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ANALYSIS OF RICE PRODUCTION PROJECTION IN MALANG REGENCY

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ABSTRACT

Rice as the main crop in rice production makes it very important in meeting the rice needs of the population, sufficient rice production can also guarantee adequate rice availability for the community. The population in Malang Regency increases every year. The increasing population causes the community's need for food, especially rice, to also increase. Therefore, the purpose of this study is to analyze the projection of rice production in 2024-2045 in Malang Regency. With a quantitative approach, using secondary data, data obtained from the Central Statistics Agency (BPS) of Malang Regency. The analysis method uses Box-Jenskins ARIMA analysis. The results of the analysis of the rice production projections shown by Malang Regency in 2024 - 2045 will experience an increase in rice production with an average percentage increase of 1.15% per year. The highest rice production is in 2045 at 629,707 Ton-GKG. This is because the projected harvest area will increase every year with an average growth of 4.45% and productivity will increase with an average growth of 0.01% each year.

Keywords: *Projections, Rice Production, ARIMA, Projections 2045*

ABSTRAK

Padi sebagai tanaman utama dalam produksi beras menjadikannya sangat penting dalam memenuhi kebutuhan beras penduduk, produksi padi yang mencukupi juga dapat memastikan ketersediaan beras yang memadai bagi masyarakat. Penduduk di Kabupaten Malang meningkat setiap tahunnya. Jumlah penduduk semakin bertambah menyebabkan kebutuhan masyarakat akan bahan pangan terutama beras juga mengalami peningkatan. Oleh karena itu tujuan dari penelitian ini adalah menganalisis proyeksi produksi padi pada tahun 2024-2045 di Kabupaten Malang. Dengan pendekatan kuantitatif, menggunakan data sekunder, data yang diperoleh dari Badan Pusat Statistik (BPS) Kabupaten Malang. Metode analisis menggunakan analisis Box-Jenskins ARIMA. Hasil analisis dari proyeksi produksi padi menunjukkan Kabupaten Malang pada tahun 2024 – 2045 akan mengalami peningkatan produksi padi dengan rata-rata persentase kenaikan sebesar 1,15% per tahun. Produksi padi tertinggi yaitu pada tahun 2045 sebesar 629.707 Ton-GKG. Hal ini disebabkan karena luas panen diproyeksikan akan meningkat setiap tahunnya dengan rata-rata pertumbuhan 4,45% dan produktivitas akan meningkat dengan rata-rata pertumbuhan 0,01% setiap tahunnya.

Kata kunci*: Proyeksi, Produksi Padi, ARIMA, Proyeksi 2045*

INTRODUCTION

Rice production is closely related to the need and availability of rice. Rice as the main crop in rice production makes it very important in meeting the rice needs of the population, sufficient rice production can also ensure adequate rice availability for the community. East Java Province is the largest province in rice production. Based on data from the Central Statistics Agency of Indonesia (2024), the largest national rice production is East Java Province, in 2024 East Java produced 9,526,515 tons of rice if converted into rice it produced 5,500,801 tons of rice. Demographically, Malang Regency had a population of 2,425,311 people in 2009 and increased to 2,703,175 people in 2023. In terms of physical aspects, the area of rice fields in Malang Regency increased in 2009 from 66,353 Ha to 74,509 Ha in 2023. This condition will affect rice production in Malang Regency. Rice production in Malang Regency in 2009-2023 experienced fluctuations. The highest rice productivity was achieved in 2013 at 7.6 tons/ha. In 2012 there was a decline which had an impact on decreasing rice production in Malang Regency.

