



Agricultural Financing and Food Security in Sumatra: The Role of Islamic and Conventional Banks in a Dual Banking System

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ABSTRACT

Food security is a key target of the Sustainable Development Goals (SDGs), aiming to end hunger and promote sustainable agriculture by 2030. This study examines the role of agricultural financing under a dual banking system, encompassing Islamic and conventional banks, in enhancing food security across 10 provinces in Sumatra from 2019 to 2023. Using panel regression analysis, the results indicate that agricultural financing provided by both Islamic and conventional banks has a significant and positive impact on food security in the region, highlighting the importance of bank-based financing in supporting agricultural productivity and food availability. In addition, agricultural labor, the Human Development Index (HDI), and the Farmer Exchange Rate (FER) significantly contribute to improving food security across Sumatra. These findings suggest that expanding and strengthening agricultural financing portfolios within both Islamic and conventional banking systems can effectively support government efforts to enhance national food security and promote sustainable agricultural development. Overall, this study provides policy-relevant evidence on the importance of an inclusive agricultural financing framework in strengthening food security across Sumatra.

ARTICLE INFO

Keywords:
Agricultural Financing
Conventional Banks
Food Security
Sumatra Island

Dates:
Received 10 January
2026
Revised 10 March 2026
Accepted 29 May 2026
Published 28 Juny 2026

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INTRODUCTION

Food security constitutes one of the primary targets of the Sustainable Development Goals (SDGs), particularly Goal 2, which aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture by 2030 (Abduh, 2019). Achieving this objective is inseparable from the sustainability of the agricultural sector, as agriculture functions not only as the main provider of food but also as a primary source of livelihood for the majority of rural populations. Consequently, strengthening a productive, inclusive, and sustainable agricultural system is a crucial prerequisite for maintaining national food security stability.

However, over the past decades, the agricultural sector has faced increasingly complex structural challenges. Large-scale conversion of agricultural land into residential, industrial, and infrastructure areas has reduced the availability of productive land and threatened food production capacity (Rondhi et al., 2019; Adam et al., 2018). This condition has been further exacerbated by the declining attractiveness of agriculture as a viable income source, which has accelerated rural-to-urban labor migration (Abduh, 2019; Osabohien et al., 2020). As a result, agricultural productivity has weakened, dependence on food imports has increased, and the risks of food price volatility and supply instability have intensified. In addition, the slow regeneration of farmers poses a serious challenge to the long-term sustainability of the agricultural sector. The dominance of an aging farming population, limited access to capital, land, and technology, as well as the high risks associated with agricultural activities, have reduced the willingness of younger generations to engage in farming (Leavy & Hossain, 2014; Ma'rufah et al., 2022; Mardiyanti et al., 2023; Dalmiyatun et al., 2024). If these conditions persist, national food security will become increasingly vulnerable, particularly amid growing global uncertainties.

Global economic instability driven by geopolitical conflicts, the prolonged impacts of the COVID-19 pandemic, and escalating health and climate risks has created a Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) environment that directly affects food systems (Sharif & Irani, 2017; Kotur et al., 2024). Such uncertainty has the potential to suppress investment and financing in the agricultural sector, thereby undermining food availability, accessibility, and utilization. In this context, the role of the financial sector—particularly the banking system—has become increasingly strategic in supporting food security through the provision of adequate and sustainable agricultural financing.

A growing body of empirical literature has examined the relationship between agricultural financing and agricultural productivity as well as food security, particularly in developing countries. Osabohien, Adeleye, and Tyrone (2020), using Johansen and Canonical Cointegration approaches for Nigeria during the period 1981–2018, found that agricultural sector financing has a positive and significant impact on agricultural productivity. Similarly, Osabohien et al. (2020), employing propensity score matching (PSM) on data from 4,210 farming households in Nigeria, demonstrated that households with access to agricultural financing achieved significantly higher crop yields than those without such access. Supporting evidence from Osabohien, Afolabi, and Godwin (2018) and Egwu (2016) further confirms that bank credit and agricultural credit guarantee schemes play a significant role in enhancing agricultural output, promoting economic growth, and reducing poverty. Conversely, Adetiloye (2012) showed that the weak performance of agricultural credit schemes contributed to low levels of food security in Nigeria.

Beyond the Nigerian context, several studies have emphasized the role of Islamic finance and broader structural factors in supporting food security. Basyariah (2022) and Abduh (2019) highlighted the potential of Islamic finance—including agricultural financing and Islamic social finance instruments—in advancing SDG-related food security objectives. Meanwhile, Srinita (2018), examining ten provinces in Sumatra, found that food availability, access, and utilization significantly influence food security and farmers' welfare, underscoring the multidimensional nature of food security at the regional level. This means that the demand for Sharia-based financing is increasing and that it plays a key role in supporting the economy (Trimulato *et al.*, 2026).

