A Mathematical Model for Predicting Future Rice Prices

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Abstract

The purpose of this research is to create a mathematical model that is able to predict future rice prices. The research method used is a case study of rice prices in Indonesia using data collected by the Central Statistics Agency (BPS). Linear regression is used as a method of predicting rice prices in the future. In this study, the price of rice is the effect variable and land area, production and consumption are the independent variables. The linear regression equation obtained is $Y=157318.387-013X_1-1034.254\ X_2+0.001X_3$

***Keywords**:* Linear regression, Mathematical models, Rice Price Prediction.

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Introduction

Rice is a staple food in Indonesia, with most of the population relying on it as their main source of nutrition. Therefore, predicting rice prices is crucial to ensuring food security and stability in the country. By understanding the factors that affect rice prices, policymakers and stakeholders can make informed decisions to mitigate possible price fluctuations and ensure that rice remains affordable and accessible to all Indonesians (P. C. Nadya, N. Mukhammad, and I. Khusna., 2024). With a growing population and increasing demand for rice, it is crucial to have accurate predictions to avoid shortages or surpluses that could lead to price spikes or drops. By utilizing data analysis and modelling techniques, researchers and economists can provide valuable insights into the future of rice prices, helping to create a more stable and sustainable food system for Indonesia.

This predictive capability can also help policymakers and farmers make informed decisions regarding production levels, distribution channels, and trade agreements. By understanding the factors that affect rice prices, such as weather patterns, market trends, and government policies, stakeholders can work together to mitigate potential risks and maximize opportunities in the rice market (S. U. Rafif and F. S. H. Wibowo., 2023). Through collaboration and data-driven insights, countries can build a more resilient and efficient agricultural sector that benefits both producers and consumers. For example, if stakeholders monitor weather patterns and market trends to predict declines in rice production due to drought, they can proactively adjust trade agreements to ensure sufficient supply. This proactive approach also allows farmers to be better prepared for challenges that may arise and make informed decisions regarding crop management.

Literature Review

Prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information, so that the error (the difference between something that happens and the results of the forecast) can be minimized (Veri at al., 2024). One method that can be used to predict rice prices is linear regression. Linear regression is a statistical technique used to model the relationship between independent variables and dependent variables (N. Awalloedin, W. Gata, and H. Setiawan, 2023). The selection of linear regression as a forecasting method in this study is based on the simple model parameters and the advantages of time series-based data estimation. In addition, this method allows for analysis using multiple independent variables (X), which can result in more accurate predictions."(A. Rizaldy, Muhammad, A. Saputra, Tri, D. Cipto, and S. Wibowo, 2023). Related research in predicting using linear regression DKI Jakarta Premium Rice Price Estimates Using Linear Regression to predict the price of premium rice. This linear regression method is believed to be suitable and suitable for time series rice price data. compiled by Ricky Eka Putra, Anita Sindar Sinaga (R. E. Putra and A. S. Sinaga, 2020). Related research in predicting using linear regression Application of Linear Regression Algorithm for Prediction of Rice Crop Yield. Accuracy testing is done by measuring the Root Mean Squared Error (RMSE). The average value of the resulting RMSE accuracy, of 0.432, indicates that the variation in the value produced by a forecast model is close to accurate, compiled by Heru Wahyu Herwanto, Triyanna Widiyaningtyas, Poppy Indriana. (H. W. Herwanto, T. Widiyaningtyas, and P. Indriana, 2019). The Linear Regression prediction method is used, what distinguishes it from other previous studies in this study is the use of different types of variables and using data mining (D. Lukman Hakim and L. Utari, 2020).

Another related research in predicting using linear regression is Predicting the Number of New Students. In this study, the independent variable is the academic year period while the dependent variable is the number of new students. The data to be used is data on new students of the faculty of science and technology consisting of 6 study programmes with a MAPE (Mean Absolute Percentage Error) value of mathematics (7.2%), marine science (8.76%), biology (5.84%), information systems (6.46%), architecture (7.98%), and environmental engineering (7.52%). prepared by N. Almumtazah1, N. Azizah, Y. L. Putri, and Dian C. R. Novitasari (N. Almumtazah, N. Azizah, Y. L. Putri, and D. C. R. Novitasari, 2021). The purpose of this research is to create a mathematical model that is able to predict the price of rice.

Research Methodology

The regression method is a statistical method that makes predictions using the development of mathematical relationships between variables, namely the dependent variable (Y) and the independent variable (X). The dependent variable is the effect variable or the cause variable or the influenced variable, while the independent variable is the cause variable or the influencing variable (N. Kusumawati,F.Marisa, I.D. Wijaya, and U.W. Malang, 2017). Prediction of the value of the dependent variable can be done if the independent variable is known (R. Gustriansyah, 2017). Basically, the price of commodities such as rice can be modelled using simple linear regression. The variables used in this study are:

1. The independent variables (X) are harvested land area per hectare (X1), average consumption per capita per year (X2), and production per year (X3),
2. The dependent variable (Y) is the annual average price of rice for medium quality at the milling level

All data used in this study were sourced from the Central Statistics Agency (BPS) from 2019 to 2023.

