

Changes in strategic foods and farmers' terms of trade that are causally related

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ABSTRACT

This study seeks to analyze the price fluctuations of strategic food items, specifically rice and cayenne pepper, in NTT Province, and to examine the correlation between these price changes and the farmer exchange rate in the region. Fluctuations in the prices of food goods in substantial volumes can significantly impact the inflation rate. The study that was conducted made use of secondary data, which was collected from the NTT Provincial Central Statistics Agency. These data were in the form of a time series. The coefficient of variation and multiple linear regression analysis were two of the analytical methodologies that were used. The price of cayenne pepper undergoes substantial fluctuations over time. The price of rice and NTP exhibit a significant positive correlation, indicating that an increase in rice prices is associated with an increase in NTP, consistent with the positive coefficient observed in the regression equation. This research suggests that the government should address fluctuations in rice and cayenne pepper prices by enhancing production and effectively managing supply and demand, thereby improving income and welfare.

Keywords:

Chili, Price changes, Rice, Term of trade

1. Introduction

Over the past three years, the Food Price Index has exhibited ongoing fluctuations [1–3]. Statistical measures that track the changes in the price of food items over time exhibit gradual fluctuations, resulting in limited access to agricultural inputs and research and development, which are regarded as inadequate, while the volatility of agricultural production is viewed positively.

In East Nusa Tenggara (NTT) Province, the predominant portion of the people relies in the food and farming industry, particularly food crops, for their sustenance. Nonetheless, a measure of food safety of NTT Province has seen a drop followed by a gradual rebound. The cultivation of primary food crops in NTT is very susceptible to meteorological and climatic fluctuations, as indicated by the analysis. This indicates that present food prices do not ensure reliable income and food accessibility for the population.

Multiple elements and issues, including production, distribution, supply sources, demand, and supply, influence food prices, particularly for critical commodities [4]. Variations in food commodity prices primarily arise from a disparity between the supply provided by farmers as producers and the demand required by consumers [5]. Fluctuations in the prices of food goods in substantial volumes can significantly impact the inflation rate [6–8].



How things work when fluctuating with strategic food pricing provides a robust foundation to ensure one of the lowest possible prices for a product at the producer level, that also considers consumer interests. In food economics, pricing is a critical factor that must be examined, as it may affect income and subsequently influence the Farmer's Terms of Trade (NTP) as an indicator of farmer wellbeing. Regional governments have a crucial role in stabilizing and mitigating fluctuations in the pricing of essential food items for the community [9]. This study examines the fluctuations in food prices, particularly rice and cayenne pepper, and their causal link with the Farmer Term of Trade (NTP) as a measure of farmer wellbeing in East Nusa Tenggara Province. The research addresses the term of trade rate analysis [10]. This study introduces application regression using multiple linear models for assessing and clear impact from rice and cayenne pepper price on local terms of trade.

2. Methods

The study carried out in NTT Province and utilized data from the Office of the Provincial Statistician (BPS) in NTT [11]. The data utilized is quantitative and sourced from secondary data. The secondary data collection included non-participant observation, and documenting time series data, specifically monthly data (IDR/kg) for rice and cayenne pepper from 2021 to 2023. This research utilizes 36 data points. The analytical approach to achieving the aim involves calculating price changes using the Coefficient of Variation (CV) using Microsoft Excel. To address the second aim, employ more than one linear regression study to examine and ascertain correlation association between price fluctuations and NTP utilizing the SPSS 26 program [12].

The pricing data's coefficient of variation over time indicates variations that assess the price stability of a product. Prior to assessing the coefficient of variation, one must first calculate the mean and standard deviation. The First Formula for Data Dispersion (SD) is as follows:

$$SD = \frac{\sqrt{\sum (X_i - \bar{X})^2}}{n} \quad (1)$$

SD = Dispersion of prices
 X_i = Price changes
 $\bar{X}$ = Average price change
 n = Average price amount data

The Second Formula for the Variance Coefficient (CV) is as follows:

$$CV = \frac{S}{\bar{X}} \times 100\% \quad (2)$$

CV = Variance Coefficient
 S = Data Dispersion
 $\bar{X}$ = Average price Strategic Food

This research employs two independent variables: NTP (Y) and the prices of rice (x1) and cayenne pepper (x2) serving as an indicator of farmer welfare. Quantitative variables comprise these three variables. Multiple linear equations:

$$Y = \alpha + \beta_1.x_1 + \beta_2.x_2 + \epsilon \quad (3)$$

Y = Term of trade

A = Constant

β_1 = Regression coefficient x1

β_2 = Regression coefficient x2

x1 = Rice Price

x2 = Price of Cayenne Pepper

ϵ = error

3. Results and Discussion

3.1. Variance Coefficient

The coefficient of variation in price data across temporal intervals denotes fluctuations that are employed to ascertain the price stability of a commodity. The coefficient of variation aims to predict data variables based on the average that has been taken from the field [13].