The average population growth rate is 0.75% from 2010 to 2023. Meanwhile, rice production fluctuates. The highest rice production occurred in 2016 with a total production of 505,138 tons and in 2017 it decreased to 493,794 tons. Increases and decreases in production can occur due to changes in harvest area and productivity (Hikmah *et al*., 2020). Rice production fluctuates but tends to increase with an average growth of 1.47%. Rice production in Malang Regency fluctuates but is not comparable to population growth which increases every year. The increasing population causes the community's need for food, especially rice, to also increase. Meanwhile, rice production fluctuates following planting patterns and weather changes, so that there is a gap between the availability of rice and rice consumption (Khasanah & Gunanto, 2024).

The increase in rice consumption in a region will be directly proportional to the increase in the population in that region and the problem that arises is that the area of agricultural land that currently exists will not increase and even the area of land allocated for agriculture will decrease, because the conversion of agricultural land into building land will increase along with the increase in the number of people who need land for housing or residences. According to Nurwahdania & Sulistijanti (2020) as a country with a large population, Indonesia faces challenges in meeting its rice needs. Without careful planning to maintain national food security, this will result in food insecurity in the coming years (Ramadan *et al*., 2023).

Food availability is related to the provision of food, especially from domestic production. Various efforts made by the government to increase domestic production are expected to increase food security and achieve sustainable food self-sufficiency. To realize this, the government's attention is more focused on areas or regions that have the potential to become national food barns. Through the Ministry of Agriculture, Indonesia will strive to become the world's food barn by 2045 (Prasetyo, 2019). For this reason, the Ministry of Agriculture must create and prepare policies or programs to increase food security and make Indonesia the world's food barn with careful planning (Januarti *et al*., 2022). Thus, this study aims to project rice production and rice consumption in Malang Regency until 2045.

Efforts that can be made to anticipate this are by conducting an analysis of rice production projections and rice food consumption in Malang Regency in the future. This study aims to analyze rice production projections in Malang Regency in 2024 to 2045.

LITERATURE REVIEW

1. Production

The definition of production is divided into two, namely technical and economic. Technical production is the process of combining or making existing goods or substances and energy. Different from the understanding of production economically, namely work that creates utility, increases existing utility and distributes that utility among many people. So, agricultural

production economics studies the alternatives for the best use of available and efficient resources to meet the various needs of society (Imran, 2022).

The results of production can be in the form of consumer goods or industrial goods. In economics, production can be interpreted as an activity that creates benefits (utility) both in the present and in the future. The discussion of production in conventional economics only carries profit maximization as the main motive (Miftahus Surur, 2020).

2. Rice

Rice is a seasonal plant classified as grass (Gramineae), including the genus Oriza L which includes approximately 25 species spread across tropical and subtropical areas such as Asia, Africa, America and Australia. In Indonesia, initially rice plants were cultivated in dry land areas with a field system, so that at that time many people tried to stabilize their business results by irrigating areas with less rainfall. Rice plants that can grow well in tropical areas are Indica, while Japonica is widely cultivated in subtropical areas (Utomo dan Naza, 2003).

Rice plants can grow well in areas that have good rainfall, an average of 200 mm per month or more, with a distribution of 4 months, the desired rainfall per year is around 1500-2000 mm. A good temperature for rice plant growth is 23°C. The height of a suitable place for rice plants ranges from 0-1500 m above sea level. Good soil for rice plant growth is paddy soil that contains sand, dust and clay fractions in a certain ratio with sufficient water required. Rice can grow well in soil with a top layer thickness of between 18-22 cm with a pH of between 4-7 (Salman, 2014).

3. Projection Concept

Projection is a method used to predict a condition in the future. Projection can be used as an effort to provide advice on certain conditions. In conducting analysis on economic activities, economic actors should be able to estimate the conditions that will occur in the future, in other words called projection or forecasting. The benefits of projection include as a suggestion in planning, decision making and policy, and providing information that can be used.

METHODS

This study uses a quantitative approach. The study was conducted in December 2024 - January 2025 in Malang Regency with the consideration that Malang Regency is a rice producer. This study uses secondary data, data obtained from the Central Statistics Agency (BPS) of Malang Regency and the Food Security Service of Malang Regency. The type of data used in this study is time series data, namely rice production data, harvested area, and rice productivity with an interval period of 2010 - 2023.

