The Analysis Impact of Irrigation Channel on Rice Production in Bendosari, Sukoharjo Regency

Naufal Sauqi¹, Agus Anggoro Sigit², Jumadi²,³

²Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos 1 Pabelan Kartasura Surakarta 57162
³Amcolabora Institute, Jl. Raya Sukahati Kav.58, Sukahati, Cibinong, Bogor

¹Corresponding Author: naufal@gmail.com

Received: 01 July 2021 / Accepted: 20 September 2021 / Published: 31 October 2021

Abstract

The irrigation network infrastructure development and rehabilitation program has several targets to be achieved including the construction and improvement of the 9.89 million ha irrigation network, and the rehabilitation of the surface irrigation network, covering 3.01 million ha. The program for adding and repairing irrigation networks is expected to be able to realize food self-sufficiency that has been declared by the Indonesian government. The method used is a field survey. The survey method aims to obtain a general description of the object or target in this study. The variable used is the amount of rice farmland production each year based on the potential of agricultural land and irrigation channel damage. The results of the calculation of estimated rice production in Sukoharjo Regency in 2018 were 400574.62 tons. High potential rice field productivity class with 2-3 times the amount of harvest per year has the most production that is 220,327.52 tons. Potential factors of paddy farming land and the number of harvests in one year greatly affect the productivity of rice plants, while damage to irrigation channels is slightly damaged and moderate does not affect rice productivity.

Keywords: damage, irrigation channels, rice production

1. Introduction

The agricultural sector is a very important sector for some developing countries in supporting the economy. This can be clearly seen from the role of the agricultural sector in providing employment opportunities to the population, creating national income, and contributing to the overall product. Data shows that in some developing countries more than 75% of the population is in the agricultural sector and more than 50% of national income is generated from the agricultural sector and almost all exports are agricultural products (Todaro, 2000).

Table 1 shows the fluctuations in changes in rice field harvested area, productivity level, and the amount of rice production in Sukoharjo Regency in 2010 to 2016. Data from the 2016 agriculture department shows that the level of rice productivity in Sukoharjo Regency reached
72.08 kw / ha in that year. The high level of productivity must be supported by the maintenance of good infrastructure.

Table 1. Production of Paddy Agriculture Land of 2010-2016 in Sukoharjo Regency

<table>
<thead>
<tr>
<th>Rice Production</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of Harvested area (ha)</td>
<td>46.450</td>
</tr>
<tr>
<td>Productivity (kw/ha)</td>
<td>61</td>
</tr>
<tr>
<td>Production (ton)</td>
<td>283.655</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture, Sukoharjo Regency

Today, the 2015-2019 National Medium Term Development Plan (RPJMN) policy direction is to guarantee water, food and energy security in accordance with the president's vision and mission to have sovereignty over food, energy and maritime & marine resources management. Policies to ensure water and food security show how important it is to realize strong and resilient national resilience based on food sovereignty and independence.

The fundamental problems of food production at present include irrigation services that are not yet optimal. The adequacy of irrigation water is a very important factor in the process of production of lowland rice to ensure high productivity. The problem faced is that many irrigation infrastructure, such as dams, canals and water gates are damaged due to various reasons so that it does not function properly. The causes of damage include natural disasters such as earthquakes and floods, human actions themselves, erroneous construction of buildings, and lack of maintenance by government agencies, both at the central, provincial and district / city levels.

Figure 1 is the condition of irrigation channels in Bendosari, Sukoharjo Regency. In addition to the broken irrigation canal there are several other damages such as siltation due to sedimentation and landslides on irrigation channels that have not been tapped / hardened. Periodic irrigation channel rehabilitation is needed to reduce the impact of damaged irrigation channels on rice productivity.

![Figure 1. Condition of Irrigation Channels in Sukoharjo (Source: Field Survey in 2018)](image-url)
The Government through the Ministry of Public Works and Public Housing and the Ministry of Agriculture are carrying out development programs and rehabilitation of irrigation network infrastructure. The targets to be achieved in this program are the construction and improvement of the 9.89 million ha irrigation network, and the rehabilitation of the surface irrigation network of 3.01 million ha. The program for adding and repairing irrigation networks is expected to help realize food self-sufficiency that has been declared by the Indonesian government.

