

Determinants of Food Security in ASEAN Rice-Producing Countries

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ABSTRACT: This study analyzes the effects of agricultural trade openness, rice productivity, and employment in the agricultural sector on food security in seven major rice-producing countries in the ASEAN region during the period 2012–2022. Food security is measured using the Global Food Security Index (GFSI), and data are obtained from various official sources and processed using a multiple linear regression approach with panel data. The results show that agricultural trade openness has a positive and significant effect on food security, underscoring the importance of market integration in ensuring the stability of food supply and prices. Rice productivity also contributes positively to food security, reflecting efficiency and increased availability of staple food. Conversely, the proportion of labor in the agricultural sector has a negative effect on food security, indicating structural imbalances and low labor productivity in the sector. These findings highlight the need for reforms in agricultural systems and trade policies to sustainably strengthen food security in the ASEAN region.

KEYWORDS : Food security, Agricultural trade openness, Rice productivity, Employment in the agricultural sector, ASEAN.

I. INTRODUCTION

The world is currently undergoing a recovery phase following the global pandemic, while simultaneously confronting the repercussions of the Russia Ukraine war, which has disrupted the stability of both food systems and energy markets (FAO, 2023). The ongoing war in Ukraine has affected all aspects of food security, with the most significant impact observed in the dimension of food access. Declines in domestic production, damage to agricultural infrastructure and food reserves, surging agricultural input prices, land conversion and degradation, as well as labor shortages in rural areas have led to a reduction in food supply and availability. These factors have triggered rising food prices and inflation, further exacerbated by disruptions in agricultural trade, domestic markets, and global supply chains. This situation has increasingly restricted food access, particularly for the poor and vulnerable populations (El Bilali & Ben Hassen, 2024).

Food insecurity remains a critical issue faced by developing countries, including those in the ASEAN region. In 2022, approximately 114.4 million people in ASEAN experienced moderate to severe levels of food insecurity (FAO, 2023). Around 10 percent of the ASEAN population lives below the extreme poverty line, earning less than \$1.90 per day, which severely limits their purchasing power to access healthy and nutritious food. More than a quarter of the rural population in countries such as Laos, Myanmar, and Cambodia continues to struggle with limited access to adequate and nutritious food. This situation is largely driven by high poverty rates and weak infrastructure. Inadequate infrastructure contributes to increased logistical costs, which in turn raises food prices and limits accessibility, particularly for low-income communities (Asian Development Bank, 2021).

One way to measure a country's level of food security is through the Global Food Security Index (GFSI). This index assesses food security in both developed and developing countries. The evaluation is based on 68 indicators, both qualitative and quantitative, that reflect various critical aspects of food security (Economist Intelligence Unit, 2022). The indicators used in the GFSI are considered the most comprehensive representation for measuring food security, as they employ composite indicators as proxies. Furthermore, the GFSI is recognized as a valid tool that effectively represents all four dimensions of food security at the national level (Manikas et al., 2023).

Rice-exporting countries in the ASEAN region, such as Thailand and Vietnam, have leveraged trade openness to develop specialization in rice production, accounting for approximately 53.3 percent of total global net rice exports. This specialization strategy not only enhances economic gains but also strengthens the stability of regional supply chains. This is evident in Vietnam's annual export growth, which has reached 3.3 percent since 2010 (Fadah et al., 2024). The liberalization of agricultural commodity trade offers significant economic opportunities. Trade openness enables countries to capitalize on their comparative advantages, increase national income, strengthen fiscal capacity to fund social protection programs, and help stabilize the consumption and

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prices of staple foods at the global level (Smith & Glauber, 2020).

Rice remains a staple commodity in ensuring food security across ASEAN, where over 640 million people rely on it to meet approximately 50 to 70 percent of their daily caloric intake (ASEAN Secretariat, 2015). As one of the world's largest rice-producing and -consuming regions, ASEAN countries account for 22 percent of total global rice consumption and 53.3 percent of net global rice exports. This underscores the region's strategic role in maintaining the stability of food systems both domestically and internationally (Ahmed et al., 2020; Fadah et al., 2024). However, various challenges—including climate change, geopolitical tensions, and post-pandemic economic pressures—have exposed structural vulnerabilities within the regional agricultural system. These conditions have reignited discussions on the interconnection between trade policy, productivity enhancement, and labor dynamics in sustaining food security in the region (Sundram, 2023).