Table 1. Standard deviation and average price changes for rice and cayenne pepper – a calculation

Commodity	Standard Deviation (IDR)	Means (IDR)
Rice	1.369	12.221
Cayenne Pepper	10.176	63.443

The standard deviation or data dispersion quantifies the extent of price variations relative to mean data [14]. A higher standard deviation indicates more significant price fluctuations. In the interim, the average reflects the mean price of the commodity over a three-year period. To evaluate price changes for cayenne pepper and rice over a three-year period from 2021 to 2023, we first get the standard deviation and average of the monthly data. Then, we run the data through the coefficient of variation calculation. A measure of dispersion functions as a critical statistical tool for assessing variability in relation to the mean. Specifically, the coefficient of variation (CV) serves as a standardized metric that enables comparisons across different datasets, with a higher CV indicating greater relative fluctuations. The analysis of historical price data for rice in NTT Province over the past three years reveals discernible price variations. Despite these fluctuations, the overall trend suggests a movement towards stability, as reflected in a coefficient of variation of 11.20%. This figure indicates a moderate level of volatility, where rice prices exhibit notable short-term deviations but remain within a relatively controlled range over time. The observed fluctuations may be attributed to various economic, environmental, and logistical factors influencing supply and demand dynamics within the region. Analyzing the nature of these fluctuations can provide insights into market resilience. If price fluctuations are irregular and unpredictable, it may indicate underlying structural inefficiencies in the supply chain [15–17]. However, if the variations follow a consistent pattern, it could suggest a natural seasonal cycle that businesses and

policymakers can anticipate and manage effectively [18–20]. The price of cayenne pepper in NTT Province has exhibited significant fluctuations over the past three years, evidenced by a coefficient variation of 16.04%. The price of cayenne pepper in NTT Province exhibits considerable variability, reflecting substantial fluctuations over time. This outcome aligns with previous studies [21,22], yet it stands in contrast to the findings presented in research [23].

The significant variation in the price of cayenne pepper, in contrast to the more stable price of rice, indicates the presence of multiple volatile factors affecting cayenne pepper's pricing in NTT. These factors include production, distribution, sources of supply, and the dynamics of demand and supply. The significant volatility in cayenne pepper prices adversely affects individuals, particularly those with lower income levels [24,25]. Price fluctuations create uncertainty regarding the actual price, complicating consumer spending decisions, leading to a decline in purchasing power, and resulting in the community's inability to afford food.

