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Analysis of Rice Productivity and Sustainable Food Security in Bantul Regency

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study aims to find out how much rice production is in order to achieve sustainable food security in Bantul Regency in 2017-2023, and to find out how the productivity level of rice fields is. The initial idea of this study was due to the increase in the population in Bantul Regency from 2017-2023 which caused the conversion of rice fields to settlements, this will reduce agricultural land resources for rice production. This study uses a descriptive method with a quantitative approach, the data needed in this study is secondary data obtained from BPS Bantul Regency and analyzed using Microsoft Excel by comparing the demand side and the supply side. To determine the level of productivity of rice fields, the carrying capacity formula of agricultural land is used. Based on the results of the analysis carried out, it was obtained that in terms of demand or need for rice in 2023, it can be calculated based on the number of population and physical consumption

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figures of 81995.9989 tons. Meanwhile, the results of the calculation in terms of rice availability or production in Bantul Regency in 2023 are 83290.32986 tons. So if we compare the need with availability, Bantul Regency has a surplus, which means that the number of rice needs in Bantul Regency in 2023 is above the number of needs or demand. Based on the projection calculations, Bantul Regency will still experience a surplus until 2035, meaning that the rice availability in Bantul Regency until 2035 will be higher than the demand or required amount. Furthermore, when viewed from the level of rice field productivity in 2023 based on rice production or availability, it shows that Bantul Regency has a surplus with an availability of 0.082512239 tons, this figure is slightly above the minimum physical consumption figure of the population of Bantul Regency of 81.23 kg/person/day (0.08123 tons/year). Productivity based on the carrying capacity of agricultural land also experienced a deficit, the value of a shows 0.0000000010063, less than 1 (a < 1).

Keywords: Productivity; rice fields; rice production; rice needs.

1. INTRODUCTION

The development of the agricultural sector is still the main concern of the current Indonesia government and the next few decades. One of the reasons is that most of the Indonesian population continues to grow relatively rapidly, with consequences on the provision of food both in terms of quantity, quality and type in adequate quantities. According to Mubyarto, Indonesia is an agricultural country where agriculture plays an important role in the entire national economy. This can be shown from the large number of people or workers who live or work in the agricultural sector and national products derived from agriculture. According to Tati Nur Mala, agricultural production or products in a broad sense depend on genetic factors and varieties planted, the environment includes, among others, soil, climate, and technology used. While in a narrow sense it consists of plant varieties, soil, climate, and non-technical factors such as farmer skills, costs or means of production and tools used.

Food security is not only related to the adequacy of food availability, but also to access to food, and at a more advanced stage, to food safety (Lolita & Ratnasari, 2016). The importance of creating food security as a means of strengthening economic and political stability, ensuring the availability of food at affordable prices, and encouraging increased production is crucial. Ensuring sufficient food, both in quantity and quality, that is safe, equitable, and accessible to all households is a primary goal in economic development. The increasing demand for food, driven by population growth, accelerates food production to achieve price stabilization and food availability. Therefore, food security is closely linked to the government's ability to maintain the stabilization of food supply and the supporting capacity of the agricultural sector (Lolita & Ratnasari, 2016).

The need for land increases along with population growth, therefore the need for land, both for settlements, agriculture, trade and other facilities is increasing. On the other hand, the land area on the earth's surface is fixed and limited. Therefore, it is necessary to plan and arrange land use so that land is used efficiently and sustainably, in the sense that soil fertility and productivity are maintained (Nasrun et al., 2016) (Mulusew & Mingyong, 2023). A comparison of the number of people in Bantul Regency is presented in Fig. 1.

Overall, from 2017 to 2023, the population of Bantul Regency experienced fluctuations, with significant growth until 2020, followed by a decline in 2021, and then stabilizing at around 1 million in 2022 and 2023.

High population growth and land conversion will certainly affect food availability. In addition to the problem of land area, food availability in Indonesia is also vulnerable to various hydrometeorological disasters, such as floods, droughts, cyclones, erosion, and forest and land fires which will have a serious impact on the agricultural sector. Several studies both in Indonesia and in the world such as in West Africa, Ghana, Venezuela and Ethiopia have documented the negative impacts of climate change such as the occurrence of seasonal shifts and droughts which cause a decrease in agricultural production and productivity as well as a decrease in food security (Ruminta, 2016) (Djah et al., 2022) (Herrera-cuenca et al., 2022) (Bissah et al., 2022) (Kolog et al., 2023) (Herrera-cuenca et al., 2022) .