The study "Analysis of the Impact of Irrigation Canal Damage on Rice Production in Bendosari, Sukoharjo Regency" was conducted to determine the impact of damaged irrigation channels on the value of rice productivity in parts of Sukoharjo Regency. Irrigation canal conditions and rice production can be obtained by utilizing remote sensing data and geographic information systems. Remote sensing is used to identify irrigation channels and find out the distribution of irrigation channels. The data used in the form of Pleiades 1B images with the recording date of December 15, 2016. The use of these data in this study because the Pleiades 1B images can display objects up to 60cm in detail. This will facilitate the identification of irrigation channels.

Geographical information systems are used to process data on potential agricultural land and rice production data so that the distribution of rice productivity values is known in Sukoharjo Regency. Geographic information systems are also used to visualize data that has been processed so that it can display the condition of irrigation channels and distribution of rice production. Both of these data will be used to analyze the impact of irrigation canal conditions on rice production in Sukoharjo Regency.

Utilization of remote sensing data and geographic information systems is expected to be able to facilitate the identification of irrigation canal conditions and calculation of estimates of efficient rice production. This study aims to analyze the impact of irrigation canal damage on rice production in parts of Sukoharjo Regency.

2. Research Method

The method used in this study is a survey method (survey method), which is a study that takes samples from a population and uses a questionnaire as a tool to collect primary data. The survey method aims to obtain a general description of the object or target in this study as the main variables, namely the amount of rice agricultural land production and irrigation canal damage. This research was carried out only on objects of rice farming in Sukoharjo Regency with farmers as a source of supplementary information. The selection factor of Sukoharjo Regency as a research location is due to the geographical conditions that support the agricultural sector, the majority of Sukoharjo people work in the agricultural sector so there is a need for an in-depth study of irrigation canal damage and its relationship with estimates of agricultural land production.

The technique used in the non-probability method is purposive sampling technique. This technique is a sampling technique in accordance with the research objectives. Sampling is based on damaged irrigation channels based on the condition of the irrigation assets. Sampling is done to obtain the actual parameter values in the field. The parameters to be checked in the fields are the parameters of the existence and condition of secondary irrigation channels. The number of irrigation area samples as many as 39 agricultural land and irrigation canals obtained from calculations using the Slovin formula with a level of accuracy of 85%.
2.1 Preparation Phase
The preparatory stage is the initial stage of the research which includes a literature study of the literature and reference sources related to the research. Determination of the type of data to be used in this study was also prepared in accordance with the research method to be used. Data collection is obtained and processed from relevant agencies as well as from various reliable reference sources. Pleiades imagery recorded on 15 December 2016 was obtained directly from the National Aeronautics and Space Institute. Pleiades image consists of 3 multispectral bands and 1 panchromatic band. The selection of images recorded on 15 December 2016 was due to the recorded images having low cloud cover, especially in Sukoharjo Regency. Sukoharjo regency administration data and agricultural land were obtained from government agencies providing RBI map shapefiles throughout Indonesia, the Geospatial Information Agency. Secondary data on agricultural irrigation channel distribution was obtained from the Public Works and Public Housing Agency of Sukoharjo Regency.

2.2 Implementation Stage
The implementation phase includes the stages of pre-field data processing, field surveys, and post-field data processing. Pre-field data processing is used as temporary data to make it easier when field surveys. Pre-field data processing includes pleiades image processing, pansharpening, canal index transformation, and enhancement. The results of digital image data processing are used to identify tertiary level irrigation channels. The tertiary level irrigation canal data is used to determine the rice farms affected by damage to secondary irrigation channels.

The field survey was carried out to check the results of identification of rice fields from secondary data, so that they were able to represent reality on the ground. In addition, the field survey is also used to find out rice production through direct interviews with farmers so that productivity can be identified for each potential rice field. The field survey was carried out based on the sample points that had been made previously using the purposive sampling method, namely taking the sample points from members of the population. The activities carried out in the field are as follows:

2.2.1 Conducting interviews with farmers as the main information for estimating rice production.
2.2.2 Take field documentation as a description of the situation in the field for each observation point.

