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The Impact of Macroeconomic and Environmental Factors on Food Production in Malaysia: An ARDL Analysis

*Masturah Ma'in[1], Mohamad Amir Syahmi Mohd Anuar[2], Shahariah Asmuni[1], Syaza Natasya Abdul Rashid[2], Nur Hashilah Amirah Hashim[2], Nor Aliza Saedon[3]
[1]Faculty of Business and Management, Universiti Teknologi MARA, Puncak Alam Campus, Selangor, Malaysia
[2]Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Seremban 3 Campus, Negeri Sembilan, Malaysia
[3]Rahim & Co Chesterton, Menara Perak, Jalan Perak, Kuala Lumpur, Malaysia
Email: *maszan@uitm.edu.my, syahmiamir02@gmail.com, shaha154@uitm.edu.my, syazarashid5@gmail.com, nurhashilahamirah@gmail.com, 25ahim.saedon@rahim-co.com
Corresponding Author: Dr Masturah Ma'in

Abstract: Production of food is essential in ensuring the food security of a nation, depending on the economic situation and changes in the environment. This paper seeks to establish the impact of macroeconomic factors as well as environmental factors on food production in Malaysia from 1988 to 2022. The main objectives of this paper include establishing the effect of food imports, inflation rate, temperature, and agricultural land on food production in Malaysia. The stationarity tests show that the variables have different orders of integration, while the Autoregressive Distributed Lag (ARDL) bounds test establishes a long-run cointegrating relation. The study finds out that food imports, temperature, and agricultural land significantly affect long-run food production. These findings illustrate the policy implications of macroeconomic factors, particularly food imports, as well as environmental factors, namely temperature and agricultural land, on food production in Malaysia.

Keywords: *Macroeconomic, Environmental, Food Production, Malaysia, ARDL*

1. Introduction and Background

Food production is the process of preparing and producing food by using raw materials such as crops and livestock for human consumption through conversion of the raw materials into food, either at the household level or in industrial production (Daszkiewicz, 2022). A study done by Abbasi et al. (2022) pointed out that there are also food production activities that are carried out using agricultural food production, whereby farming and livestock farming are the major sources of the raw materials used in the production of foods to satisfy the food requirements of the population. As noted by Suffian and Suffian (2021), Malaysia has attained impressive growth over the last few decades in agricultural production. According to Suffian and Suffian, the agricultural industry contributes the most to the country's economy, besides the development of industrial crops like palm oil, cocoa, and rubber, which also contribute to the economic growth of Malaysia. Therefore, the production of food is not only for the provision of food but also for trade (Xie et al., 2023).

Figure 1: Worldwide Food Production Index from 2002 until 2022

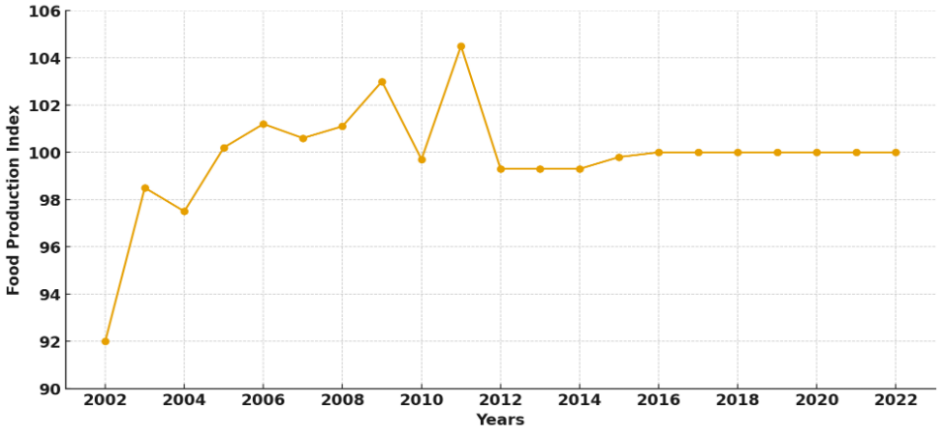


Figure 1 shows the line chart of the worldwide food production index from 2002 until 2022 that is retrieved

from the World Bank. The chart shows that global food production increased steadily from 2002 to 2011 where in 2011, when it reached its highest point at around an index of 105, showing that there was strong growth in food production. However, after 2011, the index dropped drastically and then remained almost the same from 2013 onwards, at around an index of 100. This shows that while food production grew quickly at first, it later became stable, showing that food production stayed about the same over the years. This situation may be caused by several different factors such as changes in the economy and agricultural and environmental conditions that affected food production around the world.

Food production in Malaysia faces several interconnected challenges that stem from both economic and environmental factors. The country's growing population continues to increase the demand for food, putting pressure on limited resources. At the same time, Malaysia's heavy reliance on imported food makes it vulnerable to global price fluctuations and supply disruptions. Rising inflation has also made it more expensive for farmers to buy essential inputs like fertilizers and fuel, reducing their profits and discouraging production. On the environmental side, rising temperatures and unpredictable weather conditions are affecting crop yields and quality, especially for key staples such as rice. The loss of agricultural land due to urbanization and industrial activities adds to the problem, leaving less space for cultivation (Solaymani, 2018).

Hence, several factors could influence the food production (FPRD) issue in Malaysia, whether the issue comes from a macroeconomic perspective or from an environmental perspective. According to Abang Ali (2024), five independent variables that can impact food production in Malaysia are inflation, food imports, land under cereal production, precipitation, and temperature. However, the present study focuses on four key determinants: agricultural land, temperature, food imports, and inflation. Precipitation is excluded from the model because the environmental dimension is represented by the temperature variable.