Land is one of the factors of agricultural production that has been a barrier to food sovereignty in Indonesia. The land problems

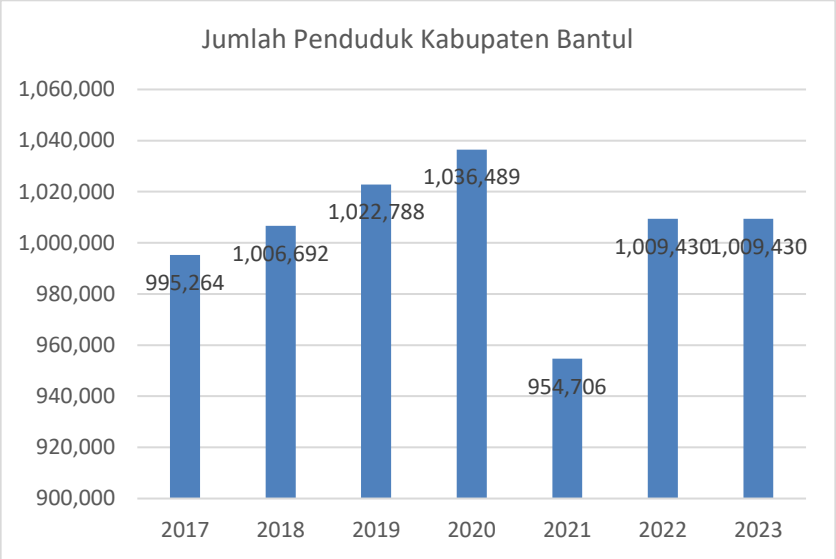

Fig. 1. Number of Population of Bantul Regency
Source: BPS Data Bantul Regency

faced so far are the insufficient availability of agricultural land, the shrinkage of available agricultural land, and the difficulty of developing new agricultural land due to various obstacles.

According to the Agency for Research and Development of Agriculture (Azwir & Ridwan, 2009), in addition to the increase in the number of populations, the demand for rice has increased due to a change in the consumption pattern of the population that is not rice to rice. On the other hand, the narrowing of fertile rice fields due to the conversion of land for purposes other than agriculture, as well as the phenomenon of irrigated rice productivity tending to decrease.

Scientifically, this research is very important because food security plays a strategic role in society. In Indonesia, food security will guarantee the right to food availability, which can become the pillar of community food security and contribute to the formation of high-quality human resources (HR), particularly rice, which is a staple food for the Indonesian population. Meeting the food needs in sufficient quantities and quality, ensuring safety, equitable distribution, and accessibility for all households is the main goal of economic development.

2. METHODOLOGY

The location of this research is in the Bantul Regency area, DIY. Meanwhile, to see a comparison of the number of population and use of rice fields by location in Bantul Regency, DIY in 2023. The tools used to support this writing are with Ms Office (Word and Excel). Meanwhile, the materials used are statistical data obtained from the Central Statistics Agency of Bantul Regency in the 2017-2023 Figures and land suitability data from related agencies. Data processing was carried out using Ms Excel 2010 and then analysed descriptively.

2.1 Data Collection Techniques

The data needed in this study uses secondary data, Secondary data sources are data obtained indirectly. Secondary data is data obtained from records / archives in the office or agency that can be held accountable and has something to do with the purpose of the research. The data used is a Documentation Study. The secondary data collected were:

1. Bantul Regency Administration Map
2. Rice production data in Bantul Regency in 2017-2023
3. Data on the population of Bantul Regency in 2017-2023
4. Data on the average agricultural harvest area of staple rice food in 2017-2023
5. Data on the use of rice fields in Bantul Regency in 2017-2023

2.2 Data Processing and Analysis Techniques

The data processing stages are as follows:

2.2.1 From the demand side

1.) Calculate the population growth rate of Bantul Regency per year based on data on the population of Bantul Regency in 2017-2023
2.) Calculate the projected population of Bantul Regency in 2017-2023 based on the average population growth rate (2017-2023) with the formula:

$$Pt = P0 (1 + r)^{n}$$

where:

P_t: Tth year resident
P_0: Population in the 0th year
r: average growth rate per year
n: Year

3.) Determine the annual rice consumption index of the population. In this case, the annual rice consumption index is determined by referring to the Regulation of the Ministry of Agriculture of the Minister of Agriculture of the Republic of Indonesia, Number 16/Permentan/ HK.140/4/ 2014 concerning Guidelines for Strengthening Community Food Distribution Institutions in 2015 and to the Directorate of Food and Agriculture, Ministry of National Development Planning / National Development Planning Agency of 124.89 kg/cap/year.