Despite these contributions, existing studies remain largely fragmented, focusing either on a single financial system or on specific country contexts most notably Nigeria. Empirical research that simultaneously examines and compares the roles of Islamic and conventional banking within a dual banking system framework in relation to food security remains scarce, particularly at the regional level in Indonesia. Addressing this gap, the present study contributes to the literature by empirically analyzing the role of agricultural financing provided by both Islamic and conventional banks in enhancing food security across ten provinces in Sumatra. By employing panel data analysis, this study offers policy-relevant

evidence on how an inclusive agricultural financing framework within a dual banking system can strengthen regional and national food security in Indonesia.

METHOD, DATA, AND ANALYSIS

Based on data availability, this study employs a sample of ten provinces on Sumatra Island over the period 2019–2023, namely Aceh, Bengkulu, Jambi, Bangka Belitung Islands, Riau Islands, Lampung, Riau, West Sumatra, South Sumatra, and North Sumatra. The selection of this region is motivated by Sumatra’s strategic role as one of Indonesia’s major national food production centers, as well as the availability of consistent provincial-level data across the study period.

The study primarily utilizes secondary data collected in aggregated form from relevant government institutions. Data on the Food Security Index are obtained from official publications of the National Food Agency (Badan Pangan Nasional, Bapanas). Meanwhile, data on agricultural financing provided by Islamic banks and agricultural credit disbursed by conventional banks are sourced from provincial-level statistical reports published by the Financial Services Authority (Otoritas Jasa Keuangan, OJK). Data for control variables—including the Farmer Exchange Rate, agricultural labor, the Human Development Index (HDI), and natural disasters—are obtained from Statistics Indonesia (Badan Pusat Statistik, BPS) for each province on Sumatra Island. The variables employed in this study consist of a dependent variable, key independent variables, and a set of control variables. A summary of the variables and their corresponding measurements is presented in Table 1.

Table 1. Research Variables and Measurement

Type of Variable	Variable	Proxy / Measurement	Data Source
Dependent Variable	Food Security	Food Security Index based on three dimensions: food availability, food access, and food utilization	National Food Agency (Badan Pangan Nasional, Bapanas)
Independent Variable	Agricultural Financing (Islamic Banks)	Total Islamic banking financing allocated to the agricultural sector at the provincial level	Islamic Banking Statistics (Statistik Perbankan Syariah, SPS) – Financial Services Authority (OJK)
	Agricultural Lending	Total conventional banking credit allocated to the	Indonesian Banking Statistics (Statistik

Type of Variable	Variable	Proxy / Measurement	Data Source
Control Variables	(Conventional Banks)	agricultural sector at the provincial level	Perbankan Indonesia, SPI) – Financial Services Authority (OJK)
	Farmer Exchange Rate (FER)	Farmer Exchange Rate by province	Statistics (BPS)
	Natural Disasters	Natural Disasters	Statistics (BPS)
	Agricultural Labor	Percentage of labor force employed in the agricultural sector	Statistics (BPS)
	Human Development Index (HDI)	Human Development Index (HDI)	Statistics (BPS)

Source: Author's compilation (2026)

The Food Security Index is measured using an indicator-weighting method as published by the Deputy for Food Insecurity and Nutrition (2023). Each indicator is first standardized using a combination of the z-score and distance-to-scale methods, producing values within a range of 0 to 100. Subsequently, the standardized indicator values are multiplied by their respective weights and aggregated to obtain the composite Food Security Index score.

Formally, the Food Security Index is expressed as follows:

$$Y_j = \sum_{i=1}^9 a_i X_{ij}$$

Where i denotes indicators 1 through 9, j represents the region (province), Y_j denotes the Food Security Index, a_i represents the weight assigned to indicator- i , and X_{ij} denotes the standardized value of indicator i in region j . The indicators and weights of the Food Security Index employed in this study are presented in Table 2.

Table 2. Food Security Indicators Based on the National Food Agency

No.	Indicator	Weight
Food Availability Dimension		
1	Ratio of normative consumption to net production of rice, maize, sweet potato, cassava, and sago, including regional government rice reserves	0.30
Food Accessibility Dimension		
2	Percentage of population living below the poverty line	0.15
3	Percentage of households with food expenditure exceeding 65% of total household expenditure	0.075
4	Percentage of households without access to electricity	0.075

No.	Indicator	Weight
Food Utilization Dimension		
5	Average years of schooling of females aged over 15 years	0.05
6	Percentage of households without access to clean water	0.15
7	Population-to-health-worker ratio	0.05
8	Percentage of stunted children under five years old	0.05
9	Life expectancy at birth	0.10

Source: Author's compilation (2026)

The Food Security Index is measured using an indicator-weighting method as published by the Deputy for Food Insecurity and Nutrition (2023). Each indicator is first standardized using a combination of the z-score and distance-to-scale methods, producing values within a range of 0 to 100. Subsequently, the standardized indicator values are multiplied by their respective weights and aggregated to obtain the composite Food Security Index score.

