Sustainability of Corn Farming Systems on Post-Sand Mining Land in Malang, East Java, Indonesia

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ABSTRACT

The sand mining activities leave a wide area ex-sand mining land. In Bambang Village, farmers who live in that area try to get their land back to produce agricultural activities that were used previously for sand mining. However, there are several obstacles to the sustainability of farming in this area, especially the matter of critical land issues, pest and disease attacks, unpredictability of price, and technology used still not optimized suboptimal use of technology. To analyze the sustainability index and the attributes that influence continuity of corn farming on post-mine sand land, a quantitative study was conducted used a five-dimension sustainability approach. This approach included the consist of ecological, economic, social, institutional, and technological dimensions. Data collected by distributing questionnaires to the respondents which are divided into 72 of farmers and five key informants, so that, total of respondents are 77 people. Multidimensional Scaling (MDS) and leverage analysis were used to determine the attributes that influence sustainability. The results of the research show corn farming continuity on post-sand mining land produce a sustainability index for about 54.86%. It is considered quite able to maintain in terms of the economic dimension (62.12%), social dimension (60.82%), and institutional dimension (60.27%). Though, the ecological dimension (46.88%) and technological dimension (44.23%) were classified as weak in terms of sustainability. Additionally, leverage analysis shows about 25 sensitive attributes which is influenced the sustainability of corn farming on post-sand mining land.

Keywords: sand mining; farming; corn; sustainability; multidimensional scaling (MDS)

How to cite:


1. Introduction

Sand mining is part of non-logam mining business activities aim to produce any minerals and another similar product. Another definition of sand mining is the excavation under the surface of the land whether on the land or underground river flow with the intention to restore of non-metallic mineral (sand) which has an economic significance (Nur Fatulloh, 2019). According to Sonna, et al. (2022) and Green (2012), Sand mining involves exploration and excavation beneath surface of the land, both of them are on land and under the riverbeds. Mining sand activity do the opening layer closing land, excavation mining materials, and to transportation activity (Anto, 2008). Madyise (2013) and (2021) also stated that sand mining activities include a series of stages, starting from clearing the ground cover, continue to extract mining materials, and end up with carriage the sand. All the processes are interconnected. Sustainability management of sand mining operations is critical to mitigate the potential to environmental aspect and social impacts.

An Intensive sand mining has caused various extremely serious problems, especially for
environmental damage such as the changes in land function and loss of fertile topsoil as a result of infertile or critical land. (Department of Food Crops Agriculture 2011). Ali (2020) also stated that critical land is an area that experiences physical, chemical, and biological damage due to unsuitable use and potential. This might be cause of hydrological damage, and urological functions, agricultural production, settlements, social life, economic, and environmental life.

According to the potential data in Wajak district of Malang Regency, is geographically located around 4 villages are located on a-slope and the rest are living on the mainland which their topography classified as hills and the mainland. Bambang Village has land area approximately 1.761 ha. Bambang Village also has critical area cultivation area since there are many people are involved in sand mining activities and those activities already occurred since 1969. According to Hayati (2018), a critical land in cultivation area in Wajak District is caused mining activities of mineral substance C (sand) which been conducted in part of their side job besides farming activity. The final report stated by Suhartini (2017), that mining sand in Subdistrict Wajak potentially becomes landslide vulnerable area for those who living around the mine area. The result of mining activities shows that sand mining activities isn't development priority for the community and village apparatus. Sand mining activities leave behind wide ex-sand mining land. Therefore, the farmer community in Bambang Village who live in that area try to get their land back to produce agricultural activities that were used previously for sand mining. The former sand mining land is being reused for agricultural activities, specifically for cultivating corn farming because it becomes a superior commodity in Bambang Village.

Agriculture sustainability is defined as a business that utilizes resources optimally while conserving them. It produces optimal harvest products using a certain medium and reasonable cost, being able to fulfill social, economic, and environmental sustainability criteria. It is also using a renewable medium production and resources all time (Rachmawatie et al., 2020). Several dimensions, such as ecology, economics, social, technological, and institutional aspects, need to be seen further because of their influence. The ecology, economics, social, technology and institutional aspects are dimensions need to be seen for further influence. These dimensions could be served as a reference for formulating agricultural management policies in that area (Nababan et al., 2007).

