively sustainable, and 75.01% - 100% good or highly sustainable.

Leverage analysis to determine the variables that are sensitively influencing the sustainability; the analysis result expressed in terms of Root Mean Square (RMS) percentage of each attribute; the highest percentage value indicating the sensitively influencing attributes [17][18].

Evaluation of the random error effects on all variables during the calculation process of ordination value using Monte Carlo analysis; aiming to see the effects of errors in attribute scores, various scores, wrong data entry, data lost, high stress value, and repeated stability process of MDS analysis process.

3. Results

Based on the ordination analysis result of economic dimension of the sustainable rice production in West Kalimantan using Rap-Rice Eco Kalbar of the 19 influencing attributes, the value of sustainability index is 50.57%, relatively sustainable (figure 1); it means that today’s economic condition reasonably supports the sustainability of rice production in West Kalimantan.

![Figure 1](image.png)

Figure 1. The index value of economic dimension of sustainable rice availability in West Kalimantan

The result also indicates reveals that the stress value is 0.1285 and R2 value is 0.96% (Table 1). The stress value which is less than 0.25 indicates that the analysis result is considered good enough. The R2 value shows that the used variables in the model can describe the 96% system of sustainable rice production in West Kalimantan. Consequently, it is concluded that the resulted analysis model of MDS is accurate and sufficient to estimate the economic dimension of sustainability of rice production in West Kalimantan. To see the validity of MDS analysis, Monte Carlo analysis was performed (Table 1).

| Table 1. Stress value and determination coefficient (R²), and economic dimension of sustainable rice availability in West Kalimantan |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| MDS             | Monte Carlo (MC)| Difference (MDS-MC) | Stress Value | R²        |
| 50.57           | 50.47           | 0.12             | 0.1285        | 0.96      |

Table 1 shows the small difference (<5%) between the MDS index value and Monte Carlo analysis; this indicates that the MDS method used to determine the sustainability index of rice production in West Kalimantan has a high level of confidence. This suggests that: a) the effect of making errors and
scoring variations is very small; b) data query error is very small; c) procedural errors that may affect the stability of the MDS process are relatively small.

Based on leverage analysis, the attributes sensitively influencing the sustainability of rice production in West Kalimantan are shown by those with the highest percentage of RMS; they are farmers’ accepted grain prices (2.85%), availability of production facilities (2.57%), government subsidy (2.45%) and farmers’ bargaining position in crop sales (2.24) (Figure 2).

**Figure 2.** Leverage analysis score (root mean squared /RMS)

4. Discussion

Based on leverage analysis, there are several important leverage attributes that need to get government and community attention on support of sustainable rice production in West Kalimantan, they are farmers’ accepted grain prices, availability of production facilities, government subsidy and farmers’ bargaining position in crop sales.

The farmers’ accepted rice price is one of the attributes sensitively influencing the sustainability of rice production in West Kalimantan. It is an important factor which can contribute to the farmers for increasing their productivity and rice production through the improvement of the farmers’ income. When the research was conducted, the rice price was relatively higher than the standard buying price stipulated by the government referring to the Presidential Instruction of the Republic of Indonesia No.5/2015 on the Procurement of Rice and Distribution of Rice by the Government.

The farmers’ accepted rice price was from 4,000 rupiahs to 4,200 rupiahs per kilogram while the standard buying price was 3,700 rupiahs per kilogram. The farmers expected for higher price due to the continuous improving input prices including rice seeds, fertilizers, pesticides, and manpower wages. The cost of rice production in Indonesia was 4,079 rupiahs per kilogram while it was only 1,679 rupiahs per kilogram in Vietnam; the cost of rice production in Indonesia was 2.5 higher than of in Vietnam [19]. The policy of 10% and 15% raise of the standard buying price by the government would improve the domestic rice production and rice surplus while the policy of 10% and 15% raise of
the highest retail NPK fertilizer prices had negative impacts on the domestic rice production; this disfavored the farmers but favored the fertilizer producers [20]. The higher raise of selling price could increase the profit for the farmers although the production cost increased doubly due to the high fertilizer price [21].

Another attribute which is sensitively influencing the sustainability of rice production is the availability of production facilities for improving the rice production. It includes fertilizers, certified superior seeds, and drugs for pest and disease control. The availability of production facilities which is adequate, timely and inexpensive is needed by the farmers to improve the rice production. The use of fertilizer, seeds, and pesticides has a significant effect on rice production [22]-[23]. One percent increase in fertilizer application could increase paddy output by 0.21-0.25 percent in dry season [21], the use of appropriate and balanced fertilizers is one of the important factors in improving both quality and quantity of crops [24].