The data analysis used in this study is the Box-Jenskin ARIMA analysis using the Stata SE 18 application. Forecasting rice production and rice consumption is analyzed using ARIMA analysis. Production forecasting is analyzed using ARIMA analysis as research conducted by Bangun (2017). This analysis is a model that completely ignores independent variables in making estimates. It uses past and present variable values. The analysis uses Autoregressive Integrated Moving Average (ARIMA), divided into two parts, namely the autoregressive process (AR) and the moving average process (MA).

1. Autoregressive (AR)

   This AR model shows the value of the dependent variable Yt that affects the value of the previous period. In general, the form of the autoregressive (AR) model is written as:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_p Y_{t-p} + e_t$$

Description:

Y_t	=	rice production/ harvested area/ productivity
$Y_{t-1}, Y_{t-2}, Y_{t-p}$	=	lag of dari Y
p	=	AR level

2. Moving Average (MA)

In the second ARIMA method is the Moving Average (MA) model. The q-order MA process explains the predicted value of Yt only depends on the residual value or error from the previous period. The general form of Moving Average (MA) can be written as:

$$Y_t = \alpha_0 + \alpha_1 e_{t-1} + \alpha_2 e_{t-2} + \ldots + \alpha_q e_{t-q}$$

Description:

Y_t	=	rice production/ harvested area/ productivity
$e_{t-1}, e_{t-2}, e_{t-q}$	=	Lag of Y
q	=	MA level

According to Juanda dan Junaidi (2021) In projection or forecasting, a method is needed to determine the level of accuracy of the forecast results that have been calculated using the projection method. There are many methods to determine the accuracy of the forecast. In this case, the Mean Absolute Percentage Error (MAPE) is used. A model has very good performance if the MAPE value is below 10% and has good performance if the MAPE value is between 10% and 20%. Mathematically, MAPE is formulated as follows:

$$MAPE = \frac{\sum_{t-1}^{n} PE_t}{N}$$

Description:

$PE_t = \frac{Xt-Ft}{Xt}$ x 100 (Percentage error at period t)

Xt = Actual data

Ft = Projection data

N = Many time periods

RESULT AND DISCUSSION

1. Development of Rice Production in Malang Regency

a. Development of Rice Harvest Area

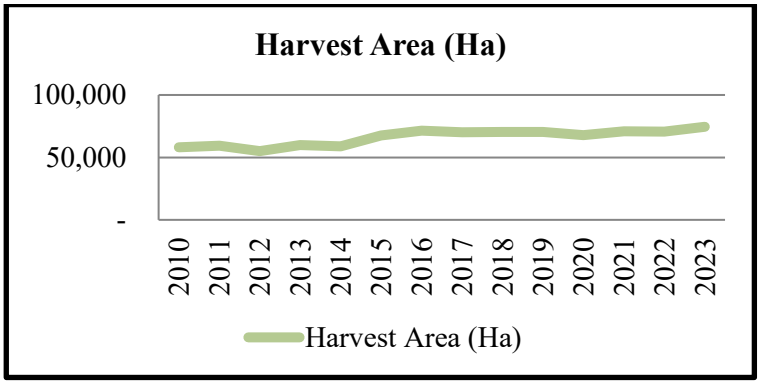

Figure 1. Development of Harvest Area in Malang Regency

The development of harvested area in Malang Regency in 2010, the harvested area was recorded at 58,152 hectares, which then decreased to 55,042 hectares in 2012. However, this figure increased again in the following years, reaching a peak with a harvested area of 74,509 hectares in 2023. During this period, there were several years where the harvested area decreased, such as in 2011 and 2014, but overall the trend showed a steady increase, especially from 2016 to 2023. During this period, the harvested area tended to increase with

an average increase of 1.75 percent. This reflects the ongoing efforts to increase productivity and efficiency in rice cultivation in Indonesia, although challenges such as climate change and increasing food needs remain major concerns for farmers and the government.