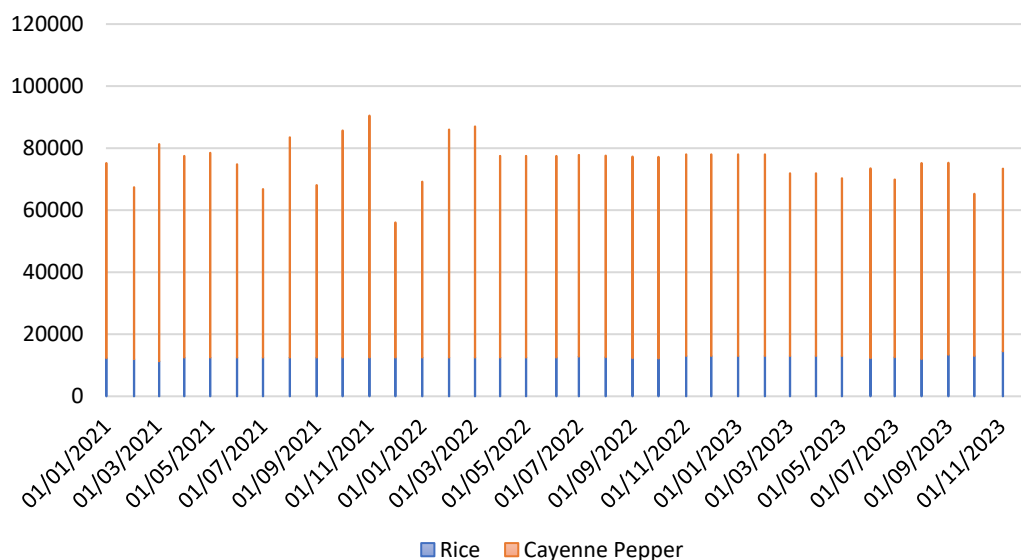


Figure 1. Illustrates the price fluctuations of rice and cayenne pepper in NTT from 2021–2023

The graph that is located above indicates fluctuations in the prices of rice and cayenne pepper. Over the three-year duration of observation from 2021 to 2023, there has been noticeable fluctuation in the prices of key food commodities, specifically rice and cayenne pepper. During the three-year period, the price of rice is projected to peak at IDR 15,000 in December 2023, while the lowest recorded price was IDR 11,300 in March 2021. In December 2023, the price of cayenne pepper peaked at IDR 82,950, marking the highest price observed in the past three years. Conversely, the lowest recorded price was IDR 43,555 in January 2021. The data analysis indicates that the price of rice in NTT Province over the past three years exhibit fluctuations that are generally stable, as evidenced by a coefficient variation of 11.20%. The price of rice in NTT Province exhibits moderate variability, as it fluctuates by more than 10%. This indicates that there are notable price changes occurring periodically, though these changes are not excessively large in magnitude. The fluctuations in rice prices over a specific timeframe align with various perspectives [26–28]. Subsequently, it was

found that the price of cayenne pepper in NTT Province exhibited significant fluctuations over three years, exceeding 15%, with a coefficient of variation calculated at 16.04%. Research provides explanations for the significant fluctuations observed in food prices [29–31].

3.2. *Fluctuation*

Throughout the three-year observation period from 2021 to 2023, there was noticeable fluctuation regarding the prices of critical food items, including rice and cayenne pepper. During the three-year period, the price of rice peaked at IDR 15,000 in December 2023, in contrast, the lowest recorded price was March 2021 will bring IDR 11,300. In December 2023, the price of cayenne pepper peaked at IDR 82,950, marking the highest point in a three-year span. Conversely, the low recorded price was January 2021 will cost IDR 43,555.

While price fluctuations indicate instability to some degree, their magnitude and frequency determine whether they reflect a volatile market or a market with predictable cyclical patterns [32–34]. In the case of rice prices in NTT Province, the observed fluctuations over the past three years suggest a mix of short-term volatility and long-term stabilization. This suggests that external pressures—such as climate variability, transportation costs, and production output—impact price movements but do not lead to extreme or unpredictable surges. The significant variability in the price of cayenne pepper, in contrast to the more stable price of rice, indicates the presence of multiple volatile factors affecting cayenne pepper prices in NTT. These factors include production, distribution, sources of supply, and the dynamics of demand and supply. The significant volatility in cayenne pepper prices adversely affects individuals, particularly those with limited financial resources. Price fluctuations create uncertainty regarding the actual price, complicating individuals' decision-making processes when it comes to spending their money. Meanwhile, moderate fluctuations in rice prices do not have a significant negative impact, but if these fluctuations occur continuously or are extreme, they can also cause price uncertainty and affect people's purchasing power.

3.3. *Classical Assumption Test*

Testing classical assumptions in multiple regression is crucial to verify that the employed model satisfies the necessary criteria, thereby enhancing the accuracy of the analysis results.

3.3.1. *Heteroscedasticity Test*

The heteroscedasticity test is designed to assess whether there is a variance inequality among the residuals of different observations within the regression model. This research examines the Scatterplot Graph to determine the presence of heteroscedasticity.

The findings from the heteroscedasticity test conducted on the scatterplot indicate that the data points are distributed randomly, with a presence both above and below the zero mark on the Y-axis. The absence of heteroscedasticity in the regression model indicates its suitability for application.

