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The Strategic Role of Multiple Linear Regression in Forecasting Changes in the Farmer's Exchange Rate

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Abstract: This study aims to analyze and forecast the Farmer Exchange Rate (NTP) in Indonesia using a non-experimental quantitative approach. Secondary data in the form of time series covering the period 2015-2024 were obtained from official sources, such as the Central Statistics Agency (BPS) and Bank Indonesia. In this study, a multiple linear regression model was applied to measure the influence of independent variables, such as inflation, interest rates, global commodity prices, harvest area, and rainfall on NTP. The results of the analysis show that there are fluctuations in the value of NTP, with a general increasing trend, especially after the recovery period after the COVID-19 pandemic. Projections for the period 2025-2029 show a consistent increase in the NTP value, from 132.59 in 2025 to reach 177.82 in 2029. Evaluation of the model using the Mean Squared Error (MSE) indicator of 0.55% and Mean Absolute Percentage Error (MAPE) of 0.4635, which indicates a very good level of prediction accuracy. These findings indicate that the multiple linear regression model is effective in projecting NTP and can be used as a basis in formulating strategic policies for the agricultural sector, especially in improving farmers' welfare through optimization of subsidies, efficient land management, as well as strengthening market access and adoption of modern agricultural technology.

Keywords: Farmer's Exchange Rate, Multiple Linear Regression, Time Series.

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A. INTRODUCTION

Farmer Exchange Rate (NTP) is a macroeconomic indicator of the agricultural sector that describes the balance between farmers' income and expenditure (Panggabean et al., 2020). NTP reflects farmers' purchasing power for goods and services, and serves as a reference for evaluating their economic welfare. Various economic variables, such as inflation, interest rates, international commodity prices, and labor market conditions, contribute to NTP fluctuations (Juswadi & Sumarna, 2024). To understand the simultaneous influence of these variables, multiple linear regression (MLR) is a relevant statistical method. MLR can identify complex relationships between one dependent variable and many independent variables simultaneously, resulting in a more thorough prediction of changes in farmers' exchange rates (Maharadja et al., 2021).

Multiple linear regression is a crucial statistical method in agricultural economic analysis because it is able to explain the collective influence of several factors on production outcomes (Sarumpaet & Hermanto, 2025). Through this approach, the relationship between agricultural yields such as rice production and variables such as rainfall, temperature, and land area can be analyzed simultaneously. Studies in Bantul district show that the MLR model can predict rice production with good accuracy (MAD = 0.101), while in Minahasa, the R^2 of 0.667 indicates the strength of the model in explaining variations in the data. The application of software such as AgroReg in R enhances the analysis by providing in-depth visualization and statistical output. However, MLR has limitations such as the assumption of linearity and potential multicollinearity between independent variables (Panggabean et al., 2020).

Changes in NTP cannot be separated from the influence of interacting macroeconomic factors. High inflation directly reduces farmers' purchasing power, which has a negative impact on NTP (Mona et al., 2015). Interest rates also affect farmers' borrowing capacity, where high interest rates tend to reduce NTP due to increased production costs (Maharadja et al., 2021). On the other hand, labor dynamics affect production efficiency and input prices, while fluctuations in global commodity prices, such as oil, impact terms of trade. Studies show that exchange rate depreciation worsens farmers' position in international trade (Nurani et al., 2023). Subsidy policies and access to credit have proven to be a balancing factor to stabilize NTP and support farmers' competitiveness in the market.

MLR has been used in various fields to improve prediction accuracy, including in health and environment (Prasetyo, 2022). In cardiac risk prediction, the combination of NT-proBNP and RCRI showed an AUC of 0.882, indicating high predictive accuracy, although the addition of variables did not always improve accuracy. In the environmental sector, MLR effectively predicted rainfall in India and showed superiority over simple regression, confirming the potential of MLR in forecasting complex phenomena, including in agricultural economics (Fitriyah et al., 2021). However, challenges such as overfitting and interpretation difficulties remain to be addressed. Hence, the integration of this statistical method with machine learning becomes relevant to improve prediction performance in the future (Susanti & Saumi, 2022).