Moreover, inflation can affect the costs of production and consumer purchasing power. Increased inflation leads to high costs of inputs like fertilizers, machinery, and fuel which in turn lowers the profit margins of the farmers and discourages agricultural practices (Weremczuk & Malitka, 2022). Moreover, inflation increases food prices and hence it can minimize consumer demand for some products, and this creates imbalances in the market which may further limit the growth of production. Besides macroeconomic factors, environmental factors such as temperature are also closely related to food production. Based on Hatfield and Prueger (2015)'s study, temperature is a primary factor that affects the rate of plant development. Temperature changes have profound effects on crop growth, development, yield and quality which is particularly important for an essential crop like rice (Liu et al., 2025). Therefore, the consistency of the temperature will support efficient crop cycles and higher yields; otherwise, it will affect food production.

Other than that, agricultural land is also amongst the factors that affect food production in Malaysia as it dictates the potential and sustainability of agricultural output in the country. Mohd Azman et al. (2023) noted that increasing agricultural land can be effective in improving domestic food production, decreasing reliance on imported goods and services, and promoting national food security. However, Malaysia is experiencing problems like urbanization, industrialization and land conversion, which are decreasing the size of arable land for farming (Marzuki & Jais, 2020).

Further study about the determinants of food production at a national level is important and should be done earlier to identify which factors contribute the most to food production. This is to avoid disasters, including famine and malnutrition, in a country that are caused by limited food resources faced by the population. It also helps government agencies and policymakers make decisions to improve food production conditions, thus ensuring food security in Malaysia.

Accordingly, the study focuses on examining the determinants of food production in Malaysia. The dependent variable is food production (FPRD), while the independent variables are inflation rate (INFR), food imports (FIMP), agricultural land (AGRL) and temperature (TEMP). The study utilizes secondary data collected from the World Bank, the International Monetary Fund (IMF), and the Food and Agriculture Organization of the United Nations (FAO) using time series analysis from 1988 to 2022. Therefore, the objective of this study is to determine the impact of macroeconomic variables, temperature and agricultural land on food production.

This study examines macroeconomic and environmental conditions that affect food production in Malaysia between 1988 and 2022. It seeks to gain a deeper understanding of the economic and environmental determinants of food production in Malaysia. In addition, it can enrich the literature with current data specific to Malaysia in addressing food-related challenges, thus ensuring improvements in food productivity and food security domestically. With these results, it will help the government agency mainly the Ministry of Agriculture and Food Security (MAFS), to determine the strategic direction and development trajectory of food production in Malaysia.

The remainder of this study proceeds as follows. Section 2 reviews past studies on the relationship between food production and the variables introduced, which shows the gap between this study and past studies. Section 3 outlines the data and method used to complete the study. Section 4 presents and interprets the results. Section 5 concludes and supports some recommendations for future researchers to explore topics related to food production

2. Literature Review

Theoretical Findings: This study adopts two theoretical perspectives to gain a deeper understanding of factors influencing food production. Firstly, the Keynesian economic model of aggregate demand (AD) and aggregate supply (AS) explains food production from a macroeconomic perspective that emphasize on overall demand and supply conditions influence output levels. Secondly, Environmental Determinism, also known as Climate-Production Theory, will explain food production from an environmental perspective, suggesting the influence of natural factors, including temperature and land, on food productivity.

The Keynesian aggregate demand (AD) and aggregate supply (AS) theory is a theory about the responsiveness of food production to changes in expenditure, income and economic capacity. Increases in income and government spending trigger consumption and investment when the economy is not running at full capacity, and this promotes greater agricultural production. Empirical studies indicate that an increase in agricultural expenditure can increase productivity by a large percentage with 1% growth (Ngobeni & Muchopa, 2022), and that infrastructure development and export promotion can enhance productivity and minimize losses after the harvest period (Awokuse, 2005). On the other hand, insufficient aggregate demand may cause oversupply, a decline in price and slow food production growth.

Similarly, Aggregate Supply (AS) is the sum of the goods and services that producers are willing to offer at various prices. When the agricultural sector works within a horizontal range, unutilized resources like land, labor force, and machinery can enable production to be increased without affecting prices. But when capacity factors such as insufficient farmland or inputs come into play, increased demand primarily increases prices but does not affect production (Zeng et al., 2021), which shows low supply responsiveness. Poor technology, poor storage, and unavailability of credit also hinder farmers from maximizing output (Adekunle et al., 2023). As a result, supply is slow in responding to increased demand, leading to food inflation or scarcity. Technological advancement and investment have the potential to push the AS curve to the right over time, which makes production more sustainable.

According to the Keynesian AD-AS model, balanced intervention policy is necessary to maintain food production. The government must boost its aggregate demand via expenditure, rural income subsidy, and promotion of trade whilst at the same time mitigating supply-side limitations by means of investing in infrastructure, technologies, and education (Zeng et al., 2021). This implication is supported by Ghanaian and Indian evidence that public investment and input subsidies only promote agricultural growth in combination with access to credit and technological infrastructure (Yeboah et al., 2025; Zafar et al., 2023). Therefore, the Keynesian policy implication is that demand management and capacity building are essential in attaining sustainable food production and long-term food security.