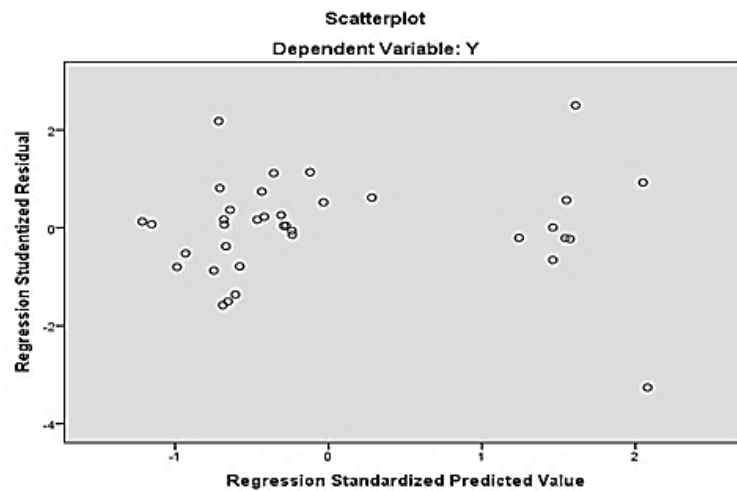


Figure 2. Presents the results of the heteroscedasticity test as depicted in the scatterplot graph

3.3.2. Autocorrelation Analysis

The Autocorrelation Analysis is designed to evaluate the present correlation between confounding errors at time t and those at time $t-1$ within the linear regression model [35,36].

Table 2. Autocorrelation analysis

Model	R	R Square	Adjusted R Square	Estimate	Durbin-Watson
1	.455	.207	.159	1.48437	1.628

a. Predictors: (Constant), X2, X1

b. Dependent Variable: Y

The Durbin-Watson value presented in the table is 1.628. This value will be assessed against the value of the Durbin-Watson (DW) table system at when taking into consideration a sample size of 36 and two independent variables, the significance threshold of α is set at 5%. The analysis of the equation above indicates that the regression equation does not exhibit an autocorrelation issue.

3.4. Normality Test

The purpose of the normality test is to assess whether the confounding or residual variables in the regression model exhibit a normal distribution. Multiple methods exist for assessing normality, one of which involves the examination of diagrams of histograms. If the distribution of the data's residuals is typical, the data points will align along a line that is diagonal. When the data aligns along a line or histogram that is diagonal in shape exhibits a distribution pattern that is more usual, it indicates that model of regression analysis meets the criteria for generating the form of a rising curve, indicating that the pattern follows a regular and consistent distribution [37,38].

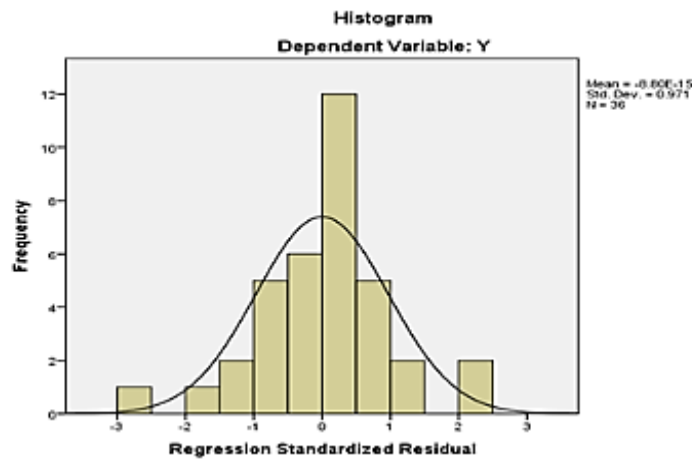


Figure 3. The normality test using histogram

The histogram normality test results, as illustrated in the graph above, indicate a mountainous curve shape, suggesting that the data follows a normal distribution pattern.

3.5. Multiple Linear Regression

Multiple linear regression analysis is employed to assess the relationship between the price of rice and cayenne pepper and the farmers' terms of trade [39].