b. Development of Productivity

The development of rice productivity in Malang Regency from 2010 to 2023 shows interesting variations. In 2010, rice productivity was recorded at 7.13 tons/hectare, but experienced a gradual decline to reach 7.03 tons/hectare in 2018. Despite fluctuations, the general trend shows a recovery in productivity in the following years. In 2022, rice productivity increased again to 7.09 tons/hectare and peaked at 7.62 tons/hectare in 2023. This increase can be attributed to the application of better agricultural technology, the use of superior seeds, and more efficient agricultural practices. Although the harvested area has decreased in several years, the increase in productivity shows that farmers have succeeded in increasing yields per hectare, reflecting progress in the agricultural sector in Malang Regency.

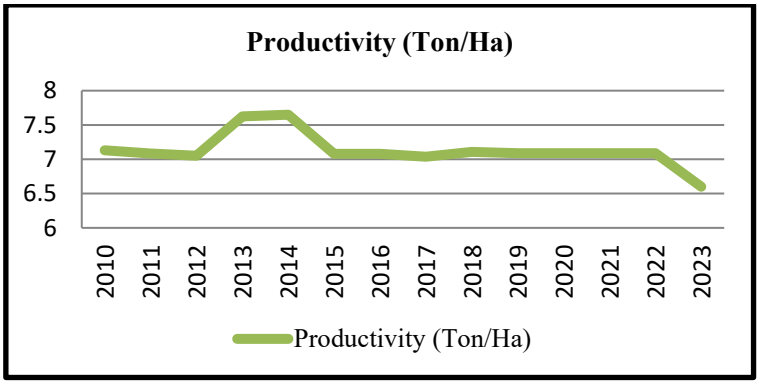

Figure 2. Development of Productivity in Malang Regency

a. Development of Rice Production

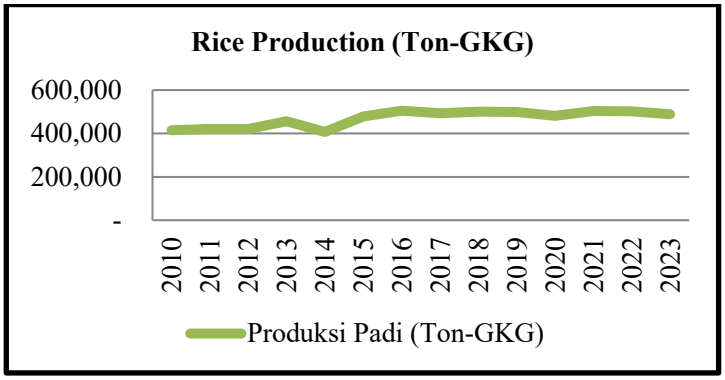

Figure 3. Development of Rice Production in Malang Regency

The development of rice production in Malang Regency in 2010-2023 can be seen in Figure 5. During this period, rice production fluctuated but tended to increase, with an average increase of 1.47% per year. From 2010 to 2023, the highest rice production occurred in 2016 with a total production of 505,138 tons and decreased in 2017 to 493,794 tons. The lowest production was in 2014 with a total production of 407,118 tons. The decline in rice production in 2014 was caused by the long dry season. The long dry season (El Nino) affected rice production in several regencies/cities in East Java so that the harvest in several areas decreased. The influence of uncertain climate has an impact on reducing the growth of total rice production.

2. Projections of Rice Production in Malang Regency

a. Projection of Harvest Area

In this study, the data used is the data on the harvested area of rice production in Malang Regency in 2010 - 2023. The data on the harvested area of rice production in Malang Regency has increased and decreased every year. This shows that the data is not yet stationary. Data identification is carried out to determine whether the data is stationary with respect to the variance and mean. Data identification uses the test *Augmented Dicky Fuller* (ADF), The Augmented Dickey-Fuller (ADF) test is a statistical method used to test for the presence of a unit root in time series data, which is an indicator of data stationarity. The following ADF test results can be seen in Table 1.