The Environmental Determinism or Climate-Production Theory explains that environmental conditions, particularly temperature and land availability, play a fundamental role in determining agricultural productivity. This theory assumes that natural factors set the limits for human activities such as farming. This means favorable temperature and sufficient agricultural land contribute to higher food production, while extreme temperature or land scarcity can reduce output. Temperature is a key contributor to climate change

and serves as a fundamental basis for human survival and the development of agricultural production (Yuan et al., 2024). This means that any temperature change, whether small or large, can have a significant impact on agricultural productivity and food production (Choo, 2021). On the other hand, agricultural land may not directly determine food production but can act as an influencing factor that interacts with other variables, such as temperature, to improve agricultural productivity. According to Maruschke et al. (2024), land availability for agricultural activities has increasingly become a concern because of extreme climate change.

Empirical Findings: Food production is often used as a key indicator of a country's agricultural performance by utilizing inputs including land, labor, capital and material are used, where an increase in the production growth rate compared to the input use rate indicates improved efficiency in transforming inputs into food output (Sarma et al., 2024). In this research, food production is taken as the dependent variable, as it is influenced by various factors such as population growth, imports, inflation, employment, temperature and agricultural land.

A study by Abdullah et al. (2025) examined how climate change, especially rainfall and temperature variability affects paddy productivity in Malaysia in eight granary areas from 1994 to 2023. The results show that excessive rainfall significantly reduces yield across all regions while temperature variability has mixed effects. In 2024, the World Bank suggested that the government overcome this problem by utilizing public investment in digital agricultural technologies (DATs) to enhance Malaysia's agrifood productivity and resilience. Thus, showing that increased spending up to an optimal amount positively influences output before diminishing returns set in (Zhi & Wong, 2020).

In addition, a study on China's water-land-food (WLF) system found that food import competition can positively influence domestic food production by improving the coordination of land and water use, which allowed agricultural resources to be utilized more efficiently (Li et al., 2025). In contrast, a study by Barel-Shaked and Buda (2025) on OECD countries reported that greater reliance on food imports is often associated with lower domestic food self-sufficiency. Similarly, Mahase-Forgenie and Forgenie (2025) conducted a study on Caribbean Small Island Developing States (SIDS) that showed that although imports contribute to food availability, the overall impact on domestic food production remains insignificant.

Inflation has been found to influence food production in some ways especially in terms of farmers' income and price differences that encourage or discourage food production. A study by Rozi et al. (2025) found that inflation in the soybean market in Indonesia boosted farmers' income. However, Ahmed et al. (2025) examined the impact of inflation on rice and wheat prices in Bangladesh, where it showed that inflation increased the production costs and reduced food production.

Temperature can be considered one of the most critical environmental factors influencing agricultural productivity in the context of food production. Xu et al. (2024) demonstrated that rising temperature in Northeast China significantly reduces yields. Tan et al. (2021) showed that the minimum temperature has a positive correlation with rice yield in Malaysia, while maximum temperature has a negative correlation particularly during the off-season. Sethuraman et al. (2025) discovered that the optimum temperature for crop yield, including paddy, in Malaysia is 35°C. On the other hand, Kyaw et al. (2023) found that rice particularly does not affected by temperature, while Sjulgård et al. (2023) discovered that certain crops possess the ability to tolerate extreme temperatures.

Agricultural land serves as the foundational resource for food production. A study by Laghari et al. (2025) showed a significant positive relationship between the availability of agricultural land and the output of food production. Similarly, Dong et al. (2023) found that soil properties, farmland water conservation, and soil nutrients significantly impact agricultural land conditions and crop yields. Halperin et al. (2023) found that the lack of agricultural land due to urbanization will lead to a lack of food provision and livestock and crop production. Therefore, protecting high-quality agricultural land is essential not just for maximizing food output, but also for maintaining a balanced supply of ecosystem services (Aleminew, 2023). However, Li et al. (2024) found a negative relationship between land and food production, showing that land resource mismatch ultimately reduces food production. Similar findings were reported by Ahmed et al. (2025) and Azizan and Hussin (2015).

Literature Gap: Although many studies have been conducted on food production, there are still some gaps that need to be filled further, especially in Malaysia. Most past studies only focused on either macroeconomic factors or environmental factors, but not both together. As for the current study, the objective is to examine how important both factors, macroeconomic factors such as food imports and inflation rate, along with environmental factors such as temperature and agricultural land, may influence food production in Malaysia. Thus, it shows that there is still a need to study how these factors together influence food production in Malaysia. Secondly, many studies were done in different countries, such as China, India, and South Africa where the situations of these countries are not the same as Malaysia that has a tropical climate, smaller agricultural land and depends a lot on imports specifically. Therefore, this study will fill the gap by examining how both macroeconomic and environmental factors influence food production in Malaysia

3. Research Methodology

Model Specification: The model is theoretically founded on Keynesian aggregate demand-aggregate supply (AD-AS) and climate-production theory, which jointly elucidate the impact of the economic and environmental factors on food production. Through a combination of these frameworks, the model incorporates economic motivations and environmental limitations in influencing food production in Malaysia and adopts the model from Abang Ali (2024) as follows:

$$LFP_t = \alpha + \beta_1 LFI_t + \beta_2 LINF_t + \beta_3 LTEMP_t + \beta_4 LAGRL_t + \varepsilon_t \quad (1)$$

where LFP denotes the log of food production in Malaysia; LFI is the log of food imports; LINF is the log of the inflation rate; LTEMP is the log of temperature; and LAGRL is the log of agricultural land. β_0 denotes a constant value, β_1 to β_4 denotes the parameters to be estimated, and ε denotes the error term that captures idiosyncratic shocks.

Natural logarithms of all the variables serve many functions in economic estimation in order to provide accurate estimations and elasticity values. Variables which have been used in equation (1) have been justified in terms of theory by means of recent research.