Another attribute, either financial assistance or subsidy from the government, is considerably needed by the farmers since there are more poor farmers and have limited capital. The fertilizer subsidy does give impact to the paddy and rice industry in Malaysia, through increasing rice yields [25]. Whereas, agricultural subsidy is more highly related to the farmers’ lives in India [26]. The distribution of direct assistance of superior seeds and the direct assistance of fertilizers, given simultaneously, could increase the rice productivity to 22.7% [27].

Based on the result of agricultural censuses of West Kalimantan in 2014, 26.70% farm household accepted financial assistance, either grants or subsidies, for rice cultivation for a year; the financial assistance was given either by the government, non-governmental institutions, or personals. In the following year was it expected that more farmers receive the financial assistance for farming.

Subsidies of production infrastructure input such as subsidy of fertilizer prices and superior seeds, were considerably helpful for the farmers to achieve rice self-sufficiency. The program of subsidized fertilizers allocated for the farmers based on Definitive Plan for Group Needs includes urea fertilizer, NPK, SP 36 and ZA. To get the subsidized fertilizers, the farmers are supposed to pay at the amount of the highest retail prices stipulated by the government stated in the Regulation of Minister of Agriculture of the Republic of Indonesia No. 130/Permentan/SR.130/11/2014 on demand and the highest retail price of fertilizers. The prices are considered lower than of the unsubsidized fertilizers (Table 2). The use of subsidized fertilizers increased due to the increasing prices of agricultural commodity, the higher use of fertilizer dose and the earlier growing season.

Another influencing attribute is the farmers’ bargaining position in crop sales. The previous researches [28][29] proposed that the bargaining position is a key in farming. However, in the observed area of this research, the farmers’ bargaining position was weak. The selling prices of both grain and rice are mostly determined by the traders.

| No | Kinds of Fertilizers | Subsidized Prices (IDR/Kg) | Unsubsidized Prices (IDR/Kg) |
|----|----------------------|----------------------------|-----------------------------|
| 1  | Urea                 | 1,800                      | 4,950                       |
| 2  | ZA                   | 1,400                      | 3,400                       |
| 3  | NPK                  | 2,300                      | 4,900                       |
| 4  | SP-36                | 2,000                      | 5,750                       |
| 5  | Organic              | 500                        | 2,500                       |

Source: Department of Agriculture and Horticulture in West Kalimantan, 2017.

Most of the farmers in the area are small farmers whose cultivation field is less than 1 ha; farming is their main source of income. The farmers need cash income to fulfill their family needs, to buy production infrastructure to restart the farming, or to pay the debt of the previous growing period.
Consequently, the farmers accepted any prices of the rice determined by the traders. Based on the interview results, there were some farmers who borrowed money from either collectors or rice mill owners to fulfill their family needs or to buy production infrastructure at the next growing period; the payment was at the harvest time thus they directly sold the crops to the collectors or the rice mill owners at the current price or even lower price. The lack of accurate information on prices in the market [30], the bad infrastructure, the limited marketing facilities, insufficient loans and updated market information [29] and the minimum farmer organization [31] let the farmers accepted any prices of the rice determined by the collectors. The weak farmers’ bargaining position in crop sales resulted in unassured farmers’ welfare. The low welfare resulted in the loss of farmers’ intensive for reproduction so that the production level could directly harm the food availability.

To anticipate the low selling prices at the harvest period, some of the farmers in the research area chose to save their crops first and sold the crops when the price increased. Some of farmers save their crops for family consumption in the following year. This occurred due to the high difference of the grain and rice prices in the farm level and in retail level. The prices of grain and rice in the farm level were from 4,000 rupiahs to 4,200 rupiahs and from 8,000 rupiahs to 9,000 rupiahs respectively, depends on the rice condition; in the retail level, the rice price was from 10,000 rupiahs to 13,000 rupiahs. Consequently, the farmers spent more money to fulfill their family needs of rice consumption. The increase of rice price in the market un-proportionally influenced the increase of grain price in the farm level. If the rice price increased by 100%, the grain price would increase by 33 %; the other 67% was taken by the traders [32].

Besides, some policies by the government are needed to strengthen the farmers’ bargaining position in crop sales. The policies involve the delivery of market information specifically that is related to the most updated price to farmer community [30], development, and empowerment and reinforcement of farming organization [31].

5. Conclusion
The index value of economic dimension of sustainable rice production in West Kalimantan is 50.57%, relatively sustainable. The attributes that are sensitively influencing the sustainability involve the farmers’ accepted rice prices, the production infrastructure availability, the subsidy, and the farmers’ bargaining position in crop sales.

Acknowledgments
The Authors would like to thank the Ministry of Research, Technology and Higher Education of the Republic of Indonesia for financial support of this research.

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