Journal of Science-FAS-SEUSL (2026) 07(01) 62-67
ISSN: 2738-2184

Rice yield–price correlation in Sri Lanka: Implications of the 2021 fertilizer policy

D.M.P.S. Disanayaka[1*], A.M. Razmy[1], A.M.A.C. Bandara[1] and A.M. Nahfees[2]

[1]Department of Mathematical Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka

[2]University Library, South Eastern University of Sri Lanka

[*]pspurni97@gmail.com

Abstract

This study examines whether the implementation of Sri Lanka's 2021 fertilizer policy was associated with changes in the relationship between rice yield and market prices in the South Coastal region of the Ampara District. In May 2021, the government introduced restrictions on the import of chemical fertilizers and agrochemicals, which coincided with changes in rice production conditions and market dynamics. The study investigates the differences in yield–price relationships before and after the policy implementation. Data were collected from 145 farmers during the Yala 2021 season (before the policy implementation) and the Maha 2021/22 season (after the policy implementation) using structured questionnaires. For both seasons, yield per acre and price per kilogram of dry paddy were calculated, with wet yields standardized into dry yields to ensure consistency in analysis. The results indicate that yield and selling price showed a significant positive linear association during the Yala season ($r = 0.254$, $p = 0.002$). The variance-based analysis further showed that the income variability during the Yala season differed from the assumption of yield–price independence ($F = 1.877$). In contrast, during the Maha season, no significant linear association was observed between yield and selling price ($r = -0.068$, $p = 0.415$), and the variance-based analysis was consistent with the assumption of yield–price independence ($F = 1.02$). Although no significant difference in income variance was observed between the two seasons, selling price variability was significantly higher during the Yala season (124.38 $(Rs./kg)^2$) compared. Overall, the findings indicate that yield–price relationships and price variability differed between the two cultivation seasons. The observed reduction in price variability and changes in the yield–price association during the Maha season coincided with the implementation of the fertilizer policy; however, these changes may also have been influenced by other factors, including seasonal market conditions and agricultural conditions. Further research incorporating additional economic and behavioural variables is required to better understand the long-term implications of fertilizer policy changes on farmer income stability and decision-making.

Keywords: Fertilizer policy, price variability, rice yield, Sri Lanka, yield-price relationship

Introduction

The Sri Lankan government implemented a prohibition on the importation of chemical fertilizers and agrochemicals, including insecticides and herbicides, without fully considering the benefits of programs promoting the rational use of fertilizers on May 6th, 2021. This decision was enacted under Imports and Exports (Control) Regulation No. 07, published in Gazette Extraordinary No. 2226/48 (Ministry of Agriculture, 2021). The regulation banned the import of certain minerals or chemical fertilizers and required import control licenses for others. However, on July 31st, 2021, the government revised these regulations by issuing Imports and Exports (Control) Regulation No. 11 of 2021, reclassifying specific minerals and chemical fertilizers from the "banned"

Corresponding Author: pspurni97@gmail.com

category to the "import control license" category. These changes were published in Gazette Extraordinary No. 2238/45 (Central Bank of Sri Lanka, 2021). The policy led to a sharp decline in fertilizer use in rice cultivation, resulting in a significant decrease in rice yield and consequently driving up rice prices. This study investigates whether the implementation of the 2021 fertilizer policy altered the relationship between rice yield and selling prices by comparing yield–price dynamics before and after the policy intervention.

Methodology

Yield data and selling prices for this study were collected using a structured questionnaire administered during two cultivation periods: the Yala 2021 season, representing the period before the implementation of the fertilizer policy, and the Maha 2021/22 season, representing the period after the policy implementation. A structured questionnaire was developed to collect information on cultivated extent, paddy yield, selling price, fertilizer usage, and income-related variables. The questionnaire was pre-tested with a small group of farmers before the main survey to ensure clarity and reliability. The sample consisted of 145 paddy farmers selected using proportional sampling based on cultivated extent across the 11 Divisional Secretariat divisions in the South Coastal region of Ampara District.

During data collection, farmers reported paddy yield either as wet yield (freshly harvested paddy containing higher moisture content) or dry yield (paddy after drying). Since wet and dry yields are not directly comparable, wet yields were converted into equivalent dry yields before analysis. The conversion was performed using the following equation:

$$No\ of\ bags\ with\ dried\ yield = No\ of\ bags\ with\ wet\ yield \times \frac{9}{10} \qquad (1)$$

In this equation, 9/10 represents the standard conversion factor used to adjust wet paddy yield into dry paddy yield. The factor assumes that drying reduces the weight of harvested paddy by approximately 10% due to moisture loss. Therefore, the dry yield is considered to be 90% (9/10) of the wet yield.

After converting the wet yield into dry yield, the total yield per acre was calculated in kilograms using:

$$Amount\ of\ yield\ in\ Kg\ per\ acre = No\ of\ bags\ with\ dried\ yield\ \times\ 65.5 \qquad (2)$$

Where 65.5 kg represents the standard weight of one bag of dried paddy. This conversion ensured that all farmers’ yield values were expressed using a common measurement unit (kg per acre) for subsequent statistical analysis.