A careful data analysis process is required to uncover predictive patterns and significant relationships in the collected dataset. The method used in this study is multiple linear regression. This statistical method is used to analyses the relationship between independent and dependent variables. Regression consists of two basic models simple linear regression and multiple linear regression. Simple linear regression models are used to predict the relationship between two variables, while multiple linear regression involves two or more independent variables. The equation for multiple linear regression is

$$Y = a + b_1X_1 + b_2X_2 + \cdots + b_nX_n$$

From the above equation, the dependent variable is symbolized as the letter Y which is tied to the independent variable (X). The symbol a is a constant and b is a regression coefficient of variable X. The value of an and b on variable X is obtained by the following equation

$$a = \frac{(\sum y)(\sum x^2)-(\sum x)(\sum xy)}{n-(\sum x^2)-(\sum x)^2}$$

$$b = \frac{n-(\sum xy\ \ )-(\sum x)(y)}{n-(\sum x^2)-(\sum x)^2}$$

Results

The following are the results and discussion of this research processed using SPSS:

a. Model Summary

Table 1. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.999[a]	.997	.989	112.00525

a. Predictors: (Constant), production, consumption, area

From the output above, the R Square value is 0.997. This value means that the effect of x1 to x3 on y is 99.7%, while 0.3% is influenced by variables not examined. Thus it can be concluded that the influence of the independent variable is very large on the influence of the dependent variable.

b. Anova

Table 2. Anova

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4533980.657	3	1511326.886	120.471	.047[b]
	Residual	12545.177	1	12545.177		
	Total	4546525.834	4			

a. Dependent Variable: price

b. Predictors: (Constant), production, consumption, area

The value of prob. F count (sig.) in the table above is 0.047 smaller than the significance level of 0.05 so it can be concluded that the estimated linear regression model is feasible to use to explain the effect of the independent variable on the dependent..

c. Coefficients[a]

Table 3. Coefficients[a]

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	157318.387	12836.730		12.255	.052
	area	-.013	.001	-2.365	-10.062	.063
	consumption	-1034.254	100.691	-1.612	-10.272	.062
	production	.001	.000	.383	2.749	.222

a. Dependent Variable: price

Based on the table above, the regression model obtained is:

$Y=157318.387-013X_1 -1034.254\ X_2 +0.001X_3$

Where: X_1= Land area

X_2= Consumption

X_3= Production

Y= Price production, consumption, area

Conclusion

Based on the tests conducted using the linear regression method, the results show a large influence between the independent variables, namely land area, amount consumed and production on the dependent variable, namely the price of rice. For future research, it is recommended to add variables such as weather conditions, rainfall, types of rice varieties, government policies, and other macroeconomic data, as these variables can provide additional information that can improve prediction accuracy.

References

P. C. Nadya, N. Mukhammad, and I. Khusna. "Konsekuensi P. I. pada P. L. di P. T. terhadap H. P. di P. Nur, “Konsekuensi Perubahan Iklim pada Pertanian Lokal di Pakel Tulungagung terhadap Harga Pangan di Pasaran,” 2024, [Online]. Available: https://jurnal.stikes-ibnusina.ac.id/index.php/JUREKSI/article/view/1070

S. U. Rafif and F. S. H. Wibowo. "Digitalisasi D. B. A. “Simpeldesa”: I. D. M. K. P. B. D. D. C. W. R., “Digitalisasi Desa Berbasis Aplikasi ‘Simpeldesa’: Inovasi Dalam Mewujudkan Ketahanan Pangan Berkelanjutan Di Desa Cibiru Wetan,” 2023, [Online]. Available: http://thejournalish.com/ojs/index.php/thejournalish/article/view/601

Veri at al., “Prediksi Peningkatan Omset Penjualan Menggunakan Metode Regresi Linear Berganda”. 2024

N. Awalloedin, W. Gata, and H. Setiawan, “Prediksi Harga Beras Super dan Medium Menggunakan LSTM dan BILSTM (Moving Average Smoothing), 2023” Jurnal Ilmu Komputer, vol. 16, no. 1, [Online]. Available: https://hargapangan.id

A. A. Rizaldy, Muhammad, A. Saputra, Tri, D. Cipto, and S. Wibowo, “Penerapan Metode Regresi Linear Sederhana Untuk Prediksi Penyebaran Vaksin Covid 19 di Kabupaten Cilacap 1).” 2023

R. E. Putra and A. S. Sinaga, “Perkiraan Harga Beras Premium DKI Jakarta Menggunakan Regresi Linier.” 2020

H. W. Herwanto, T. Widiyaningtyas, and P. Indriana, “Penerapan Algoritme Linear Regression untuk Prediksi Hasil Panen Tanaman Padi,” Jurnal Nasional Teknik Elektro dan Teknologi Informasi (JNTETI), vol. 8, no. 4, p. 364, Nov. 2019, doi: 10.22146/jnteti. v8i4.537.

D. Lukman Hakim and L. Utari, “Prediksi Jumlah Pembelian Sepatu Dengan Penerapan Metode Regresi Linear,” vol. 10, pp. 71–80, 2020, doi: 10.36350/jbs. v10i2.

N. Almumtazah, N. Azizah, Y. L. Putri, and D. C. R. Novitasari, “Prediksi Jumlah Mahasiswa Baru Menggunakan Metode Regresi Linier Sederhana,” JURNAL ILMIAH MATEMATIKA DAN TERAPAN, vol. 18, no. 1, pp. 31–40, Jun. 2021, doi: 10.22487/2540766x.2021.v18. i1.15465.

N. Kusumawati.F.Marisa, I.D. Wijaya, dan U.W. Malang, " Prediksi Kurs Rupiah terhadap Dolar Amerika dengan Menggunakan Metode Regresi Linear," JIMP-J.Inform. Merdeka Pasuruan, Vol.2, No.3, hlm. 45-56, 2017.

R. Gustriansyah, " Analisis Metode Single Eksponential Smoothing dengan Brown Eksponensial Smoothing pada Data Kasus Memprediksi Kuantiti Penjualan Produk Farmasi di Apotek," Semin, Nas. Teknol.Inf.Multimed, no February,hlm.6-11,2017.