Thus, based on the background behind the important of that study, it aims to give an overview and support the efforts regarding agricultural sustainability, especially for corn farming on post-sand mining land based on 5 aspects of sustainability (Suyitman et al., 2009), those are: ecological, economic, socio-cultural, technological and institutional aspects. In addition, hopefully this research become a determining factor continuity the development of extensification agricultural food land in Village Bambang, Wajak District, Malang Regency in the future.

2. Theoretical Underpinning

Mining is a technological and business activity related to the mining industry including prospecting, exploration, evaluation, mining, processing, refining, transportation, to marketing activities. Mining activities, according to Law Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining, is part or all of the stages of activities in the context of research, management and exploitation of minerals or coal which includes general investigations, exploration, feasibility studies, construction, mining, processing and refining, transportation and sales, as well as post-mining activities.

Based on the Decree of the Director General of Reforestation and Land Rehabilitation No.41/Kpts/V/1998, critical land is an area which experienced damage so its function has been lost or reduced to a specified or expected limit. Critical land defined as land that was originally best for agriculture activities but became unsuitable after many activities occurred on that land. Critical land could also be viewed from the other aspects, such as an area having vegetation cover less than 25%, the topography land about less than (>45%) which could be affected erosion or gully erosion.

Land utilization is made to help human being fill their needs yet it required further processing. Thus, making policy and decision need to arrange land-use policy. The definition of land use according to Nugraha, Setya (2007), "Land use is every form of human intervention (interference) on land in order to fulfill their needs, both material and spiritual aspects”.

Corn (Zea mays) is a cereal plant originating from the American specifically Mexico. This grass plant with monocot seed type. In Indonesia, corn is used for animal feed, basic ingredients for food
and beverage industry, flour, oil, etc. Corn plants are starting to be intensively planted in the context of food self-sufficiency in Indonesia (Wulandari and Lalu. 2019).

Sustainability is an important pillar of development system. As mobilized by the United Nations (UN) with the formation of the global sustainability concept on Sustainable Development Goals (SDGs) in 2030. In the agricultural sector or referred to the 17 Sustainable Development Goals (SDGs). SDGs is a long-term world program which is made to optimize all the potential and resources possessed by each country, one of them is Indonesia. The 17 goals must be achieved are eliminating hunger, achieving food security and good nutrition, and improving sustainable agriculture (Irhamsyah, 2019).

3. Research methods

This research is used quantitative approach. Quantitative research is used to obtain data based-on numbers through survey methods and direct interviews with selected respondents with research instruments in the form of questionnaires. This research was conducted in Bambang Village, Wajak District, Malang Regency. The location is selected purposively with the consideration an area that had land for corn farming on post-sand mining land. This research was conducted in October until November 2022. There were 77 respondents consist of 72 farmers and five key informants of agricultural extension workers, village leader, and leader of farmer groups.

In this research, sustainability analysis was carried out on five dimensions, for each of them is containing of 5 attributes and analyzed it using the method of multidimensional scaling (MDS) with the RapFarm software (Rapid Appraisal for Farming) which have been modified from the program RapFish (Rapid Appraisal for Fisheries) developed by the Fisheries Center, University of British Columbia (Kavanagh and Pitcher, 2004). This RapFarm analysis produces a sustainability index value of the system being studied. This analysis also aims to analyze how far the sustainability status of each dimension has been researched.

The sustainability index of corn farming on post-sand mining land using RapFarm technique is determined systematically. This is performed based on the stages determined by Nababan et al. (2008) which are as follows: 1) Reviewing the attributes on every dimension of continuity and defining these attributes through field observations and literature review. 2) Scoring based on the results of field observations. Scores range is started from 1 up to 5 which is interpreted as ranging from bad to good depends on the condition for each attribute. 3) Analyzing the score using the MDS program in R software to determine the position of the sustainability status of corn farming on post-mining land in each dimension stated in the scale index continuity. The index values and sustainability status categories can be seen in Table 1 below:

<table>
<thead>
<tr>
<th>Index Value</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-25.00</td>
<td>Bad (unsustainable)</td>
</tr>
<tr>
<td>25.01-50.00</td>
<td>Less (less sustainable)</td>
</tr>
<tr>
<td>50.01-75.00</td>
<td>Sufficient (sustainable enough)</td>
</tr>
<tr>
<td>75.01-100.00</td>
<td>Good (very sustainable)</td>
</tr>
</tbody>
</table>


4. Results and Discussion

4.1. Sustainability Analysis

The results of the Rapfarm sustainability analysis (MDS) consists of five dimensions show that the average sustainability index value is 54.86% with the highest value of economic dimension 62.12%, social 60.82%, institutional 60.27%, ecological 46.88%, and the last for technology 44.23%. The MDS sustainability status is shown in a kite diagram as in Figure 1 below.

The sustainability index for corn farming on post-sand mining land is represented by a kite diagram. The economic dimension has the highest index value because most farmers use their own or private land for farming. On the other hand, the technological dimension has the lowest level of sustainability due to the limited costs, and farmers in Bambang Village are still not optimized the usage of technology the most. The small number of farmers have mastered and understood use of technology optimally.
Figure 1. Corn Farming Sustainability Index on Post-Sand Mining Land

Besides, producing a sustainability status index value using Rapfarm’s analysis also obtained a Monte Carlo value. The differentiation between the Monte Carlo value and the sustainability index, is less than one, it indicates the validity of the Rapfarm simulation results (Fauzi A. 2019). See the results in table 2 below.

Table 2. Sustainability Index and Monte Carlo

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Index</th>
<th>Monte Carlo</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecology</td>
<td>46.88</td>
<td>46.73</td>
<td>0.15</td>
</tr>
<tr>
<td>Economy</td>
<td>62.12</td>
<td>62.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Social</td>
<td>60.82</td>
<td>60.64</td>
<td>0.18</td>
</tr>
<tr>
<td>Institutional</td>
<td>60.27</td>
<td>60.24</td>
<td>0.03</td>
</tr>
<tr>
<td>Technology</td>
<td>44.23</td>
<td>44.13</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>54.86</strong></td>
<td><strong>54.76</strong></td>
<td><strong>0.11</strong></td>
</tr>
</tbody>
</table>

Based on table 2, the results of the sustainability index value have an average value of 54.86, while in Monte Carlo it has an average value of 54.76, with an average difference value of 0.11. It shows that the difference value between the sustainability indices and Monte Carlo is smaller than 1. If the difference between MDS and Monte Carlo is smaller than 1, then the index result is more than 90% accurate. Seeing the influence of sensitive attributes in providing contribution to index sustainability of corn farming on post-sand mining land, leverage analysis is performed. The leverage analysis used to determine attributes which has the most sensitive role towards sustainability. This analysis determines the influence sustainability factor which is determined by the bigger value of Root Mean Square (RMS), so the greater the role or influence of these attributes on the sensitivity of sustainability status (Kavanagh and Pitchers, 2004). The results of the leverage analysis of five dimensions produced 25 sensitive attributes. These attributes stand as the most important factors which provide basic information about factors need to be corrected or increased for the sustainability of corn farming on post-sand mining land. Sensitive attributes are seen in table 3 below.

Table 3. Attributes That Influence Corn Farming on Post-Sand Mining Land

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Sustainability Indicators</th>
</tr>
</thead>
</table>
| Ecology (X1) | (X1.1) Percentage of use of fertilizers and pesticides  
(X1.2) Number of plant species on land in one year  
(X1.3) The area of land where conservation is implemented  
(X1.4) Utilization of plant waste for animal feed  
(X1.5) Utilization of livestock waste for crops |
| Economy (X2) | (X2.1) Use of agricultural equipment in corn farming  
(X2.2) Origin of capital for corn farming  
(X2.3) Profits from corn farming  
(X2.4) Land ownership status for corn farming  
(X2.5) Determination of the selling price of the harvest |
Social (X3)  
(X3.1) Farmer's education level  
(X3.2) Culture of mutual cooperation in society  
(X3.3) Frequency of conflict  
(X3.4) Intensity of education about land conservation  
(X3.5) Experience in running a farming business