Data Description: The analysis utilizes annual time-series data covering the period from 1988 to 2022 for Malaysia giving 35 observations. The World Bank and the Food and Agriculture Organization (FAO) provide information on agricultural land and food production. The data on food imports and inflation rates are obtained from the World Bank, and the International Monetary Fund (IMF); the temperature data are compiled in international climate databases. All variables are considered on an annual basis and adjusted to make them time-consistent. Data consistency and reliability were achieved through cross-verification of various sources. Multiple sources can be used to minimize bias in measurement by making comparisons between sets of data, keeping variables defined and measured similarly. Table 1 is a summary of variable types, variables, measurement, and sources.

Table 1: List of Variables and Measurement

Type of Variable	Descriptive Statistics Variable	Source of Data	Measurement
Dependent Variable	Food Production (FP)	World Bank Open Data	Index (2014-2016 = 100)
Independent Variable	Food Imports (FI)	World Bank Open Data	Percentage (%)
	Inflation Rate (INF)	IMF	Percentage (%)
	Temperature (TEMP)	FAO	Celsius (°c)
	Agricultural Land (AGRL)	World Bank Open Data	Hectare (ha)

Unit Root Test: This study applies a unit root test to prevent spurious regression and results from being distorted (Granger & Newbold, 1974; Ridwan, 2025). According to Islam et al. (2024) and Nielsen (2005), the stationarity of regression variables needs to be tested through differencing and stationary techniques for estimation. Augmented Dickey-Fuller test (Dickey & Fuller, 1979) and the Phillips-Perron test (Phillips &

Perron, 1988) were applied to test for unit roots. These analyses were conducted to determine the order of integration of the variables, specifically whether they are integrated of order zero, I (0), or order one, I (1).

Auto-Regressive Distributed Lag (ARDL): The Auto-Regressive Distributed Lag (ARDL) method has been utilized to achieve the objectives. Valid reasons support the selection of this approach. First, the ARDL technique offers more flexibility and eliminates the restriction that all time-series variables must have the same order of integration (Kuri et al., 2025). The technique is used regardless of whether the regressors are integrated of order I(0) or I(1) (Pesaran et al., 2001). This is because ARDL estimation does not depend on pre-testing the order of integration among the variables. Subsequently, it reduces the problem of uncertainty associated with the pre-testing of the variables (Narayan & Narayan, 2005).

Second, the ARDL approach is suitable for small sample sizes and produces more reliable estimates of the true parameters compared to the cointegration technique developed by Pesaran and Shin (1999). ARDL estimators generally produce more efficient and consistent coefficient estimates. Likewise, Laurenceson and Chai (2003) argued that the ARDL framework effectively represents the data-generating process through a general-to-specific modelling approach by employing a sufficient number of lags. Further, an unrestricted error correction model (UECM) of an ARDL model procedure is specified in equation (2).

$$\begin{aligned}\Delta LFP_t = \quad & \alpha + \sum_{i=1}^{p-1} \phi_i \, \Delta LFP_{t-i} + \sum_{i=0}^{q_1-1} \theta_{1i} \, \Delta LFI_{t-i} + \sum_{i=0}^{q_2-1} \theta_{2i} \, \Delta LINF_{t-i} \\ & + \sum_{i=0}^{q_3-1} \theta_{3i} \, \Delta LTEMP_{t-i} + \sum_{i=0}^{q_4-1} \theta_{4i} \, \Delta LAGRL_{t-i} \\ & + \lambda_1 LFP_{t-1} + \lambda_2 LFI_{t-1} + \lambda_3 LINF_{t-1} + \lambda_4 LTEMP_{t-1} + \lambda_5 LAGRL_{t-1} + \varepsilon_t. \end{aligned} \tag{2}$$

where

- Δ denotes the first-difference operator.
- $\sum \phi_i \Delta LFP_{t-i}$ captures the short-run dynamics of the dependent variable.
- $\sum \theta_{ji} \Delta X_{t-i}$ represent the short-run effects of the explanatory variables.
- The lagged level variables ($LFP_{t-1}, LFI_{t-1}, LINF_{t-1}, LTEMP_{t-1}, LAGRL_{t-1}$)capture the long-run relationships and are jointly tested using the Bounds Test for cointegration
- ε_t is the white-noise error term.

The F-statistics obtained from the calculation need to be compared to the higher and lower critical values. If the value obtained from the test exceeds the upper critical bound, the hypothesis of non-cointegration should be rejected (Pesaran et al., 2001).

Diagnostic Tests: The ARDL model needs important diagnostics to confirm that the estimated model is well-specified. Many statistical models require normally distributed error terms to ensure valid statistical inference; it is important to examine the normality of the residuals using the Jarque–Bera test and to assess the presence of serial correlation to confirm that the residuals are independent over time. To detect heteroscedasticity and non-constant variance in the residuals, the Breusch-Pagan-Godfrey test is used. The Ramsey RESET test is employed to validate whether the model is correctly specified.

4. Results

This section clarifies the empirical results on the relationship between macroeconomic and environmental factors and food production in Malaysia. The analysis consists of a unit root test, a bound test for long-run co-integration, and diagnostic tests.

Unit Root Test: Table 2 displays the results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for the variables LFP, LFI, LINF, LTEMP, and LAGRL. The purpose of these tests is to determine

the stationarity properties of the variables and find their order of integration. A variable is considered stationary when the null hypothesis of a unit root is rejected at the significance levels (Dickey & Fuller, 1979; Phillips & Perron, 1988).