4.) Calculate rice needs in Bantul Regency based on the projected population and the rice consumption index of the population per year by: Total rice demand = projected population x rice consumption index

2.2.2 In terms of availability (Supply)

1.) Calculating rice production in Bantul Regency with the following approach:

Total rice production (tons) = Rice field area (Ha) x IP x rice productivity (tons/ha)

Note: to calculate IP (Rice Planting Index) use the formula:

IP = 1-year planting area / Planting area

Information:

IP (Planting Index): Average planting time in a year
Planting Area: Rice Planting Area on Land in 1 Year
Planting Area: The area of land planted (the value is fixed)
The rice planting index (IP) in Bantul Regency is 1.281904.

2.) Calculating rice production in Bantul Regency with the following approach:

Total rice production (Tons) = Total Rice Production / GKG (Tons) x Rice to Rice conversion index

Note: Rice to rice Conversion Index (1 Kg GKG = 0.6306 Kg of Rice)

Showing the Productivity Level of Rice Fields in Meeting the Rice Needs of the Population in Bantul Regency.

1.) If the total supply < 81.23 kg/capita/year, then it can be said that Bantul Regency has a deficit in meeting the food needs of the population (rice).

2.) If the total supply = 81.23 kg/capita/year, then it can be said that Bantul Regency is experiencing optimality in meeting the food needs of the population (rice).

3.) If the total supply > 81.23 kg/capita/year, then it can be said that Bantul Regency has a surplus in meeting the food needs of the population (rice).

2.2.3 Calculating the carrying capacity of rice farmland in Bantul Regency

To calculate the carrying capacity of the land, it is calculated with the following formula:

$$a = X / k$$

Information:

α = Land carrying capacity
X = area of land available for cultivation of food crops/rice (X is searched by
using the formula), X = Harvest Area / Total Population
k = the area of land required for food self-sufficiency. (k is searched by formula)
k = Minimum Physical Consumption of Rice / Average Rice Production

Minimum Physical Consumption (KFM) is calculated from the need for rice of 81.23 kg/capita/year. The average rice production/ha was converted to rice by 0.6306. The value of α

is used as an indicator of the ability of rice plantations to the number of people in one area. The criteria for α values are included in the evaluation standards as follows:

α > 1, means that the region is able to be self-sufficient in food in the sense that the population is below the optimal population.
α < 1, means that the area is not able to be self-sufficient in food in the sense that the population has exceeded the optimal population.
α = 1, means that the area has optimal carrying capacity.

3. RESULTS AND DISCUSSION

3.1 Rice Availability

This report uses population data and rice production data obtained from the Central Statistics Agency of Bantul Regency.

3.1.1 From the demand side

Based on the population of Bantul Regency in 2023. Rice needs in Bantul Regency and the annual rice consumption index of the population by using the rice consumption figure (ABK) used in 2023 used by BPS, there is an AKB used which is 81.23 kg/capita/year or if converted into a unit ton to 0.08123 tons/capita/year. Formula:

> Total rice demand = number of population x rice consumption index/rice consumption figure (ABK)
>
> Rice demand = Rice demand / 0.6306 (conversion of grain to rice in Bantul regency)
>
> Harvest area requirement = Rice requirement / average productivity

Until 2023, the demand for rice in Bantul Regency will reach 81995.9989 tons with the need for land area that must be available to meet the needs of the population is 24177131.04 ha. Meanwhile, the demand for rice/GKG in tons in Bantul Regency in 2023 is 130028.5425 tons.

3.1.2 In terms of availability (supply)

To calculate rice production and rice production, the following formula is used:

> Total rice production (tons) = Rice field area (Ha) x IP x rice productivity (tons/ha).
>
> Total rice production (tons) = Total Rice Production / GKG (Tons) x Rice to Rice conversion index.

In Table 2, in 2023 the total rice production of GKG will reach 26503.42502 tons while the production will reach 83290.32986 tons, where the land conversion factor is calculated at 0.6306 percent with a land area considered fixed at 14,945 ha.

The increasing population has resulted in an increase in daily needs including food needs, as well as changes in agricultural land use to non-agricultural can lead to a decrease in the availability of food agricultural land.

Comparison of rice supply and demand in Bantul Regency in 2023 with a fixed per capita rice consumption rate of 81.23 kg/capita/year, it is known that Bantul Regency in 2023, the availability of food, in this case rice, has a surplus of 1294.330955 tons, this means that Bantul Regency has been able to meet the rice needs of its population.