The price of paddy obtained on wet basis was converted to dried basis. These calculations were performed using information provided by the farmers and millers.

For Yala season,

$$Price\ per\ bag\ for\ dry\ yield\ =\ Price\ per\ bag\ for\ fresh\ yield\ +\ 700 \qquad (3)$$

For Maha season,

$$Price\ per\ bag\ for\ dry\ yield\ =\ Price\ per\ bag\ for\ fresh\ yield\ +\ 1300 \quad (4)$$

The price per kg of rice was calculated as:

$$Price\ per\ kg\ for\ dry\ yield\ =\ (\ Price\ per\ bag\ for\ dry\ yield)/65.5 \quad (5)$$

Yields for i^{th} farmer per acre in kg for the Yala season is denoted by X_{iy} and for the Maha season X_{im}. Price of dry paddy sold by the i^{th} farmer in the Yala season is denoted by Y_{iy} and for Maha season Y_{im}. The income from an acre for the i^{th} farmer in the Yala season Z_{iy} can be written as:

$$Z_{iy} = X_{iy}Y_{iy} \quad (6)$$

The variance of income $[Var(XY)]$ is calculated from the equation:

$$Var(XY) = E(X^2Y^2) - [E(XY)]^2 \quad (7)$$

Here,

$$E(X^2Y^2) = Cov(X^2, Y^2) + E(X^2)E(Y^2) \quad (8)$$

And

$$[E(XY)]^2 = [Cov(X,Y) + E(X)E(Y)]^2 \quad (9)$$

Then,

$$Var(XY) = Cov(X^2, Y^2) + [Var(X) + [E(X)]^2].[Var(Y) + [E(Y)]^2] - [Cov(X,Y) + E(X)E(Y)]^2 \quad (10)$$

If the variables X_is and Y_is are independent,

$$Cov(X^2, Y^2) = 0$$

And

$$Cov(X,Y) = 0$$

Then,

$$Var(XY) = E(X^2Y^2) - [E(XY)]^2$$
$$= Var(X)Var(Y) + Var(X)[E(Y)]^2 + Var(Y)[E(X)]^2 \quad (11)$$

$$Var(XY)_{Indep} = Var(X)Var(Y) + Var(X)[E(Y)]^2 + Var(Y)[E(X)]^2 \quad (12)$$

If the variables X_is and Y_is are not independent, and the equation for the calculation is:

$$Var(XY)_{Depend} = Cov(X^2, Y^2) + [Var(X) + [E(X)]^2].[Var(Y) + [E(Y)]^2] - [Cov(X,Y) + E(X)E(Y)]^2 \quad (13)$$

The Hypotheses for testing the equality of these variances can be written as:

$$H_0: \ \sigma^2_{XY_{Depend}} = \sigma^2_{XY\ Indep}$$
$$H_1: \sigma^2_{XY_{Depend}} \neq \sigma^2_{XY\ Indep}$$

The number of samples in the study in the Yala and Maha seasons $n = 145$.

$$\left[{(n-1)Var\left(X_{iy}Y_{iy}\right)_{Depend}} \Big/ {\sigma^2_{X_{iy}Y_{iy}{}_{Depend}}} \right] \sim \chi^2_{(n-1)} \tag{14}$$

$$\left[{(n-1)Var\left(X_{iy}Y_{iy}\right)_{Indep}} \Big/ {\sigma^2_{X_{iy}Y_{iy}{}_{Indep}}} \right] \sim \chi^2_{(n-1)} \tag{15}$$

$$\frac{\left[{(n-1)Var\left(X_{iy}Y_{iy}\right)_{Depend}} \Big/ {\sigma^2_{X_{iy}Y_{iy}{}_{Depend}}} \right] \Big/ {(n-1)}}{\left[{(n-1)Var\left(X_{iy}Y_{iy}\right)_{Indep}} \Big/ {\sigma^2_{X_{iy}Y_{iy}{}_{Indep}}} \right] \Big/ {(n-1)}} = F_{[n-1,n-1]} \tag{16}$$

$$\frac{Var\left(X_{iy}Y_{iy}\right)_{Depend} \Big/ \sigma^2_{X_{iy}Y_{iy}{}_{Depend}}}{Var\left(X_{iy}Y_{iy}\right)_{Indep} \Big/ \sigma^2_{X_{iy}Y_{iy}{}_{Indep}}} \sim F_{(n-1),(n-1)} \tag{17}$$

Equations 9 to 12 were shown for the Yala season, and these can be replicated for the Maha season. Dependency of the price of paddy on yield can be tested for each season separately based on the test above.

Results and Discussion

The combined variances assuming X_i and Y_i are independent and dependent are calculated separately for Yala 2021 and Maha 2021/2022 and presented in Table 1 using the equations derived in the methodology part.