Generally, the findings show a combination of stationary and non-stationary variables. Specifically, LFP is integrated of order one [I(1)], whereas LFI, LINF, LTEMP, and LAGRL are integrated of order zero [I(0)]. The absence of variables integrated of order two [I(2)] satisfies the main condition for the application of the Autoregressive Distributed Lag (ARDL) bounds testing approach, which can be employed when variables are a mixture of I(0) and I(1) but not I(2) (Pesaran, Shin, & Smith, 2001).

Table 2: Unit root test results

		ADF		PP		Order of Integration
Variables		**Level**	**First-order difference**	**Level**	**First-order difference**	
LFP	Intercept	-0.894	-3.280**	-1.354	-3.196**	I(1)
	Intercept with Trend	-2.284	-3.233*	-2.199	-3.151*	
LFI	Intercept	-2.058	-4.732***	-2.183	-4.674***	I(1)
	Intercept with Trend	-3.718**	-4.846***	-3.994**	-4.763***	
LINF	Intercept	-4.905***	-4.941***	-4.905***	-19.699***	I(0)
	Intercept with Trend	-5.624***	-4.689***	-6.149***	-18.602***	
LTEMP	Intercept	-4.057***	-2.604*	-3.999***	-15.082***	I(0)
	Intercept with Trend	-10.122***	-2.324	-6.922***	-15.933***	
LAGRL	Intercept	-3.790***	-7.977***	-3.790***	-11.638***	I(0)
	Intercept with Trend	-4.641***	-7.897***	-4.456***	-11.625***	

Note: ***,**, * denote the rejection of the null hypothesis at the 1%, 5%, and 10% levels, respectively. The optimal lag length was chosen automatically using the Schwarz Information Criterion (SIC) for the ADF test, and the bandwidth was chosen using Newey-West for the PP unit root test.

Bound Test and Long-run Co-integration: Table 3 exhibits the results from the bound test. The food production model computed F-statistic in the bound test is 7.34. The calculated value exceeded the upper bound critical values at the 10%, 5%, and 1% significance levels, which were 3.52, 4.01, and 5.06, respectively. Therefore, the initial hypothesis that posits the absence of cointegration among the variables was rejected. The rejection of the hypothesis means that there is evidence of a long-run relationship existing between LFP, LFI, LINF, LTEMP, and LAGRL in Malaysia from 1988 – 2022.

Table 3: Bound test result

Test statistic	Value	k
F-statistic	7.34***	4
Significance	Lower 1(0)	Upper 1(1)
10%	2.45	3.52
5%	2.86	4.01
1%	3.74	5.06

Note: 1. The critical values are based on Pesaran et al. (2001), Case III: unrestricted intercept and no trend. 2. k is an independent variable, and it is equivalent to 4. ***, **, * denote the rejection of the null hypothesis at the 1%, 5%, and 10% levels, respectively.

These results provide a theoretical basis for examining both long-run and short-run dynamics and justify the application of an error correction model (ECM) to analyze the speed at which short-run disequilibria adjust towards the long-run equilibrium. Thus, given the significant result of the Bound test in Table 3, further

evaluation was extended to long run cointegration is exhibited in Table 4.

Table 4: ARDL Long-run and Short-run

Variables	Long-run	Short-run
LFI	0.679*** (0.079)	
LINF	-0.038 (0.034)	
LTEMP	0.073* (0.0417)	
LAGRL	-5.271*** (1.612)	
DLFI		-0.127** (0.054)
DLINF		-2.707** (0.006)
DTEMP		0.0240* (0.012)
DLAGRL		-0.441** (0.164)
ECT (Speed Adjustment)		-0.369***(0.090)
Constant	73.939	27.349
R-squared	0.801	

Note: *, p < 0.1, **, p< 0.05, and ***, p < 0.01. Standard errors are presented in parentheses.

Table 4 reveals the ARDL estimations for both the long-run and short-run relationships. The estimation results indicate that LFI (food imports) is positively associated with LFP (food production) at the 1% significance level in the long run, but negatively associated with LFP at the 5% significance level in the short run. The positive long-run relationship is consistent with Li et al. (2024), who found that food imports positively influence domestic food production by improving the coordination of land and water use in agricultural resources. This finding is also supported by Subramaniam (2024), who found that food imports significantly improve food availability by supplementing domestic production. However, the negative short-run effect indicates that greater reliance on food imports is associated with lower domestic food self-sufficiency (Barel-Shaked & Buda, 2025).

Table 4 also shows that LINF (inflation) has no significant effect on LFP in the long run but has a significant negative effect in the short run. The short-run findings are consistent with Ahmed et al. (2025), who found that inflation increases production costs and indirectly reduces food production. Meanwhile, LTEMP reveals a weak positive association with LFP at the 10% significance level in both the long and short run. In contrast, LAGRL (agricultural land) has a negative and statistically significant effect on food production in both the long run and the short run. This finding is consistent with previous studies showing that agricultural land-use transformation, land degradation, and the conversion of productive farmland reduce agricultural productivity and food production (Li et al., 2024; Ahmed et al., 2025).

The estimated ECT coefficient indicates that approximately 36.9% of short-run disequilibrium is corrected each year, implying a relatively moderate speed of adjustment toward the long-run equilibrium following short-run shocks.

The error correction model (ECT) coefficient is negative (-0.369) at the 1% significance level, confirming the presence of a stable long-run equilibrium relationship among LFP (food production), LFI (food imports), LTEMP (temperature), and LAGRL (agricultural land). The findings are consistent with Boutfssi et al. (2026), Mala et al. (2025), Engle and Granger (1987) and Pesaran et al. (2001). The estimated ECT coefficient indicates that approximately 36.9% of short-run disequilibrium is corrected within a year, showing a relatively moderate speed of adjustment toward the long-run equilibrium due to short-run shocks.