A review of previous studies shows that while multiple linear regression is widely used to predict agricultural output or climatic phenomena, its specific application for forecasting NTP changes is limited. Most studies only examine the effect of specific variables on NTP without integrating multivariate analysis as a whole. On the other hand, there are not many approaches that combine MLR with actual macroeconomic data in the local context of Indonesian farmers. Therefore, this study aims to fill the gap by building a strategic and empirical data-based multiple linear regression model to forecast NTP changes more accurately and predictably.

B. METHOD

This research falls into the quantitative non-experimental category, as it relies on numerical data to measure the relationship between variables without direct manipulation. The quantitative approach is used to analyze the relationship between Farmer Exchange Rate (NTP) as the dependent variable and various economic factors such as inflation, interest rates, global commodity prices, and agricultural variables such as harvest area and rainfall as independent variables. The data used is secondary data obtained from official institutions such as the Central Statistics Agency (BPS), Bank Indonesia, and relevant scientific publications. The data were collected in the form of time series and then processed to ensure consistency and completeness before further analysis.

The research procedure started from the process of collecting and tabulating data into a spreadsheet format which was then analyzed using statistical software such as MATLAB or Python. A multiple linear regression (MLR) model was built to predict NTP by including more than one independent variable. The next steps involved estimating regression parameters, testing classical assumptions, and validating the model through the prediction process. Model accuracy was measured using two main indicators: Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE). MSE shows how large the average squared error is between the actual and predicted values, while MAPE gives an idea of the average absolute percentage error against the actual value. Low MSE and MAPE values below 20% generally indicate that the model has good prediction accuracy. Interpretation of the results focuses on the significance of each variable's influence on NTP, which is ultimately used as the basis for formulating data-based agricultural policy conclusions and recommendations.

The general formula for multiple linear regression is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_K X_K + \varepsilon$$

Explanation:

- Y = Dependent variable (the one to be predicted)
- $X_1, X \ldots\ldots X_k$ = Independent variable (Predictor)
- β_0 = Intercept (Constant)
- $\beta_1, \beta_2, \ldots.\beta_K$ = regression coefficient for each variable X
- ε = error (errors or glitches)

To assess the accuracy of the regression model used, this study applies two evaluation parameters, namely Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE). MSE is used to measure the average of the squared difference between the actual and predicted values; the smaller the MSE value, the more accurate the prediction model. Meanwhile, MAPE presents the error rate as a percentage, making it easy to understand in a practical way. MAPE values below 10% are categorized as excellent, 10-20% as good, 20-50% as fair, and above 50% as poor. By referring to these two parameters, researchers can assess how effective the multiple linear regression model is in accurately projecting the farmer exchange rate. The general formula for multiple linear regression is as follows:

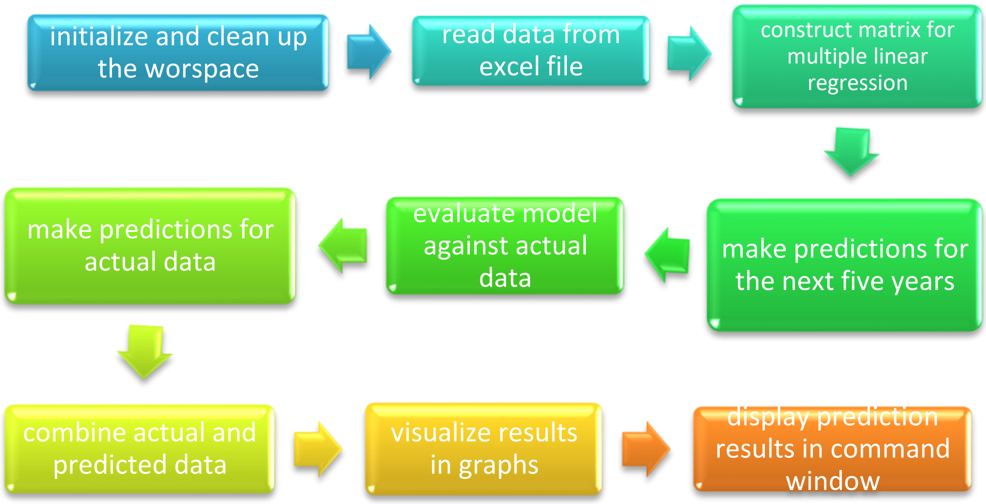

Figure 1. NTP Prediction Algorithm with Multiple Linear Regression

Figure 1 shows the Interpretation of NTP Prediction Process Flow with Multiple Linear Regression The analysis and prediction process begins with initializing and cleaning the workspace to ensure a clean working environment free of previous variables or graphs. Next, data is read from an Excel file containing historical information on year, subsidy amount, farm size, and farmer exchange rate (NTP). The imported data was then organized into a multiple linear regression matrix for statistical modeling purposes.

The next step is to predict the actual data using the regression model that has been formed. The prediction results are then evaluated through error calculations, such as Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE), to measure the accuracy of the model against historical data. After the evaluation, predictions were made for the next five years using estimates of future subsidy values and land area. This predicted data was combined with historical data to provide a comprehensive picture of NTP trends.

C. RESULTS AND DISCUSSION

1. Data Description

Table 1. Data To Be Predicted

Year	Farmer exchange rate
2015	106,22
2016	106,56
2017	107,48
2018	110,91
2019	115,27
2020	109,22
2021	106,88
2020	107,98
2023	122,81
2024	123,31

Based on Table 1, the data shown illustrates the development of the farmer exchange rate (NTP) during the period 2015 to 2024. In general, the NTP fluctuates with a trend that tends to increase, although there are some decreases in certain years. At the beginning of the period, from 2015 to 2019, the NTP showed a relatively stable upward trend, from 106.22 in 2015 to 115.27 in 2019. This indicates an improvement in the relative welfare of farmers, reflecting an increase in farm income relative to farm household consumption expenditure. However, in 2020 there was a significant decline to 109.22, which was most likely caused by economic disruption due to the COVID-19 pandemic. This decline continued in 2021 with a value of 106.88, although the following year (2022) NTP increased again to 107.98, indicating a gradual recovery in the agricultural sector. A sharp spike occurred in 2023 and 2024, with NTP of 122.81 and 123.31, respectively. This increase may reflect the positive impact of policies or economic stimulus that support the agricultural sector, or the increase in the selling price of agricultural products relative to the cost of production and consumption. Overall, although the NTP has fluctuated, the long-term trend shows an upward direction. This indicates an improvement in farmers' purchasing power, which is an important indicator in assessing the welfare of agricultural businesses in Indonesia.

2. Forecasting Result Data and Decision Making

Table 2. Prediction Result Data Table

Year	NTP Predicted
2025	132,59
2026	143,9
2027	155,2
2028	166,51
2029	177,82

Based on the results of forecasting using multiple linear regression models, the Farmer Exchange Rate (NTP) is projected to experience a consistent upward trend over the next five years, starting from 2025 to 2029. In 2025, the NTP is estimated to be at 132.59, then increased to 143.90 in 2026, and continued to grow until it reached 155.20 in 2027. This increase continues in 2028 with a predicted value of 166.51, until finally projected to reach 177.82 in 2029. This positive trend reflects the potential for improvements in purchasing power and farmer welfare in the medium term, assuming that economic conditions and production factors remain stable or increase. The results of this prediction also provide a basis for policy makers to continue to strengthen support for the agricultural sector through optimization of subsidies, land efficiency, and other strategic interventions to maintain the stability and growth of NTP in the future.