Table 1. Rice Needs in Bantul Regency in 2023

Year	Population	Rice Consumption Index (kg/cap/year)	Rice Requirement (tons)	Rice/GKG Needs (tons)	Harvest Area Needs (Ha)
2023	1009430	81.23	81995.9989	130028.5425	24177131.04

Source: Data Processed

Table 2. Rice Production in Bantul Regency in 2023

Year	The day after tomorrow, Rice Field (ha)	Rice/GKG Production (tons)	Rice Conversion Factor (kg)	Rice Production (tons)
2023	14.945	26503.42502	0.6306	83290.32986

Source: Data Processed 2023

Table 3. Rice Field Productivity in Bantul Regency in 2023

Year	Number of Population X	Rice Production /Supply (ton) Y	Minimum Rice Physical Consumption /year (ton)	Supply Beras (ton) Y/X	Information
2023	1009430	83290.32986	0.08123	0.082512239	Surplus

Source: Data Processed by BPS in 2023

The tendency of the difference in supply and demand of rice in Bantul Regency in 2023, which is the need for food, in this case rice, indicates that Bantul Regency has the strength to maintain its food security, to maintain this, a strategy is needed to maintain and maintain food security in Bantul Regency.

3.1.3 Rice field productivity level in meeting the rice needs of the population in bantul regency, DIY

To calculate the Productivity of Rice Fields, the formula is used:

Rice supply = rice production: number of populations

Assuming that:

a. If the total supply < 0.08123 tons/capita/year or equivalent to 81.23 kg/capita/year, then it can be said that Bantul Regency has a deficit in meeting the food needs of the population (rice).
b. If the total supply = 0.08123 tons/capita/year or equivalent to 81.23 kg/capita/year, then it can be said that Bantul Regency is experiencing optimal in meeting the food needs of the population (rice).
c. If the total supply > 0.08123 tons/capita/year or equivalent to 81.23 kg/capita/year, then it can be said that Bantul Regency has a surplus in meeting the food needs (rice) of the population. The productivity of paddy fields is presented in Table 3.

Based on Table 2. The availability of rice in Bantul Regency is above the minimum rice consumption rate, so it can be said that Bantul Regency has a surplus in the fulfillment of the rice needs of its population, this happens because of the increasing number of people which has an impact on the conversion of agricultural land, besides that the change of rice fields to vegetable cultivation land also has an impact on the productivity of rice fields. In addition to the above data, the productivity of rice fields can also be seen based on the carrying capacity of agricultural land, with the following formula:

a = X/k
a = Land carrying capacity
X = area of land available for cultivation of food crops/rice (X is found by formula)
X = land area/population
k = area of land required for food self-sufficiency (k is found by formula)
k = physical consumption of rice / average rice production/ha

Minimum Physical Consumption is 81.23 kg/capita/year. Assuming the following:

a. a > 1, means that the region is able to be self-sufficient in food in the sense that the population is below the optimal population.

b. a < 1, means that the area is not able to be self-sufficient in food in the sense that the population has exceeded the optimal population.

c. a = 1, means that the area has an optimal carrying capacity

Table 4. shows that the carrying capacity of agricultural land in Bantul Regency in 2023 a value shows less than 1 (a < 1) which means that Bantul Regency is no longer able to be self-sufficient in food, which means that the number of its population has exceeded the optimal population.

Table 4. Carrying Capacity of Rice Fields in Bantul Regency in 2023

Year	Available Land Area (X)	Required Land Area (k)	Land carrying capacity (a)	Information
2023	0.022709846	22567761.25	0.0000000010063	A < 1