Diagnostic Tests: Table 5 presents the necessary diagnostic tests for the reliability and accuracy of the dynamic ARDL method's estimated equation. The diagnostic test results display a normal distribution of residuals and the functional form is linear, proving the absence of serial correlation and heteroskedasticity issues.

Table 5: Diagnostic test results

Diagnose tests	Null hypothesis	Chi-Square
Jarque-Bera test	H_0: The residuals have a normal distribution	0.4871
Lagrange Multiplier test	H_0: There is no autocorrelation	0.1047
Breusch-Pagan-Godfrey	H_0: There is no heteroskedasticity	0.3895
Ramsey RESET test	H_0: Functional form is linear	0.2280

5. Conclusion

This paper examines the macroeconomic and environmental factors of food production in Malaysia using annual data covering the period from 1988 to 2022. By analyzing both macroeconomic and environmental factors within a single empirical framework, this study provides a clearer picture of the key drivers influencing food production performance in Malaysia.

The empirical results indicate that food imports, temperature, and agricultural land have significant long-run effects on food production. These findings highlight the importance of both macroeconomic factors, specifically food imports, and environmental factors, namely temperature and agricultural land, in influencing food production in Malaysia.

From a policy implication, the positive relationship between food imports and food production suggests that the Malaysian government should maintain a balanced import strategy that secures essential food commodities and agricultural inputs without undermining domestic production. The positive effect of temperature on food production suggests that current climatic conditions may still support agricultural productivity. Nevertheless, adaptive farming technologies are necessary to reduce the potential adverse impacts of future climate change. Meanwhile, the negative effect on agricultural land indicates the need to improve land-use efficiency by protecting productive farmland from conversion and enhancing agricultural productivity through modern technologies rather than depending solely on land expansion.

This research study has several limitations despite its contributions. The analysis is based on a few macroeconomic and environmental variables and fails to include aspects of rainfall, advancements in technology, government spending on agricultural activities, or government intervention.

More climatic indicators could be included in this work; comparisons across nations could be possible for investigation. This extension would provide better insight into the interaction between economic conditions, environmental change, and food production as tricky. Overall, this paper can be added to the current list of the literature on food security as it proves the utmost importance of the macroeconomic and environmental factors in shaping agricultural performance in Malaysia.

References

Abang Ali, D. H. (2024). Food Security in Malaysia: An Empirical Analysis of Macroeconomic Determinants. *International Journal of Academic Research in Economics and Management Sciences, 13*(3). https://doi.org/10.6007/ijarems/v13-i3/22076

Abbasi, R., Martinez, P., & Ahmad, R. (2022). The digitization of agricultural industry: A systematic literature review on agriculture 4.0. *Smart Agricultural Technology, 2*, 100042. https://doi.org/10.1016/j.atech.2022.100042

Abdullah, M. Z., Applanaidu, S. D., & Kalimuthu, K. (2025). Impact of Climate Change on Paddy Productivity in Malaysia's Granary Areas: A Markov Chain Monte Carlo Analysis. *GATR Accounting and Finance Review, 9*(4), 1–12. https://doi.org/10.35609/afr.2025.9.4(1)

Adekunle, C., Kao, P., & Sergeo, T. T. N. (2023). Farm households' input demand and output supply response to price shocks in Nigeria. *Mediterranean Agricultural Sciences, 36*(1), 37–46. https://doi.org/10.29136/mediterranean.1189118

Ahmed, Z., Kadir, A., Alam, R., Hafiz-Al-Rezoan, & Laskor, M. A. H. (2025). The impact of staple crop price instability and fragmented policy on food security and sustainable development: A case study from Bangladesh. *Discover Sustainability, 6*(1). https://doi.org/10.1007/s43621-025-00878-7

Aleminew, A. (2023). Impacts of Land Degradation on Crop Yields and its Management Options: A review. *Agricultural Reviews.* https://doi.org/10.18805/ag.rf-263

Ali, R., Ahmad, A. A., & Safari, S. (2020). Economic impacts of import liberalization policy on the agricultural food sector in Malaysia. *International Journal of Food and Agricultural Economics, 8*(4), 325–342. https://doi.org/10.22004/AG.ECON.307653

Awokuse, T. O. (2005). Impact of macroeconomic policies on agricultural prices. *Agricultural and Resource Economics Review, 34*(2), 226–237. https://doi.org/10.1017/S1068280500008388

Azizan, M. U., & Hussin, K. (2015). Understanding the pressure on agricultural land as a safeguard for food security in Malaysia. *International Journal of Built Environment and Sustainability, 2*(4), 278–283. https://doi.org/10.11113/ijbes.v2.n4.95

Barel-Shaked, S., & Buda, E. (2025). Charting resilience: a typology of food self-sufficiency in OECD nations. *Agriculture and Food Security, 14*(1). https://doi.org/10.1186/s40066-025-00537-0

Boutfssi, A., Zizi, Y., & Quamar, T. (2026). Short-run inertia and long-run adjustment in bank credit: An ARDL–ECM analysis of monetary transmission in an emerging economy. *Journal of Risk and Financial Management, 19*(3), 195. https://doi.org/10.3390/jrfm19030195

Choo, E. Y. (2021). The impact of climate change in Asia: An econometric analysis of the agriculture sector. *KNOWLEDGE–International Journal, 47*(3), 455–461. https://ojs.ikm.mk/index.php/kij/article/view/4731

Daszkiewicz, T. (2022). Food production in the context of global developmental challenges. *Agriculture, 12*(6), 832. https://doi.org/10.3390/agriculture12060832

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366), 427–431.