3. NTP data description Farmer Exchange Rate

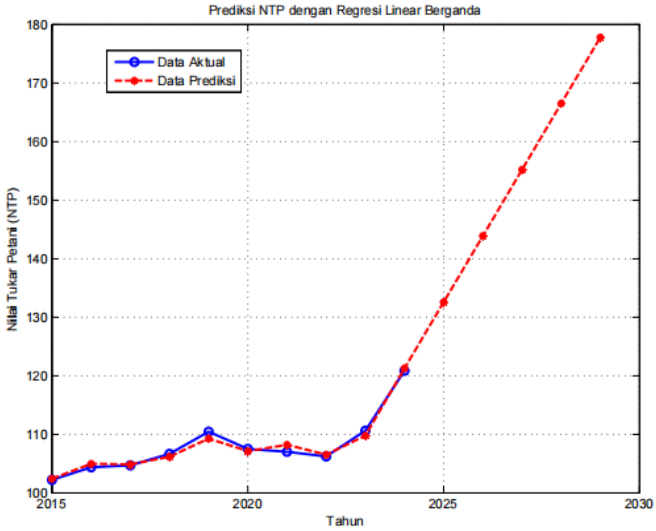

Figure 2. Graph

Figure 2 shows that the graph above presents a comparison between the actual data and the predicted farmer exchange rate (NTP) based on multiple linear regression models for the period 2015 to 2029. The horizontal axis (X) shows the years of observation and projection, while the vertical axis (Y) shows the magnitude of the farmer exchange rate. In general, the graph shows that the multiple linear regression model is able to follow the actual data pattern quite accurately until around 2023. The blue line representing the actual data appears to experience moderate fluctuations from 2015 to the early 2020s, with a trend that tends to increase slowly. The actual NTP value moves from around 100 in 2015 to reach around 122 in 2023.

Furthermore, the dashed red line representing the prediction results shows a sharper growth trend from 2024 to 2029. The model predicts that the NTP will continue to increase significantly, passing 130 in 2026 and approaching 180 in 2029. This trend reflects that the model projects a consistent increase in farmer welfare in the future, assuming that input variables such as subsidies and land area continue to grow linearly. Based on Figure 2, the trend in the farmer exchange rate (NTP) from 2015 to 2024 shows a consistent increase. The graph shows that every year the NTP value has increased, without any significant decline. Thus, it can be concluded that the trend of NTP during the period 2015-2024 is an upward trend. From a visual observation of the graph, the NTP value starts at around 100 in 2015, and continues to increase until it approaches around 160 in 2024. Based on this, a simple statistical estimate can be drawn:

- Minimum: around 100 (in 2015)
- Maximum: around 160 (in 2024)
- Average: is in the range of 130, i.e. the middle value between the minimum and maximum numbers (due to the linear trend, the average can be calculated as (100 + 160)/2 = 130).

Thus, over the course of a decade, the farmer exchange rate experienced steady and positive growth. This trend reflects the improvement or strengthening of farmers' exchange rates over time, in accordance with the direction of the linear regression used in the prediction model.

Table 3. Table of MSE and MAPE Values of Prediction Results

MSE	MAPE
0,55%	0,4635

Table 3 shows that the Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE) values, it can be concluded that the prediction results of the multiple linear regression model show a high level of accuracy. The MSE value obtained of 0.55% reflects that the average square of the difference between the predicted value and the actual value is relatively small, which indicates that the model prediction error is within very low limits. Meanwhile, the MAPE value of 0.4635 indicates that the average absolute percentage error of the model against the actual value is less than 1%, which means that the model has a very low prediction error rate in percentage terms. Thus, these two evaluation indicators indicate that the multiple linear regression model used in this study has excellent performance in predicting the Farmer Exchange Rate (NTP), and is suitable for use as a basis for decision-making in agricultural policy planning.