Table 1: Combined variance for the income

Season	$Var(XY)_{Indep}$	$Var(XY)_{Dep}$	$\dfrac{Var(XY)_{Depend}/\sigma^2_{XY_{Depend}}}{Var(XY)_{Indep}/\sigma^2_{XY_{Indep}}}$ or $\dfrac{Var(XY)_{Indep}/\sigma^2_{XY_{Indep}}}{Var(XY)_{Dep}/\sigma^2_{XY_{Dep}}}$	$F_{\alpha/2,144,144}$
Yala 2021	446902565	839206158	1.877	1.4327
Maha 2021/2022	1488421198	1459178540	1.02	1.4327

In the Yala season, the calculated F-statistic of 1.877 exceeds the table value of 1.4327, indicating that the variance of income assuming yield and price are independent is incorrect. This suggests that the selling price of paddy and yield are not independent during the Yala season. Therefore, the observed income variability in the Yala season was inconsistent with the assumption that yield and price were independent, suggesting the existence of an association between these two variables. In contrast, during the Maha season, the F-statistic of 1.02 is lower than the table value of 1.4327, implying that the variance of income assuming yield and price are independent is accurate. The correlation analysis did not provide sufficient evidence of a linear association between yield and price during the Maha season, as the correlation was not significant ($r = -0.068$, $p = 0.415$). Consequently, this result may indicate a weaker relationship between production levels and selling prices; however, farmers' perceptions regarding pricing decisions require further investigation through behavioural surveys. A test of income variance between the two seasons showed no significant difference ($F = 1.18$, $p = 0.278$). However, the variance in selling prices was considerably higher in the Yala season [124.38 $(\text{Rs./kg})^2$] compared to the Maha season [55.18 $(\text{Rs./kg})^2$]. A test for equality of variance confirmed that the price variance in Yala was significantly greater than in Maha ($F = 2.254$, $p = 0.006$).

Conclusion

The study examined the relationship between paddy yield and selling prices before and after the implementation of the 2021 fertilizer policy in the South Coastal region of the Ampara District, Sri Lanka. The findings indicate differences in yield–price dynamics between the Yala 2021 and Maha 2021/22 seasons. During the Yala season, a significant positive correlation was observed between paddy yield and selling price ($r = 0.254$, $p = 0.002$), suggesting the presence of a linear association between production levels and market prices. In contrast, during the Maha season, no significant linear relationship was identified between yield and selling price ($r = -0.068$, $p =$

0.415), indicating that the association observed during the Yala season was not evident after the implementation of the fertilizer policy.

The variance-based analysis further showed that the observed income variability during the Yala season differed significantly from the assumption of yield–price independence (F = 1.877), whereas the Maha season results were consistent with the independence assumption (F = 1.02). However, these findings should be interpreted as statistical differences in yield–price relationships rather than direct evidence of changes in farmers' pricing behaviour. The analysis of income variance between the two seasons revealed no significant difference ($F(144,144) = 1.18$, $p = 0.278$). Nevertheless, the variability of selling prices was significantly higher during the Yala season compared with the Maha season ($F(144,144) = 2.254$, $p = 0.006$).

Overall, the results suggest that the implementation of the fertilizer policy coincided with changes in the yield–price relationship and price variability during the Maha 2021/22 season. While reduced price variability and changes in yield–price association were observed after the policy intervention, these changes may also have been influenced by other factors, including seasonal market conditions, government interventions, and broader agricultural factors. Therefore, further studies incorporating additional economic and behavioural variables are required to establish the long-term impacts of fertilizer policy changes on farmers' decision-making and income stability.

References

1. Abate, G. T., Abay, K.A., & Spielman, D.J. (2020). Fertilizer use in sub-Saharan Africa: Trends, determinants, and policy responses. *Agricultural Systems*, 177, 102729.
2. Ahmed, A.N., & Razmy, A.M. (2005). Profitability of Paddy Production in the Coastal Region of the Ampara District. *Journal of Agricultural Sciences*, 1(1), 1-11.
3. Abeygunawardhana, P. & C.A. Pope. (1986). Impacts of price and yield variation on profitability of management plans of subsistence farmers in Sri Lanka. *Agricultural Administration*, 22, 197-204.
4. Department of Census and Statistics. (2021). Paddy statistics: Maha season 2021/22. Retrieved from http://www.statistics.gov.lk/Agriculture/StaticalInformation/PaddyStatistics/PaddyStatistics/2021-22MahaSeason
5. Department of Census Statistics Sri Lanka. (2021). Area, production and yield of paddy during Yala season - 2021. Retrieved from http://www.statistics.gov.lk/Resource/en/Agriculture/paddystatistics/PaddyStatsPages/2021yala.pdf
6. Ekanayake, H. (2009). The Impact of Fertilizer Subsidy on Paddy Cultivation in Sri Lanka. *Staff Studies (Colombo).*
7. Stack Exchange. (2011). Variance of product of dependent variables [Online forum post]. Retrieved from *https://stats.stackexchange.com/questions/15978/variance-of-product-of-dependent-variable*.