The agricultural sector remains the largest source of employment in developing countries, contributing significantly to national income and predominantly composed of smallholder farmers (Darfour & Rosentrater, 2016). Small-scale farmers, who represent approximately 80 percent of the total agricultural workforce in ASEAN, are experiencing declining incomes due to fragmented land ownership and rising input costs. This situation threatens the sustainability of the agricultural sector, particularly amid accelerating urbanization and increasing youth migration from rural to urban areas. Labor dynamics within the agricultural sector further complicate efforts to safeguard food security. Although around 30 percent of the ASEAN workforce still depends on agriculture, labor productivity in the sector remains stagnant, reaching only about 40 percent of the productivity observed in the industrial sector. This disparity perpetuates the cycle of poverty and poses a serious threat to food security in rural areas (Yudhatama et al., 2021).

Most empirical studies to date have primarily focused on the impact of globalization and trade liberalization on specific aspects of economic development, such as economic growth and poverty levels; however, the findings remain inconclusive. As poverty reflects a broad indicator of societal well-being, scholarly attention over the past decade has increasingly shifted toward the issue of food insecurity, which emphasizes the fulfillment of basic needs (Traub & Jayne, 2008). Earlier literature often employed energy supply as a proxy for food security (Fan et al., 2024), whereas this study adopts the Global Food Security Index (GFSI) as a more comprehensive proxy for food security data. Existing studies have largely examined trade openness in general, rather than focusing specifically on agricultural trade openness, which has a direct connection to food security. This study adopts the approach developed by Zhao & Liu (2015), which measures agricultural trade openness through a combination of export and import openness of agricultural products. While previous research typically uses cereal yield (in kilograms per hectare) as an indicator of agricultural productivity (Dithmer & Abdulai, 2017), this study specifically employs rice yield (kg per hectare) as a proxy for productivity, considering that rice is the primary staple food for populations in the ASEAN region. To address gaps in the existing literature, this study analyzes the effects of agricultural trade openness, rice productivity, and agricultural sector employment on food security in major rice-producing countries in ASEAN.

II. LITERATURE REVIEW

A. Food Security

Food security is a condition in which all individuals, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2008). The Global Food Security Index (GFSI) evaluates food security based on four key dimensions: (1) affordability, (2) availability, (3) quality and safety, and (4) sustainability and adaptability. The assessment covers 113 countries worldwide. The GFSI is constructed using 68 quantitative and qualitative indicators that represent various aspects of food security (Economist Intelligence Unit, 2022).

B. Agriculture Trade Openness

The theory of comparative advantage, proposed by David Ricardo (1817), asserts that a country can gain economic benefits by specializing in the production of goods that it can produce more efficiently than other countries. By allocating resources to the most efficient sectors and importing food from countries with lower production costs, cost efficiency can be achieved, leading to lower food prices for consumers. Ultimately, this contributes to reducing food insecurity, particularly in vulnerable countries (Clapp, 2014). The theory of price stability in international markets emphasizes the crucial role of global trade in mitigating fluctuations in global food commodity prices. Through international trade, countries can meet domestic food needs during periods of shortage caused by crop failure, thereby minimizing pressure on domestic markets. Conversely, when a country experiences a production surplus, the excess can be directed to the global market, contributing to the balance of supply and demand at the international level (Kym Anderson & Will Martin, 2006).

C. Rice Productivity

The agricultural sector plays a strategic role in economic development by ensuring food security, contributing to exports,

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creating employment opportunities, and generating capital surpluses. Productivity improvements can be achieved through the adoption of modern agricultural technologies, enhanced education, strengthened research activities, and effective extension services. Investment in agricultural research and education, along with the development of infrastructure and support systems, is essential to increase production efficiency. In developing countries, agricultural productivity growth and structural transformation are fundamental to achieving sustainable economic growth (Johnston & Mellor, 1961).