Source: Data Processed by BPS 2023

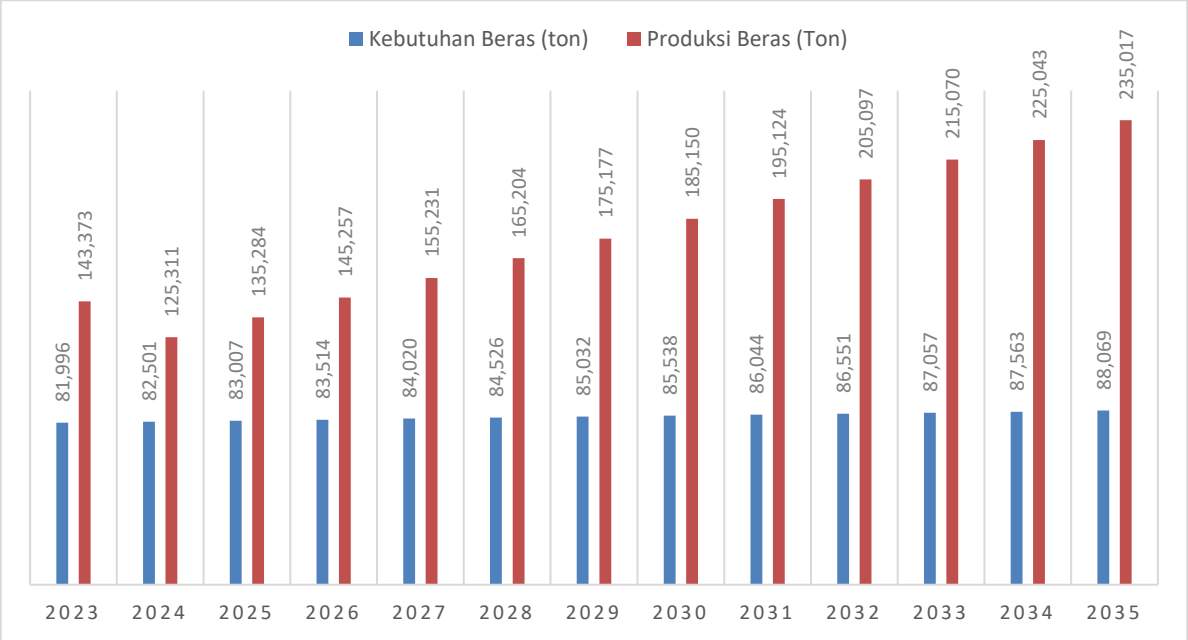

Fig. 2. Trend of Rice Consumption and Producion in Bantul Regency
Source: Data Processed by BPS 2023

3.2 Discussion of Rice Field Productivity in Meeting the Rice Needs of the Population in Bantul Regency, DIY

Productivity is the ability of the soil to produce certain crops under certain tillage conditions, productive soil is soil that can produce crops well and profitably. Land productivity can be influenced by many factors that can reduce agricultural production, including land area, irrigation conditions, climate, soil type and nutrients in the soil. Meanwhile, the definition of needs according to KBBI is something that is needed.

Rice is something that is needed by the community as the main food ingredient in daily life. Rice is the main food of the people of Indonesia, in general rice is white but there is also rice that is red, the plant that produces rice is rice plants that belong to the grass group. The need for rice will continue to increase along with the increasing rate of population growth.

In observations made based on data that has been obtained from BPS Bantul Regency, the preliminary study found the fact that the number of people in Bantul Regency in 2023 has increased, this will have an impact on increasing food needs, in this case rice which is the staple food of the population in Bantul Regency.

After the data was obtained, an analysis was carried out to find out how much rice production in Bantul Regency will be in 2023 and what is the level of productivity of rice fields in Bantul Regency.

Based on the projection calculations, Bantul Regency will still experience a surplus until 2035, meaning that the rice availability in Bantul Regency until 2035 will be higher than the demand or required amount.

4. CONCLUSION

From the results of the calculations carried out, it was found that the population in Bantul Regency had increased. Meanwhile, the physical consumption figure of the population according to the Directorate of Food and Agriculture is 81.23 kg/capita/year.

In terms of demand or demand for rice in 2023, it can be calculated based on the number of population and physical consumption figures of 81995.9989 tons. Meanwhile, the results of the calculation in terms of rice availability or production in Bantul Regency in 2023 are 83290.32986 tons.

From the calculation above, if we compare the need with availability, Bantul Regency has a

surplus, which means that the number of rices needs in Bantul Regency in 2023 is above the number of needs or demand.

Furthermore, when viewed from the level of rice field productivity in 2023 based on rice production or availability, it shows that Bantul Regency is experiencing a deficit with availability of 0.082512239 tons, this figure is below the minimum physical consumption figure of the population of Bantul Regency of 81.23 kg/capita/year.

Productivity based on the carrying capacity of agricultural land also experienced a deficit, the value of a indicates less than 1 (a < 1) which means that Bantul Regency is no longer able to be self-sufficient in food, which means that the number of its population has exceeded the number of Optimal populations.

And finally, from the results of manual calculations, it can be seen from the results of the reduction between production or availability and rice consumption or demand, and it is produced that availability/production < Demand or Consumption, thus Bantul Regency in 2023 will experience a rice deficit, this is in line with the vadinicum theory (Wahed et al., 2015) which states that rice production basically depends on two variables, namely land area and yield per hectare, if the harvest area or the productivity of the unity of the area increases, which in turn will automatically increase the welfare of the population, in this case the rice needs will be met.

The productivity of rice fields in meeting the rice needs of the population in Bantul Regency is still experiencing a deficit, this needs to be increased because if this continues to be left unchecked, Bantul Regency will experience a famine disaster and will continue to rely on rice imports from other regions or regencies in Yogyakarta, the role of the government is also very reliable in providing counseling to farmers in Bantul Regency regarding the impact of low land productivity in an effort to fulfil The food needs in this case are rice.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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