Tabel 1. Uji Augmented Dicky Fuller (ADF)

Total Differencing	p-value
0	0,7797
2	0,0013

Source: secondary data processed, 2025.

It can be seen in Table 1 the results of the ADF test show that the data on the area of rice production land in Malang Regency is stationary with a probability of 0.0013 < 0.05, when a stationarity test is carried out with 2 differentiating times. The ARIMA parameter estimation model uses the best ARIMA model. Based on the analysis, the best model is ARIMA (1,2,0) with the lowest AIC value of 252.9955.

Tabel 2. Projection of Rice Harvest Area in Malang Regency

D2.harvestarea	Coefficient	OPG Std. err.	z	P>|z|
harvestarea_cons	283.4262	1640.93	0.17	0.863
ARMA AR (1)	-.7039546	.5121411	-1.37	0.169

Year	Harvest Area (Ha)	Year	Harvest Area (Ha)
2024	75.932	**2035**	122.651
2025	79.482	**2036**	128.542
2026	82.018	**2037**	134.743
2027	85.751	**2038**	141.208
2028	89.124	**2039**	147.970
2029	93.233	**2040**	155.006
2030	97.308	**2041**	162.332
2031	101.889	**2042**	169.937
2032	106.597	**2043**	177.829
2033	111.699	**2044**	186.002
2034	117.006	**2045**	194.459

Source: secondary data processed, 2025.

Table 3. MAPE Value of Harvested Area

Model	MAPE
Harvest Area	4,67%

Source: secondary data processed, 2025.

Based on Table 3, it is explained that the MAPE obtained for the land area projection has a percentage value of 4.67% which provides an indicator that the projection obtained is in the very good category.

The results of the rice harvest area projection show an increase in the area of rice harvest land until 2045. The average growth in rice harvest area in Malang Regency is estimated to increase by 4.45% each year. The highest harvest area is in 2045 at 194,459 hectares. This increase in harvest area reflects ongoing efforts to increase agricultural productivity through the application of modern technology, the use of superior varieties, and more efficient agricultural practices.

b. Projection of Productivity

Table 4. Augmented Dicky Fuller (ADF) Test

Total Differencing	p-value
0	0,2266
2	0,0268

Source: secondary data processed, 2025.

It can be seen above that the results of the ADF test show that the land productivity data of Malang Regency is stationary with a probability of 0.0268 when the stationarity test is carried out with 2 differentiating times. After obtaining stationary data at the 2nd level, the best model is ARIMA (1,2,0) with the lowest AIC value of 13.42487.

Table 5. Projection of Productivity

D. Productivity	Coefficient	OPG Std. err.	z	P>|z|
Productivity_cons	.0043374	.094221	0.05	0.963
ARMA AR (1)	-.253087	.2708304	-0.93	0.350

Year	Productivity (Ton/Ha)	Year	Productivity (Ton/Ha)
2024	7,10	**2035**	7,49
2025	7,11	**2036**	7,55
2026	7,13	**2037**	7,62
2027	7,15	**2038**	7,69
2028	7,18	**2039**	7,76
2029	7,21	**2040**	7,84
2030	7,25	**2041**	7,93
2031	7,29	**2042**	8,01
2032	7,33	**2043**	8,11
2033	7,38	**2044**	8,20
2034	7,43	**2045**	8,30

Source: secondary data processed, 2025.

Based on the results of land productivity projections, there is an increase in land productivity until 2045. The average increase in land productivity in Malang Regency is estimated to increase by 0.010% each year. This increase can be achieved with the support of agricultural extension, comprehensive agricultural technology, the use of superior seeds

and balanced fertilization (Wihardjaka et al., 2020). Each year, productivity is projected to experience a gradual increase, with the figure continuing to rise until it reaches a peak of 8.30 tons/hectare in 2045.