D. Employment in Agriculture

The agricultural sector often experiences a surplus of labor, where the available workforce exceeds the amount required to maintain current levels of agricultural output. This excess labor can be absorbed by the growing industrial sector without diminishing agricultural production. However, if this transition is not properly managed, a reduction in the agricultural labor force may lead to decreased output and pose a threat to food security (Lewis, 1954). Labor migration from rural to urban areas is generally driven by wage differentials between the agricultural and industrial sectors or by limited employment opportunities in rural regions. If such migration is not accompanied by increases in agricultural productivity, the declining rural labor force may further weaken food security (Harris & Todaro, 1970).

III. METHODS

This study is a descriptive research employing a quantitative approach. The data used are a combination of cross-sectional and time-series data, commonly referred to as panel data. The cross-sectional data consist of seven ASEAN countries: Indonesia, Vietnam, Thailand, the Philippines, Myanmar, Cambodia, and Laos. These countries are part of the "Top 20 Countries in Rice Production 2023." The time-series data cover the observation period from 2012 to 2022. All data utilized in this study are secondary and were obtained from various official websites. Data processing was conducted using E-Views software.

Table 1. Description Variable

Variable	Description	Indicators	Source
Y	Global Food Security Index	%	https://impact.economist.com/
X1	Agriculture Trade Openness	%	https://www.fao.org/faostat/
X2	Rice Productivity	Kilogram per hectar	https://data.worldbank.org/
X3	Employment in Agriculture	%	https://data.worldbank.org/

To identify the influence of the independent variables on the dependent variable, the formulated equation is transformed into a panel regression model.

$$Y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \mu_{it}$$

Dimana :

Y _{it}	= Global Food Security Index (%)
X1 _{it}	= Agriculture Trade Openness (%)
X2 _{it}	= Rice Productivity (kg per heCtar)
X3 _{it}	= Employment in Agriculture (%)
i	= 1,2, ...,n, indicates the number of cross-sectional units
t	= 1,2, ...,n, indicates the time series dimension
β ₀	= Constant or intercept
β ₁ , β ₂ , β ₃	= Regression coefficients
μ _{it}	= Error term

IV. RESULT AND DISCUSSION

A. Study Result

In selecting the appropriate panel data regression model, this study considers three types of models : Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). These models are tested to determine the most suitable one for this study. The test results indicate that Fixed Effect Model (FEM) is the best-fitting model for this study.

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Table 2. Model Selection

Test	Selection	Prob	Conclusion
Chow Test	FEM or CEM	0,000	FEM
Cross-section Chi-Square			(P<0,05)
Hausman Test	FEM or REM	0,000	FEM
Cross-section Random			(P<0,005)

Source : E-views Output

After conducting a series of tests to ensure the fulfillment of classical assumptions and to determine the most appropriate model, the next stage is to perform panel data regression analysis. This analysis aims to measure the simultaneous effects of several independent variables on the dependent variable. The regression results can be seen in Table 3. In this study, the independent variables include agricultural trade openness (X1), rice productivity (X2), and employment in the agriculture (X3). The dependent variable analyzed is food security, proxied by the Global Food Security Index (Y).

Table 3. Result of Panel Data Regression

Variable	Coeffecient	Std. Error	t-Statistic	Prob
C	-56.7678	12.81882	-4.428471	0.000
X1	138.1197	14.7733`	9.349275	0.000
X2	10.95949	1.182153	9.270786	0.000
X3	-0.158134	0.026812	-5.897927	0.000
Effects Spesification				
Period fixed (dummy variable)				
R-squared	0.871797	Mean dependent var		59.22208
Adjusted R-squared	0.845343	S.D. dependent var		5.639047
S.E. of regression	2.21764	Akaike info criterion		4.59373
Sum squared resid	309.8294	Schwarz criterion		5.019876
Log likelihood	-162.8586	Hannan-Quinn criterion		4.764185
F-statistic	32.95453	Durbin-Watson stat		1.194656
Prob (F-statistic)	0.0000			

Source : E-views Output

The results of the regression estimation are presented in Equation (1):

$$Y = -56.7677 + 138.1197 X1 + 10.9594 \ln X2 - 0.1581 X3 \dots \dots \dots (1)$$

Based on the estimation results in Equation (1), it is evident that each independent variable exerts a different influence on food security (GFSI). The constant coefficient of -56.7677 indicates the predicted value of the GFSI when all independent variables are equal to zero. Although, theoretically, this value lacks strong economic meaning, since the scenario in which all variables are zero is unrealistic, the constant remains essential for constructing the overall regression model. The coefficient of the agricultural trade openness variable (X1), which is 138.1197, implies that a one percent increase in agricultural trade openness is estimated to raise the GFSI by approximately 138.12 percent, assuming other variables remain constant. The magnitude of this coefficient highlights the significant role of trade openness in enhancing food security.