Institutional (X4)  
(X4.1) Benefits of the existence of BUMDES  
(X4.2) Participation in agricultural cultivation extension and training  
(X4.3) Benefits of the existence of microfinance institutions  
(X4.4) Benefits of the existence of farmer groups  
(X4.5) Government support or role in the sustainability of land farming after sand mining

Technology (X5)  
(X5.1) Farmers' response to appropriate technology  
(X5.2) Ownership of appropriate agricultural machinery  
(X5.3) Availability of appropriate agricultural technology  
(X5.4) Farmers' adoption of appropriate technology  
(X5.5) Pest and disease control technology

4.1.1. Sensitive Attributes Leverage in the Ecological Dimension
Leverage analysis in the ecological dimension includes five attributes: (X1.1) Percentage of fertilizer and pesticide use, (X1.2) Number of plant species on land in one year, (X1.3) Area of land where the conservation is implemented, (X1.4) Utilization of plant waste for animal feed, and (X1.5) Utilization of livestock waste for plants. As for analysis leverage ecological dimension can be seen at Figure 2.

Figure 2. Leverage Analysis of Attributes Dimensions Ecology

The results of the analysis of the sustainability of corn farming on post-sand mining land in the ecological dimension have a value of 46.88%, this value is categorized less sustainable. The influencing factor is the attribute of using livestock waste for plants with the RMS value as high as 5.34. The livestock manure waste is used as organic fertilizer in the corn cultivation process, due to the condition of the used land. Sand mining loses a lot of nutrients and organic materials, so there are required improvements to quality land. Widodo & Kusuma (2018) stated that the use of organic fertilizer could make the soil loose, so that the soil aeration zone will have a very good structure so plant roots can easily penetrate the soil. Therefore, the average farmer in Bambang Village uses organic manure such as goat, chicken and cow to improve soil quality and assist maximum production.

The percentage attribute of fertilizer and pesticide use has a very small value compared to other attributes because the average farmer in Bambang Village still relying on chemical fertilizers and pesticides. Their application is still not working in accordance with the recommendations on the packaging label. Yuantari et. al. (2015) revealed that farmers' behavior in using pesticides does not comply with standards, and the usage instructions stated on the packaging labels cannot be followed and implemented.
4.1.2. Sensitive Attributes Leverage in the Economic Dimension

Leverage analysis in the economic dimension includes five attributes: (X2.1) Use of agricultural equipment in corn farming, (X2.2) Origin of capital for corn farming, (X2.3) Profit from corn farming, (X2.4) Land ownership status for corn farming, and (X2.5) Determination of the selling price of the harvest. The analysis of leverage economic dimension can be seen at Figure 3.

The results of the leverage analysis that attribute effects on dimensions of economy is an attribute of land ownership status for corn farming with an RMS value as big as 2.64. The post-sand mining land use in Bambang Village for corn farming, farmers on average have land use status, namely own or private land. Research conducted by (Ridwan, 2009) stated that land control as an owner provides benefits, security and comfort for farmers because there are no costs incurred. Moreover, the land owner will be free to determine which steps are taken to provide maximum results from the land he manages, while land owners rent, profit share, pawn, etc., The existence of agreed-upon rules makes the scope for innovation are limited (Irmanyanti, 2010).

![Figure 3. Leverage Analysis of Attributes Dimensions Economy](image)

4.1.3. Sensitive Attributes Leverage in the Social Dimension

Leverage analysis in the economic dimension includes five attributes: (X3.1) Farmer education level, (X3.2) culture of mutual cooperation in society, (X3.3) Frequency of conflict, (X3.4) Intensity of counseling about land conservation, and (X3.5) Experience in running a farming business. As for analysis leverage social dimension can be seen at Figure 4.

![Figure 4. Leverage Analysis of Attributes Dimensions Social](image)

The results of the leverage analysis show the attributes which effects on social dimension is an attribute of the culture of mutual cooperation in society with the RMS value as big as 4.18. The culture of mutual cooperation is influential attributes within dimensions social since the culture of mutual cooperation influences agriculture continues including in collaboration and solidarity. As stated by Ambarwati et al (2021) that mutual cooperation encourages farmer work the same and mutual help in agriculture activity.
This collaboration is possible to exchange knowledge and experience as well agriculture equipment, seeds, or workers. Mutual cooperation agriculture activities in Bambang Village also occurs when the wide land cannot be processed by the owner, so need exists help from other people. This circumstance definitely also experienced by the other owner it will happen between one and other who need help, then those things there will be a mutual help by the principle of reciprocity and also in community service activities carried out by farmers in cleaning and repairing road access to farmers' lands independently.