The post-field data processing stage includes the calculation of rice production data and making maps of rice productivity distribution and irrigation canal damage. Post-field data processing is used to re-interpret the results of field survey data that is not in accordance with the conditions in the field. Rice production data calculation is done to determine the value of rice productivity in Sukoharjo Regency. Rice productivity is obtained from the average of each class of potential rice farms affected by irrigation canal damage. The results of the calculation of rice productivity are used for comparison with rice production in 2016 when the irrigation channels were in good condition with the same potential paddy field. Irrigation channel damage map is used to determine the distribution of damaged irrigation channels and know the potential rice fields affected by irrigation canal damage, so it can be known the impact of irrigation canal damage on rice production.
3. Results and Discussion

The analysis of the impact of irrigation canal damage was carried out by comparing the table of potential paddy field area of irrigation canal damage and rice production in 2016 when the irrigation channel was in good condition. The table on potential paddy fields that were affected by irrigation canal shows 4 classes of potential paddy fields in Bendosari. Potential rice fields are rice fields affected by damage to secondary irrigation channels in Bendosari. Rice field data potential is obtained from the PUPR Department. Sukoharjo. Potential paddy field data is linked to inventory data of irrigation canal damage so that it is obtained from the potential rice paddy class affected by irrigation canal damage.

Table 2. Potential Rice Field Areas Affected by Irrigation Canal Damage in Bendosari

<table>
<thead>
<tr>
<th>No</th>
<th>Potential Rice Field</th>
<th>Extensive (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medium Potential Rice Field, Low Damaged Irrigation Channels</td>
<td>44.29808</td>
</tr>
<tr>
<td>2</td>
<td>High Potential Rice Field, Medium Damaged Irrigation Channel</td>
<td>114.7508</td>
</tr>
<tr>
<td>3</td>
<td>High Potential Rice Field, High Damaged Irrigation Channel</td>
<td>196.7523</td>
</tr>
<tr>
<td>4</td>
<td>High Potential Rice Field, Low Damaged Irrigation Channels</td>
<td>42.90066</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>398.7019</td>
</tr>
</tbody>
</table>

Source: Data Analysis, 2019

Table 2 shows the potential area of rice fields in Bendosari. These classes include medium potential rice fields with damage to light irrigation channels covering an area of 44.29 ha, high potential rice fields with moderate irrigation canal damage 114.7508, high potential rice fields with damage to heavy irrigation channels covering 196.75 ha, and high potential rice fields with damage mild irrigation canal 42.9 ha.

Table 3 displays the estimated results of rice production in Bendosari in 2018 and data on rice production in 2016 from the Sukoharjo regency agriculture office. Both of these data are used to compare rice production when the irrigation channel was damaged in 2018 and when the irrigation channel was good in 2016. The table shows that in each class potential medium rice fields with mild irrigation canal damage and high potential rice fields with mild, moderate and irrigation canal damage Overall height has increased rice production. Data on the increase in rice production can be seen in the following table.

Table 3. Comparison Table of Potential Paddy Class Rice Production in Bendosari in 2016 and 2018
<table>
<thead>
<tr>
<th>No</th>
<th>Classification</th>
<th>Extensive (ha)</th>
<th>Average of Harvested Rice</th>
<th>Average of Production</th>
<th>Rice Production 2018 (ton)</th>
<th>Rice Production 2016 (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medium Potential Rice Field RR</td>
<td>44.29</td>
<td>2.5</td>
<td>4.64</td>
<td>513.8577</td>
<td>317.7955</td>
</tr>
<tr>
<td>2</td>
<td>High Potential Rice Field RS</td>
<td>114.75</td>
<td>2.5</td>
<td>5</td>
<td>1434.385</td>
<td>823.2251</td>
</tr>
<tr>
<td>3</td>
<td>High Potential Rice Field RB</td>
<td>196.75</td>
<td>2.5</td>
<td>4.375</td>
<td>2151.978</td>
<td>1411.506</td>
</tr>
<tr>
<td>4</td>
<td>High Potential Rice Field RR</td>
<td>42.90</td>
<td>2.5</td>
<td>4.285</td>
<td>459.5734</td>
<td>307.7704</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>398.70</td>
<td></td>
<td></td>
<td>4559.795</td>
<td>2860.297</td>
</tr>
</tbody>
</table>