Table 3. Regression with multiple linear equations

Model	Unstandardized Coefficient		Standardized Coefficient		
	B	Std. Error	Beta	t	Sig. (p-value)
(Constant)	89.021	2.414		36.882	.000
Rice Price	.001	.000	.482	2.928	.006
Cayenne Pepper Price	-2.032	.000	-.128	-,777	.004

Table 3 indicates the outcomes of the analysis of several linear regressions together conducted out of a total of thirty-six data points. The structure about the equation for regression derived previously can be elucidated in the following manner:

$$Y = 89.021 + (0.001) \chi_1 + (-2.032) \chi_2 \quad (4)$$

The preceding calculations can be articulated in the following manner:

- The value of the Rice Price Coefficient (χ_1) is 0.001, suggesting a positive correlation between rice prices and the terms of trade for farmers. The farmer's exchange rate rises with each increment in the price of rice. Conversely, a reduction in the price of rice corresponds with a decrease in the NTP value.
- The value of the price coefficient (χ_2) for cayenne pepper is -2.032, indicating between the price of cayenne pepper and the currency rate for farmers, there is a negative association between the two. An increase in the future, the cost of cayenne pepper will result in a decrease in the NTP, whereas a decrease in the price of cayenne pepper will lead to an increase in the NTP value.

The outcomes of the study of the examination of several linear regressions indicate that the price of rice exhibits a favorable correlation between the exchange rate of the farmer and the market. However, this relationship is not statistically significant, as evidenced by the p -value of 0.006, which exceeds the threshold of 0.005. This suggests that an increase in the price of rice is associated with a tendency to increase the NTP. This indicates the presence of a positive coefficient in the equation for regression. In the meantime, the price of cayenne pepper exhibits a notable negative correlation about the currency rate for farmers, as indicated by a p -value of 0.004, which is less than 0.005. This suggests that an increase in the price of cayenne pepper is associated with a decrease in the NTP, as reflected by the negative coefficient that is included in the equation for regression. While There is a partial negative association between the prices of rice and cayenne pepper and the farmers' financial situation or terms of trade, their collective pricing dynamics are related to the NTP. Consequently, it follows that H_0 is rejected and H_1 is accepted, as there exists a partnership that exists simultaneously between fluctuations in the prices of rice and cayenne pepper and the farmer's term of trade (NTP). The alterations in farmers' terms of trade, shaped by fluctuations in commodity prices, align with the findings of the research [40,41].

The price of rice does not significantly affect the farmers' exchange rate because the fluctuation in rice prices remains below 15%. The price of rice has less influence on NTP also because farmers' production costs in producing rice are smaller than for cayenne pepper. The Indonesian government should protect farmers by setting the lowest prices for certain commodities to minimize the negative influence on farmers' NTP. Government policy programs for the agricultural sector are very important in improving the welfare of farmers [42].

The price change of cayenne pepper has a significant influence because it experiences very high fluctuations. In certain months, farmers get high income from the spike in the price of cayenne pepper, but farmers can also suffer losses if the price of cayenne pepper falls significantly.

4. Conclusion

In East Nusa Tenggara Province, the price dynamics of strategic food items such as rice and cayenne pepper reveal distinct patterns. The price of rice shows fluctuations that are relatively stable, indicating that while there are notable changes over time, they do not occur on an extensive scale. Conversely, the price of cayenne pepper exhibits high volatility, characterized by significant price changes occurring frequently. Given these findings, the government can implement targeted policies to enhance market stability. For rice, policies such as price stabilization programs, improved storage infrastructure, and farmer support initiatives can help maintain supply consistency and moderate price fluctuations. Meanwhile, for cayenne pepper, interventions like supply chain improvements, enhanced market information systems, and post-harvest technology investments can help mitigate extreme price swings and ensure fair pricing for both producers and consumers. By implementing these strategies, the government can foster a more resilient food market, reducing economic uncertainty and ensuring food security in the region.

The connection that exists between fluctuations in strategic food prices, specifically rice and cayenne pepper, and the Farmer's term of trade in East Nusa Tenggara Province indicates that rice prices and farmer's term of trade exhibit an important

source of optimism correlation. This suggests that an increase in the volatility of rice prices is likely to lead to an increase in Farmer's Term of Trade. The price change of cayenne pepper exhibits a notable inverse correlation with NTP, indicating that an increase in the price change of cayenne pepper is likely to lead to a decrease in NTP.