Dong, H., Han, J., Zhang, Y., Chen, T., Fan, H., & Wang, C. (2023). Research on influencing factors of cultivated land productivity of high-standard farmland projects in Hanzhong City, China: An empirical study based on PLS-SEM. *Frontiers in Sustainable Food Systems, 7*, 1176426. https://doi.org/10.3389/fsufs.2023.1176426

Engle, R. F., & Clive W. J. Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 55*(2), 251–276. https://doi.org/10.2307/1913236

Granger, C. W. J., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics, 2*(2), 111–120. https://doi.org/10.1016/0304-4076(74)90034-7

Halperin, S., Castro, A. J., Quintas-Soriano, C., & Brandt, J. S. (2023). Assessing high-quality agricultural lands through the ecosystem services lens: Insights from a rapidly urbanizing agricultural region in the western United States. *Agriculture, Ecosystems and Environment, 349*, 108435. https://doi.org/10.1016/j.agee.2023.108435

Hassan, N., & Jia-Yi Kam, A. (2022). Can Malaysia Feed Itself? Food Security Issues in Malaysia. *Journal of Strategic Studies & International Affairs, 2*(1). https://doi.org/10.17576/sinergi.0201.2022.02

Hatfield, J. L., & Prueger, J. H. (2015). Temperature extremes: Effect on plant growth and development. *Weather and Climate Extremes, 10*, 4–10. https://doi.org/10.1016/j.wace.2015.08.001

Islam, S., Raihan, A., Paul, A., Ridwan, M., Rahman, M. S., Rahman, J., Tanchangya, T., Bibi, R., Sumaira, & Al Jubayed, A. A. (2024). Dynamic impacts of sustainable energies, technological innovation, economic growth, and financial globalization on load capacity factor in the top nuclear energy-consuming countries. *Journal of Environmental and Energy Economics, 3*(1), 1–14. https://doi.org/10.56946/jeee.v3i1.448

Kuri, B. C., Nahiduzzaman, M., Dhar, B. K., Shabbir, R., & Karim, R. (2025). Macroeconomic drivers of sustainable tourism development in Bangladesh: An ARDL bounds testing approach. *Sustainable Development, 33*(3), 3918–3940. https://doi.org/10.1002/sd.3328

Kyaw, Y., Nguyen, T. P. L., Winijkul, E., Xue, W., & Virdis, S. G. P. (2023). The Effect of Climate Variability on Cultivated Crops' Yield and Farm Income in Chiang Mai Province, Thailand. *Climate, 11*(10). https://doi.org/10.3390/cli11100204

Laghari, F., Ahmed, F., Ansari, B., & Silveira Ferreira, P. J. (2025). Agricultural land, sustainable food and crop productivity: An empirical analysis on environmental sustainability as a moderator in the economy of China. *Sustainability, 17*(5), 1980. https://doi.org/10.3390/su17051980

Laurenceson, J., & Chai, J. C. H. (2003). *Financial reform and economic development in China*. Edward Elgar Publishing.

Li, W., Guo, G., Gu, H., Lai, S., Duan, Y., & Li, C. (2024). Digital economy as a buffer: Alleviating the adverse effects

of land resource mismatch on food security. *Land, 13*(11), 1742. https://doi.org/10.3390/land13111742

Liu, Z., Xu, D., Wang, R., Guo, X., Song, Y., Wang, M., & Cai, Y. (2025). Effects of temperature fluctuations on the growth cycle of rice. *Agriculture, 15*(1), 99. https://doi.org/10.3390/agriculture15010099

Mahase-Forgenie, M., & Forgenie, D. (2025). Chronic food insecurity in Caribbean SIDS: The role of income, globalization, and financial institution access. *Food and Humanity, 5*, 100772. https://doi.org/10.1016/j.foohum.2025.100772

Mala, C. M. F., Jumono, S., Sugianto, & Baskara, I. (2025). Regime-dependent pass-through from oil, gas, and wheat shocks to the Euro: Structural breaks, ARDL-ECM, and variance overshooting. *Korea and the World Economy, 26*(3), 177–214. https://doi.org/10.46665/kwe.2025.12.26.3.177

Maruschke, J. M., Wortha, F., & Schiller, D. (2024). The understanding of the agriculturally shaped environment: From the theoretical construct to an applied indicator of sustainable development. *Discover Sustainability, 5*(1), 462. https://doi.org/10.1007/s43621-024-00462-5

Marzuki, A., & Jais, A. S. (2020). Urbanization and the concerns for food security in Malaysia. *Planning Malaysia, 18*(3), 202–217. https://doi.org/10.21837/pm.v18i13.786

Mohd Azman, A. L. N., Abdullah, N. A., Ninam Shah, S. K., & Puteh, F. (2023). Strategic analysis of climate change and food security in Malaysia. *Journal of Administrative Science, 20*(1), 51–77. https://doi.org/10.24191/jas.v22i1.3763

Narayan, P. K., & Narayan, S. (2005). Estimating income and price elasticities of imports for Fiji in a cointegration framework. *Economic Modelling, 22*(3), 423–438. https://doi.org/10.1016/j.econmod.2004.06.004

Nielsen, H. B. (2005). Non-stationary time series and cointegration. In T. C. Mills & K. Patterson (Eds.), *Palgrave handbook of econometrics: Volume 1: Econometric theory* (pp. 297–320). Palgrave Macmillan. https://doi.org/10.1007/978-1-4039-1290-7_9