4.1.4. Sensitive Attributes Leverage in the Institutional Dimension

Leverage analysis on the institutional dimension includes five attributes: (X4.1) Benefits of the existence of BUMDES, (X4.2) Participation in agricultural cultivation counseling and training, (X4.3) Benefits of the existence of microfinance institutions, (X4.4) Benefits of the existence farmer groups, and (X4.5) Government support or role in the sustainability of farming on post-sand mining land. As for leverage analysis institutional dimension can be seen at Figure 5.

![Figure 5. Leverage Analysis of Institutional Dimension Attributes](image)

The results of the leverage analysis show that the attribute that influences the institutional dimension is the attribute of the benefits of the existence of farmer groups with an RMS value of 2.55. There are three farmer groups Bambang Village, they are the Asih Wono 1, Asih Wono 2, and Asih Wono 3 farmer groups. In line with Agricultural regulations Number.67/Permentan/Sm.050/12/2016, an effort to increase the ability of farmer groups to carry out their roles, namely as learning classes, cooperation vehicles and farming business units. The Asih Wono 3 is most active group, which often holds regular meetings and receives assistance such as corn seeds, fertilizer and counseling or training from the agricultural service regarding activities related to farming activity. Derajat (2011), revealed that farmer groups are an effort to empower farmers to increase productivity, income and farmer welfare. Hence, the existence of this farmer group in Bambang Village is very beneficial for farmers in the moment of supporting corn farming activities on post-sand mining land.

4.1.5. Sensitive Attributes Leverage in the Technology Dimension

Leverage analysis in the technological dimension includes five attributes: (X5.1) Farmers’ response to appropriate technology, (X5.2) Ownership of appropriate agricultural machinery, (X5.3) Availability of appropriate agricultural technology, (X5.4) Farmers’ adoption of appropriate technology, and (X5.5) Pest and disease control technology. As for analysis leverage technological dimension can be seen at Figure 6.

The results of the analysis of the sustainability of corn farming on post-sand mining land in the technological dimension have a value of 44.23% this value is categorized as less sustainable. The influencing factors are the attributes of the availability of appropriate agricultural technology, with an RMS value as high as 3.09. Availability of technology appropriate to use is important for agriculture purposeful sustainability to increase results in agriculture so that farmers can fulfill their needs (Virianita et al., 2019). On the other hand, what happened in Bambang Village was that many farmers still rely on traditional systems and few uses modern tools to support their farming. So that attribute needs improvement. Farmers need to understand, adopt, and integrate technology, into their practice in agriculture. Availability technology in agriculture appropriate to use not only does it benefit for farmer but also helps to make agriculture more sustainable and capable of meeting the needs for food. This without sacrifice ability generation is coming to fulfill the needs of farmers.

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5. Conclusion

Based on the results, corn farming on post-sand mining land is quite sustainable in terms of the economic dimension (62.12%), social dimension (60.82%), and institutional dimension (60.27%). However, the ecological dimension (46.88%) and technological dimension (44.23%) are included in the weak category of sustainability, with a mark index of 54.86%. Additionally, the leverage results show that there are 25 sensitive attributes that influence the sustainability of corn farming on post-sand mining land. These attributes can be used as a consideration to improve the farming system on post-sand mining land so that it remains sustainable. Sustainability is an important pillar of development, and it is a long-term program to optimize all potential and resources owned. Therefore, agricultural sustainability is crucial to business agriculture, as it utilizes and conserves resources optimally to produce optimal harvest products. It uses input facilities and costs reasonably while fulfilling social, economic, and environmental criteria. It also uses renewable production facilities and productivity resources all the time.

Credit authorsip contribution: Ahmad Khusni: Methodolgy, Writing, & Editing – original draft. Suhartini: Writing, Editing, Supervision & Validation. Sujarwo: Supervision & Validation.

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Reference


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