In this study, rice productivity is expressed in its natural logarithmic form; therefore, its interpretation follows a semi-elasticity approach, where a percentage change in X2 results in an absolute change in Y. The coefficient of the rice productivity variable (LnX2), which is 10.9594, indicates that a 1 percent increase in rice productivity (measured in kg/ha) is expected to increase the GFSI by approximately 0.1096 percentage points, assuming other variables remain constant. Meanwhile, the coefficient of the agricultural sector employment variable (X3), which is -0.1581, suggests that a one-percent increase in the proportion of labor employed in the agricultural sector is expected to decrease the GFSI by 0.1581 percentage points, ceteris paribus. This indicates that the greater a country's reliance on agricultural labor, the more likely its food security is to decline, possibly due to low labor efficiency or productivity in the agricultural sector.

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B. Discussion

The Impact of Agricultural Trade Openness on Food Security

The regression results indicate that agricultural trade openness (X1) has a positive and significant effect on food security (GFSI). This finding is consistent with and supported by the study of Ooi & Foo (2024), which found that trade openness significantly influences food security in ASEAN-5 countries. Agricultural trade openness promotes efficiency, expands market access, and reduces risks. Countries can focus on producing agricultural commodities in which they have a comparative advantage, in line with the theory of comparative advantage. Through such specialization, countries grow crops that are best suited to their natural conditions and trade them for other commodities. This approach helps enhance global agricultural efficiency and increases the availability of food. Countries experiencing food shortages can import from those with a surplus, thereby stabilizing food supplies. Thus, both exporting and importing countries benefit from improved food availability and security (Amabuike et al., 2025).

In regions such as ASEAN, which heavily rely on imports of staple food commodities like wheat, agricultural trade openness plays a crucial role in reducing the risk of food shortages. However, the Russia–Ukraine conflict has disrupted these benefits by destabilizing global supply chains. Both countries are major exporters of grains and fertilizers. The war has led to export restrictions, rising transportation costs, and shortages of agricultural products, which have collectively driven up food prices. This situation poses a serious threat to food security in ASEAN and other parts of Asia that are highly dependent on imports from Russia and Ukraine. If imports were to be completely halted, countries with limited domestic production could face severe food crises. Nonetheless, trade openness provides countries with the flexibility to seek alternative markets and diversify their sources of imports. ASEAN countries have started to establish trade partnerships with other agricultural exporters to reduce this dependence. The ability to swiftly redirect trade routes underscores the importance of an open trade system in maintaining food security amid global crises (Ben Hassen et al., 2025). Open trade also mitigates the risks associated with domestic agricultural production by enabling diversification of food sources. This diversification is vital for sustaining food security, especially in the face of climate change and other global challenges (Galedarvand et al., 2024).

The Impact of Rice Productivity on Food Security

Rice productivity is a key determinant of food security in the ASEAN region, where rice serves as the primary source of calories and livelihood for hundreds of millions of people (Ahmed et al., 2020). In most ASEAN countries, rice accounts for 50–80% of daily caloric intake. Increases in rice productivity directly enhance food availability, reduce market prices, and ensure a stable supply even during times of disruption. A decline in rice yields by 6–12% due to climate change could severely compromise food security across Southeast Asia (Putra, 2024). Challenges such as climate change continue to pose significant threats. The El Niño phenomenon has led to reduced rice production in several ASEAN countries. El Niño negatively affects rice yields in Southeast Asia, thereby jeopardizing regional food security (Ludher & Teng, 2023).