Ngobeni, E., & Muchopa, C. L. (2022). The impact of government expenditure in agriculture and other selected variables on the value of agricultural production in South Africa (1983–2019): Vector autoregressive approach. *Economies, 10*(9), 205. https://doi.org/10.3390/economies10090205

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In S. Strøm (Ed.), *Econometrics and economic theory in the 20th century: The Ragnar Frisch centennial symposium* (pp. 371–413). Cambridge University Press.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326. https://doi.org/10.1002/jae.616

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75(2), 335–346. https://doi.org/10.1093/biomet/75.2.335

Priastiwi, D. (2025). Factors influencing Indonesia's food inflation: An ARDL approach, 2020–2024. Jurnal Ekonomi dan Pembangunan Indonesia, 25(2), 394–402. https://doi.org/10.1234/jepi.2025.25.2.394

Ridwan, M. (2025). Artificial intelligence and green development: The role of financial market efficiency in the United States. *Development and Sustainability in Economics and Finance, 8*, 100099. https://doi.org/10.1016/j.dsef.2025.100099

Rozi, F., Subagio, H., Elisabeth, D. A. A., Mufidah, L., Saeri, M., Supriyadi, Burhansyah, R., Kilmanun, J. C., Krisdiana, R., Hanif, Z., Astuty, E. D., & Putri, R. L. (2025). Indonesian foodstuffs in facing global food crisis: Economic aspects of soybean farming. *Journal of Agriculture and Food Research, 19*, 101669. https://doi.org/10.1016/j.jafr.2025.101669

Sethuraman, G., Osman, N., Cheng, A., Ratnam, W., Ismail, M. R., & Mohd Zain, N. A. (2025). Effect of elevated temperature on the growth, physiological, and yield-related traits of commercial rice in Malaysia. *Sains Malaysiana, 54*(5), 1305–1318. https://doi.org/10.17576/jsm-2025-5405-09

Sarma, P. K., Alam, M. J., Begum, I. A., & McKenzie, A. M. (2024). The effect of total factor productivity on the food security and livelihood vulnerability of farm households in Bangladesh. Frontiers in Sustainable Food Systems, 8, 1395897. https://doi.org/10.3389/fsufs.2024.1395897

Sjulgård, H., Keller, T., Garland, G., & Colombi, T. (2023). Relationships between weather and yield anomalies vary with crop type and latitude in Sweden. *Agricultural Systems, 211*, 103757. https://doi.org/10.1016/j.agsy.2023.103757

Solaymani, S. (2018). Impacts of climate change on food security and the agriculture sector in Malaysia. *Environment, Development and Sustainability, 20*(4), 1575–1596. https://doi.org/10.1007/s10668-017-9954-4

Subramaniam, Y., Masron, T. A., & Loganathan, N. (2024). Imports and food security. *Global Journal of Emerging Market Economies, 16*(1), 7–24. https://doi.org/10.1177/09749101221146422

Suffian, F., & Suffian, F. (2021). Policy analysis: Food security in Malaysia. In *E-proceedings of the 8th International Conference on Public Policy and Social Science (ICoPS 2021)* (pp. 486–490). UiTM Cawangan Negeri Sembilan, Kampus Seremban.

Tan, B. T., Fam, P. S., Firdaus, R. B. R., Tan, M. L., & Gunaratne, M. S. (2021). Impact of climate change on rice yield in Malaysia: A panel data analysis. *Agriculture, 11*(6), 569. https://doi.org/10.3390/agriculture11060569

Weremczuk, A., & Malitka, G. (2022). Influence of changes in the prices of fertilizers and fuels on the profitability of production of selected crops. *Problems of World Agriculture, 22*(3), 43–55. https://doi.org/10.22630/PRS.2022.22.3.12

Xie, W., Zhou, G., Yang, H., Chen, X., Wang, C., & Ji, J. (2023). Response of food production and trade to the global socio-ecological system network. *Land, 12*(9), 1762. https://doi.org/10.3390/land12091762

Xu, Q., Liang, H., Wei, Z., Zhang, Y., Lu, X., Li, F., Wei, N., Zhang, S., Yuan, H., Liu, S., & Dai, Y. (2024). Assessing climate change impacts on crop yields and exploring adaptation strategies in Northeast China. *Earth's Future, 12*(4), e2023EF004063. https://doi.org/10.1029/2023EF004063

Yeboah, S. D., Baboo, A. M., Fumey, M. P., Ansah, M. A., & Oduro, L. (2025). Role of agricultural finance and investment in reducing rural poverty in Ghana: Insights from wavelet coherence analysis. *Discover Sustainability, 6*, 996. https://doi.org/10.1007/s43621-025-01308-4

Yuan, X., Li, S., Chen, J., Yu, H., Yang, T., Wang, C., Huang, S., Chen, H., & Ao, X. (2024). Impacts of global climate change on agricultural production: A comprehensive review. *Agronomy, 14*(7), 1360. https://doi.org/10.3390/agronomy14071360

Zafar, S., Aarif, M., & Tarique, M. (2023). Input subsidies, public investments and agricultural productivity in India. Future Business Journal, 9, 1–12. https://doi.org/10.1186/s43093-023-00232-1

Zeng, G., Zhang, C., Li, S., & Sun, H. (2021). The dynamic impact of agricultural fiscal expenditures and gross agricultural output on poverty reduction: A VAR model analysis. *Sustainability, 13*(11), 5766. https://doi.org/10.3390/su13115766

Zhi, H. L., & Wong, K. K. S. (2020). Assessment of government agriculture and rural development expenditure impact on Malaysia's agriculture production. Malaysian Journal of Agricultural Economics, 29(1), 1–12. https://doi.org/10.36877/mjae.a0000158