Source: Analysed Data (2019) and Agriculture Department of Rice Production Data (2016)

Based on table 3 above it can be seen that the class of medium potential rice fields with mild irrigation canal has a rice production of 513.85 tons where production in 2016 amounted to 317.79 tons. The high potential paddy field class of irrigation canal damage has a rice production of 1434.38 tons where production in 2016 amounted to 823.22 tons. High potential paddy field class with damage to heavy irrigation canals has a rice production of 2151.978 tons while in 2016 amounted to 1411.5 tons. Potential paddy fields with mild irrigation canal have 459,573 tons of rice production while in 2016 amounted to 307.7 tons. Each potential rice field class affected by irrigation canal damage can be seen on the map below.

This shows that irrigation canals with mild and moderate damage conditions did not significantly affect rice productivity. Damage to mild and moderate irrigation can still be categorized as functioning even though the effectiveness of irrigation is not better when the irrigation channel is in good condition. In contrast to the damage to the heavy irrigation channels which is quite influential on rice productivity. The table shows that low potential paddy fields with heavily damaged irrigation canals have a fairly low productivity value of 4.37 tons / ha. Many factors can affect potential rice fields such as physical geographical factors and the type of soil, rainfall, lithology, and slope. However, irrigation canals can still support the productivity of rice farming land with better maintenance.

Figure 2 shows the distribution of potential paddy fields affected by irrigation canal damage. Medium and high potential paddy fields with mild irrigation canal damage are in the western region of Bendosari affected by Cendono irrigation channels. High potential rice fields with moderate damage to irrigation canals are spread in the western and eastern areas of Bendosari, which is affected by damage to the Sambeng and Cendono primary irrigation channels. Potential rice fields affected by damage to heavy irrigation canals are most found in the central area of Bendosari. Damage occurred in the irrigation channels Grogol, Kedungbulus, and Sambiloro.

Damage to heavy irrigation canals caused by various things including the collapse of one of the irrigation channels in the Kedungbulus irrigation area, found sedimentation accumulation
so that in the rainy season can cause flooding. Sambeng irrigation canals are found that there are still many channels that have not been tilled (hardened) / in the form of land and in the left side of the irrigation channel overgrown with shrubs so that they can close the irrigation channel. The condition of damage to the Sambiloro irrigation canal is almost the same as that of the Sambeng Irrigation canal, namely that there are irrigation channels that have not been ditalud or only one side, so that it can cause flooding to one side of the channel, another problem found is damage to the irrigation channel floor which is feared to be able to disrupt the flow of the irrigation channel.

Figure 2. Map of Potential Rice Field Classification in Sukoharjo Regency

4. Conclusion

4.1 The condition of irrigation canals in Bendosari is divided into three classes of damage, namely mild damage class, moderate damage class, and heavy damage class where the condition of the irrigation canal is explained based on the functional irrigation channel.  
4.2 The results of the calculation of rice production in Sukoharjo Regency are 400,574.61 tons per year, with a class of high agricultural land productivity 2-3 times harvest per year having the most production which is 220,327.52 tons. 
4.3 Irrigation canal damage condition does not significantly affect the productivity of rice because mild and moderate damage to the irrigation canal does not significantly affect the functional canal as a water delivery to rice fields. The results of a survey of rice production in potential paddy fields affected by damaged irrigation channels show that there has been an increase in rice production compared to 2016 rice production data where irrigation channels are in good condition.

References


Pertanian dan Kehutanan.

© 2021 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC-BY) license (http://creativecommons.org/licenses/by/4.0/).