Table 6. MAPE Value of Productivity

Model	MAPE
Productivity	2,10%

Source: secondary data processed, 2025.

Table 6 explains that the MAPE obtained for the productivity projection has a percentage value of 2.10% which provides an indicator that the projection obtained is included in the very good category.

c. Projection of Rice Production

Table 7. Augmented Dicky Fuller (ADF) test

Total Differencing	p-value
0	0,3618
1	0,0000

Source: secondary data processed, 2025.

It can be seen in Table 7 the results of the ADF test show that the rice production data in Malang Regency is stationary with a probability of 0.0000 <0.0500, when a stationarity test is carried out with 1 time differencing. The parameter model uses ARIMA (1,1,0) with an AIC value of 306.3768.

Tabel 8. Projection of Rice Production

D. Production	Coefficient	OPG Std. err.	z	P>|z|
Production_cons	6143.318	5347.472	1.15	0.251
ARMA AR (1)	-.4348114	.1553843	-2.80	0.005

Year	Production (Ton-GKG)	Year	Production (Ton-GKG)
2024	503.209	**2035**	568.274
2025	505.749	**2036**	574.418
2026	513.459	**2037**	580.561
2027	518.921	**2038**	586.704
2028	525.361	**2039**	592.847
2029	531.375	**2040**	598.991
2030	537.574	**2041**	605.134
2031	543.693	**2042**	611.277
2032	549.847	**2043**	617.421
2033	555.986	**2044**	623.564
2034	562.131	**2045**	629.707

Source: secondary data processed, 2025.

Based on Table 8, the results of production projections from 2024 to 2045 continue to increase. At the end of 2024, rice production in Malang Regency is estimated to be 503,209 tons of dry grain. Rice production continues to increase every year and in 2045 rice production in Malang Regency is estimated to be 629,707 tons of dry grain with a growth of 0.98% from the previous year. The average rice production in Malang Regency is 565,282 tons of dry grain and the average growth in rice production each year is 1.15%.

The results of this study are supported by research conducted by Sulistyaningsih & Fatah (2022) with the same projection results showing that rice production in Bondowoso Regency increases every year. In addition, research conducted by Sopiatun Nur et al., (2023) with the projected results of rice production in West Nusa Tenggara increasing by 688,889 tons per year.

The increase in rice production in Malang Regency from 2024 to 2045 can be caused by various factors, including the increase in the area of rice fields, the use of fertilizers, pesticides, labor, and seeds. Based on research Ummah et al., (2023) Factors that significantly influence rice production are land area, urea fertilizer, pesticides, and labor.

Rice production is highly considered by the government so that the basic needs of the community in this case the community's rice consumption can always be met so that rice production is high. Rice production which continues to increase every year must still be considered and its quality improved so that the availability of rice can meet the needs of community consumption and can implement rice self-sufficiency.

Table 9. MAPE Value of Rice Production

Model	MAPE
Rice Production	4,03%

Source: secondary data processed, 2025.

Table 9 explains that the MAPE obtained for the productivity projection has a percentage value of 4.03% which provides an indicator that the projection obtained is in the very good category.

CONCLUSION

Based on the results of the analysis of rice production projections and rice food consumption in Malang Regency, it can be concluded that the projection of rice production in Malang Regency in 2024 - 2045 will experience an increase in rice production with an average percentage increase of 1.14% per year, the highest rice production in 2045 amounting to 629,707 Ton-GKG. This is because the harvested area increases every year by an average of 4.26% each year and productivity is projected to increase by an average of 0.01% each year. The The suggestion in this research is for the government and agricultural extension workers in Malang Regency can continue to support rice production in Malang Regency with the role of agricultural extension workers who actively provide extension and supervise the rice production process, provide assistance in the form of superior seeds and agricultural machinery evenly in Malang Regency.

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