Enhancing rice productivity not only increases domestic food availability but also strengthens a country's ability to withstand price fluctuations and global supply disruptions. In the ASEAN region, countries such as Vietnam and Indonesia have demonstrated substantial improvements in rice productivity. These gains are largely driven by the adoption of high-yielding varieties, integrated crop management practices, and advances in agricultural technology. In Indonesia, the agricultural technology transformation raised rice yields from 3 tons per hectare prior to 1961 to 5.46 tons per hectare by 2017 (Geng et al., 2025). Higher rice yields contribute to increased farmer incomes and purchasing power, thereby enabling better access to food and healthcare services. This outcome is in line with the rights-based approach to food security. Thet (2024) emphasizes that Myanmar's rice export capacity has grown due to improved productivity, which indirectly strengthens rural economies and enhances local food access.

Higher rice productivity contributes to the development of buffer stocks that enable governments to manage domestic price volatility, a major threat to food access among low-income populations. The integrated ASEAN rice market plays a crucial role in stabilizing cross-border supply and prices, thereby linking productivity improvements to regional food security (Daliani et al., 2024). ASEAN regional cooperation promotes research and investment in rice productivity, enhancing food security through joint seed banks, shared rice gene pools, and cross-border knowledge exchange. Countries such as Vietnam and Thailand have significantly benefited from cooperative approaches that support yield improvements (Serey et al., 2024).

The Impact of Agricultural Employment on Food Security

Employment in the agricultural sector, while vital for rural livelihoods, can negatively affect food security. In many developing countries, including those in Southeast Asia, agricultural workers are among the most vulnerable to food insecurity due to their exposure to climate change, limited access to credit, and low levels of education. This study highlights that despite the high absorption of labor in agriculture, productivity remains stagnant, thereby exacerbating rural poverty and undernutrition (Etuah et al., 2024). Without modernization and skill enhancement, employment in agriculture may become a constraint to food security, as it fails to contribute to increased national food supply or improved rural incomes. These findings are consistent with

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development theory, which posits that a large proportion of labor in the traditional agricultural sector is often associated with low economic resilience and limited dietary diversity (Otekunrin et al., 2024).

The decline in agricultural labor can disrupt food production, particularly rice, which is the staple food in most ASEAN countries. Studies show that rural-to-urban migration reduces the number of agricultural workers, which in turn can decrease food production and increase reliance on imports. This poses a significant risk to food security, especially in the event of disruptions to global supply chains. Alongside ongoing urbanization and economic diversification, the share of the labor force engaged in agriculture across ASEAN countries has been steadily declining. Data indicate that between 1991 and 2022, the proportion of Southeast Asia's population employed in the agricultural sector dropped from 60% to 29.1%. This decline reflects a broader structural shift in the region's economies, with more workers transitioning into the industrial and service sectors (Trakem & Fan, 2024).

Countries such as Indonesia and Myanmar have experienced a slow transition from labor-intensive rice farming systems to more modern and productive agricultural practices. As a result, rural food insecurity remains high despite national-level rice self-sufficiency. According to (Tri & Alfahma, 2024), informal agricultural workers face greater food security risks compared to their formal-sector counterparts. Limited access to education, technology, and social protection makes households with informal laborers more vulnerable to food inadequacy. Therefore, the dominance of low-skilled labor in the agricultural sector across the region highlights the urgent need for structural transformation, relocating surplus labor to more productive sectors while simultaneously investing in agricultural innovation and social protection. Such measures are essential to improving food security outcomes in the long term.

V. CONCLUSION

This study aims to analyze the effects of agricultural trade openness, rice productivity, and employment in the agricultural sector on food security in major rice-producing countries in the ASEAN region during the period 2012–2022. Based on the results of the empirical model estimation, it was found that agricultural trade openness has a positive and significant effect on food security. This indicates that the more open a country is in trading agricultural products, the higher its level of food security. Such openness facilitates access to diverse food sources, technologies, and greater stability in supply and prices.

Rice productivity also has a positive and significant effect on food security. An increase in productivity reflects greater efficiency in the use of agricultural resources, directly impacting the availability of staple foods—particularly rice, which is a strategic commodity in the region.

Conversely, employment in the agricultural sector has a negative and significant effect on food security. This suggests that a high proportion of labor in the sector does not necessarily translate into improved efficiency or productivity. The likely reasons include low levels of mechanization, limited skills, and insufficient access to agricultural innovations.

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