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References

1. Li Y, Yao J, Song J, Feng Y, Dong H, Zhao J, et al. Investigation of causal public opinion indexes for price fluctuation in vegetable marketing. *Comput Electr Eng*. 2024;116:109227.
2. Zhang L, Shi Q, Zhou N. The influence of grain futures market on stock price fluctuation of agricultural listed companies. *Financ Res Lett*. 2024;59:104795.
3. Zhao T, Gu X, Fang C, Wu D. Price fluctuation analysis of mutton in Qinghai based on X-13A-S method. *Procedia Comput Sci*. 2024;242:1354–61.
4. Farizi RR, Kornitasari Y. Analisis pengaruh jumlah persediaan beras dan harga beras terhadap pembentukan inflasi di Provinsi DKI Jakarta. *J Dev Econ Soc Stud*. 2023;2(2):386–403.
5. Azwina R, Syahbudi M. Pengaruh fluktuasi harga komoditas pangan terhadap inflasi di Provinsi Sumatera Utara tahun (2019-2021). *El-Mal J Kaji Ekon Bisnis Islam*. 2023;4(1):238–49.
6. Hibatulwafi F, Asmiyanto T. Business intelligence implementation for groceries commodity price data analytics. *SINTECH J*. 2024;7(2):125–37.
7. Yulia Y, Bahtera NI, Sitorus R, Asista A. Analysis of eco-friendly preference and consumer satisfaction on the attributes of rice in Toboali Bangka Selatan. *Anjoro Int J Agric Bus*. 2024;5(1):1–8.
8. Berlian GO, Wahyuningtyas ASH, Setiawan B. Identifying contributing variables on rice production: Case study of rural smallholder farmers. *Anjoro Int J Agric Bus*. 2024;5(2):51–62.
9. Sun Q, Gao X, Wen S, Chen Z, Hao X. The transmission of fluctuation among price indices based on Granger causality network. *Phys A Stat Mech its Appl*. 2018;506:36–49.
10. Salsabila S, Siregar AF. Analisis indikator nilai tukar petani (NTP) dan nilai tukar pendapatan rumah tangga petani (NTPRT) untuk mengukur tingkat kesejahteraan petani kedelai di Kecamatan Barumun Tengah Kabupaten Padang Lawas. *JASc (Journal Agribus Sci)*. 2021;5(1):57–66.
11. BPS-Statistics Nusa Tenggara Timur. Nusa Tenggara Timur Province in figures 2023. Kupang; 2024.
12. Čaplová Z, Švábová P. IBM SPSS statistics. In: Obertová Z, Stewart A, Cattaneo C, editors. *Statistics and Probability in Forensic Anthropology*. London: Academic Press is an imprint of Elsevier; 2020. p. 343–52.
13. Adrianto S, Balqis IHN, Soetanto CZN, Ohyver M. Cochrane orcutt method to overcome autocorrelation in modeling factors affecting the number of hotel visitors in Indonesia. *Procedia Comput Sci*. 2023;216:630–8.

14. Cavallo A, Kryvtsov O. Price discounts and cheapflation during the post-pandemic inflation surge. *J Monet Econ.* 2024;148:103644.
15. Ananda MI. Model analysis of gated recurrent unit for multivariate rice price forecasting. *J ELTIKOM.* 2023;7(2):125–32.
16. Antamoshkina E, Rogachev A. Modeling the impact of agricultural production on food security taking into account import substitution. In: *SHS Web of Conferences - 3rd International Scientific Conference on New Industrialization and Digitalization (NID 2020).* EDP Sciences; 2021. p. 04003.
17. Shobur M, Marayasa IN, Bastuti S, Muslim AC, Pratama GA, Alfatiyah R. Enhancing food security through import volume optimization and supply chain communication models: A case study of East Java's rice sector. *J Open Innov Technol Mark Complex.* 2025;11(1):100462.
18. Aprillya MR, Suryani E, Dzulkarnain A. System dynamics simulation model to increase paddy production for food security. *J Inf Syst Eng Bus Intell.* 2019;5(1):67–75.
19. Ayunda WA, Purwaningsih I. The elements required for multi-stakeholder collaboration to achieve sustainable agricultural: Based on jarwo super application in West Java. *Cakrawala.* 2024;18(1):35–49.
20. Badraoui I, Van der Vorst JGAJ, Boulaksil Y. Horizontal logistics collaboration: an exploratory study in Morocco's agri-food supply chains. *Int J Logist Res Appl.* 2020;23(1):85–102.
21. Ohhyver M, Pudjihastuti H. Arima model for forecasting the price of medium quality rice to anticipate price fluctuations. *Procedia Comput Sci.* 2018;135:707–11.
22. Tsuya NO, Hamano K. Mortality responses to rice price fluctuations and household factors in a farming village in central Tokugawa Japan. *Hist Fam.* 2001;6(1):1–31.
23. Valera HGA, Mishra AK, Pede VO, Yamano T, Dawe D. Domestic and international impacts of rice export restrictions: The recent case of indian non-basmati rice. *Glob Food Sec.* 2024;41:100754.
24. Barik S, Ponnamm N, C. Reddy A, Lakshmana LR, Saha K, Acharya GC, et al. Breeding peppers for industrial uses: Progress and prospects. *Ind Crops Prod.* 2022;178:114626.
25. Spence C. The king of spices: On pepper's pungent pleasure. *Int J Gastron Food Sci.* 2024;35:100900.
26. Antriyandarti E, Agustono, Ani SW, Rusdiyana E, Sukaton DLA. Consumers' willingness to pay for local rice: Empirical evidence from Central Java, Indonesia. *J Agric Food Res.* 2023;14:100851.
27. Giannioti Z, Brigante FI, Kelly S, Ogrinc N, Hudobivnik MJ, Mazej D, et al. Authentication of premium Asian rice varieties: Stable isotope ratios and multi-elemental content for the identification of geographic fingerprints. *Lwt.* 2024;209:116752.
28. Molla T, Tesfaye K, Mekbib F, Tana T, Taddesse T. Farmers' perspectives on drivers of rice yield in the Fogera Plain of Ethiopia. *Heliyon.* 2022;8(12):e12021.
29. Adriani D, Purbiyanti E, Huanza M, Damayanthi D. Discovering the socio-economic migrant performance on illegal logging activities for deforestation problem solving in Banyuasin Regency, South Sumatera (case study of Sungai Buring traditional village). *Anjoro Int J Agric Bus.* 2023;4(1):10–20.