D. CONCLUSIONS AND SUGGESTIONS

Based on the results of the analysis of historical data and projections of the Farmer Exchange Rate (NTP), it is concluded that the NTP experienced fluctuations with an increasing trend during the period 2015 to 2024, reflecting the improvement of farmers' welfare which was disrupted by the impact of the COVID-19 pandemic in 2020-2021, but gradually recovered to reach 123.31 in 2024. Projections using multiple linear regression models predict a consistent increase in NTP until 2029, with a predicted value of 177.82, indicating the potential for strengthening farmers' purchasing power if economic conditions and production factors remain conducive. This prediction model is considered highly accurate based on the Mean Squared Error (MSE) value of 0.55% and Mean Absolute Percentage Error (MAPE) of 0.4635, so it can be used as a reference in the formulation of strategic policies. In line with this, it is recommended that the government and stakeholders optimize agricultural sector policies through targeted subsidies, efficient land management, and improved market access. Regular monitoring and evaluation of the variables that determine NTP also need to be carried out so that the policies implemented are adaptive to the dynamics of the field. In addition, diversifying farmers' income sources through agribusiness development and improving market connectivity, as well as investing in human resource capacity building and the adoption of modern agricultural technology, are strategic steps that can be taken.

REFERENCES

Fitriyah, Z., Irsalina, S., K, A. R. H., & Widodo, E. (2021). Analysis of Factors Affecting Ipm Using Multiple Linear Regression. Lebesgue Journal: Scientific Journal of Mathematics Education, Mathematics and Statistics, 2(3), 282-291. https://doi.org/10.46306/lb.v2i3.86

uswadi, J., & Sumarna, P. (2024). The Development of West Java Farmer Exchange Rate (NTP) and its Correlation with Labor, Inflation, and Gross Regional Domestic Product (GRDP) of West Java Agricultural Sector. Paspalum: Scientific Journal of Agriculture, 12(1), 128. https://doi.org/10.35138/paspalum.v12i1.692

Maharadja, A. N., Maulana, I., & Dermawan, B. A. (2021). Application of Multiple Linear Regression Method for Prediction of State Losses Based on Corruption Crime Cases. Journal of Applied Informatics and Computing, 5(1), 95-102. https://doi.org/10.30871/jaic.v5i1.3184

Mona, M., Kekenusa, J., & Prang, J. (2015). Use of Multiple Linear Regression to Analyze Coconut Farmers' Income. Case Study: Coconut Farmers in Beo Village, Beo District, Talaud Regency. D'CARTESIAN, 4(2), 196. https://doi.org/10.35799/dc.4.2.2015.9211

Nurani, A. T., Setiawan, A., & Susanto, B. (2023). Performance Comparison of Decision Tree Regression and Multiple Linear Regression for BMI Prediction on Asthma Dataset. Journal of Science and Science Education, 6(1), 34-43. https://doi.org/10.24246/juses.v6i1p34-43

Panggabean, D. S. O., Buulolo, E., & Silalahi, N. (2020). Application of Data Mining to Predict Tree Seedling Orders with Multiple Linear Regression. JURIKOM (Journal of Computer Research), 7(1), 56. https://doi.org/10.30865/jurikom.v7i1.1947

Prasetyo, R. A. (2022). Multiple Linear Regression Analysis to Look at Factors Affecting Poverty in West Sumatra Province. Journal of Mathematics UNP, 7(2), 62. https://doi.org/10.24036/unpjomath.v7i2.12777

Sarumpaet, I., & Hermanto, B. (2025). Factors Affecting Income (Case Study: In Kedai Tiga Village, Barus District). AgroNusantara Journal, 5.

Susanti, I., & Saumi, F. (2022). Application of Multiple Linear Regression Analysis Method to Overcome Multicollinearity Problem in the Case of Human Development Index (Ipm) in Aceh Tamiang Regency. Gamma-Pi: Journal of Mathematics and Applied, 4(2), 38-42.