30. Saâdaoui F. Structural self-similarity pattern in global food prices: Utilizing a segmented multifractal detrended fluctuation analysis. *Pattern Recognit Lett.* 2024;184:74–9.
31. Suganda A, Mujahidin Fahmid I, Baba S, Salman D. Fluctuations and disparity in broiler and carcass price before during and after covid-19 pandemic in Indonesia. *Heliyon.* 2024;10(8):e29073.
32. Asgari M, Saghaian SH, Reed MR. The impact of energy sector on overshooting of agricultural prices. *Am J Agric Econ.* 2024AD;102(2):589–606.
33. Bai J, Perron P. Estimating and testing linear models with multiple structural changes. *Econometrica.* 1998;66(1):47–78.
34. Zhang W, Wu J, Wang S, Zhang Y. Examining dynamics: Unraveling the impact of oil price fluctuations on forecasting agricultural futures prices. *Int Rev Financ Anal.* 2025;97:103770.
35. Pötscher BM, Preinerstorfer D. Controlling the size of autocorrelation robust tests. *J Econom.* 2018;207(2):406–31.
36. Salazar JJ, Garland L, Ochoa J, Pyrcz MJ. Fair train-test split in machine learning: Mitigating spatial autocorrelation for improved prediction accuracy. *J Pet Sci Eng.* 2022;209:109885.
37. Berenguer-Rico V, Nielsen B. Normality testing after outlier removal. *Econom Stat.* 2023;
38. El Bouch S, Michel O, Comon P. A normality test for multivariate dependent samples. *Signal Processing.* 2022;201:108705.
39. Shine P, Scully T, Upton J, Murphy MD. Multiple linear regression modelling of on-farm direct water and electricity consumption on pasture based dairy farms. *Comput Electron Agric.* 2018;148:337–46.
40. Hannafi Ibrahim K, Dwi Handoyo R, Dwi Kristianto F, Kusumawardani D, Ogawa K, Azlan Shah Zaidi M, et al. Exchange rate volatility and COVID-19 effects on Indonesia's food products' trade: Symmetric and asymmetric approach. *Heliyon.* 2024;10(12):e32611.
41. Iorember PT, Mohamed Yusoff NY, Abachi PT, Usman O, Alola AA. Effect of exchange rate uncertainty, energy prices and sectoral spending on agriculture value added, household consumption, and domestic investment. *Heliyon.* 2024;10(9):e30138.
42. Mahendra B, Dwi);, Kinding PN, Alfiyya);, Safitri D. Upland program in increasing the income of highland farmers in Purbalingga Regency. *J Agri Socio Econ Bus.* 2022;4(2):171–80.