Formally, the Food Security Index is expressed as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \varepsilon_{it}$$

Where Y_{it} denotes the dependent variable (food security) in province i at time t , X_{it} represents the independent variables, β_0 is the intercept, β_n denotes the regression coefficients, and ε_{it} is the error term. Based on Equation (2), the empirical models employed in this study are specified as follows:

Model 1: Islamic Banking Agricultural Financing

$$\text{FoodSecurity}_{it} = \beta_0 + \beta_1 \text{AgriculturalFinancing}_{it} + \beta_2 \text{ControlVariables}_{it} + \varepsilon_{it}$$

Model 2: Conventional Banking Agricultural Credit

$$\text{FoodSecurity}_{it} = \beta_0 + \beta_1 \text{AgriculturalLending}_{it} + \beta_2 \text{ControlVariables}_{it} + \varepsilon_{it}$$

Under the FEM and REM approaches, the key distinction lies in whether the individual effects (λ_i) and time effects (μ_t) are correlated with the explanatory variables. To determine the most appropriate estimation model, this study applies the Chow test (PLS vs. FEM), the Lagrange Multiplier (LM) test (PLS vs. REM), and the Hausman test (REM vs. FEM), as illustrated in Figure 1.

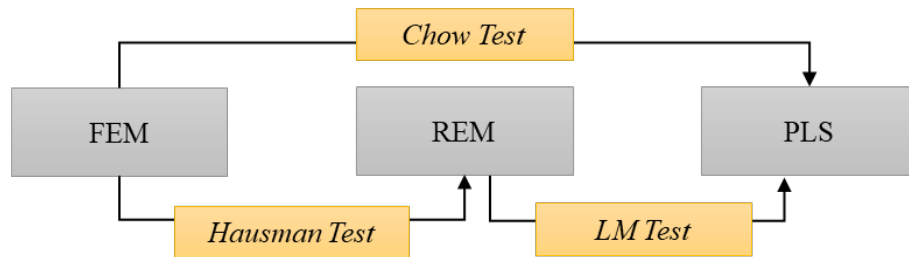


Figure 1. Illustration of the Model Selection Process

Source: Gujarati and Porter (2012a, 2012b)

RESULTS AND DISCUSSION

Table 3 presents the descriptive statistics for all variables employed in this study, including the mean, standard deviation, minimum, and maximum values. These descriptive statistics provide an overview of the characteristics of food security and its determining factors across the ten provinces on Sumatra Island during the observation period.

Table 3. Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
KP	70.4378	5.6023	56.0300	83.2200
IAF	5.7032	1.4067	1.3100	8.1600
CAL	8.6508	1.4999	4.8900	10.8200
NTP	112.9198	14.7315	94.7300	152.9300
TKP	81.7778	7.1730	66.7800	91.9900
BA	4.2086	0.9028	2.2000	5.6300
IPM	72.3262	1.6643	69.5700	77.1100

Note: KP = Food Security; IAF = Islamic Agricultural Financing; CAL = Conventional Agricultural Lending; NTP = Farmer Exchange Rate; TKP = Farmer Labor Force; BA = Natural Disasters; HDI = Human Development Index

Table 4 presents the correlation matrix among the independent variables and the dependent variable employed in the panel regression model. This correlation matrix is used to identify potential multicollinearity issues in the empirical model. Based on the pairwise correlation results, all correlation coefficients among the independent variables are below 0.80. Referring to Gujarati (2003), serious multicollinearity is generally considered to occur when the correlation coefficient between independent variables exceeds 0.80. Therefore, it

can be concluded that there is no multicollinearity problem in the model, indicating that the regression estimates are efficient and reliable.

Table 4. Correlation Matrix

Variabel	KP	IAF	CAL	NTP	TKP	BA	IPM
KP	1						
IAF	0.3698	1					
CAL	0.4661	0.7189	1				
NTP	-0.0075	0.3428	0.0385	1			
TKP	0.4884	-0.1199	0.0385	-0.3336	1		
BA	0.3702	0.5848	0.3505	0.0901	0.0872	1	
IPM	0.1442	-0.3149	-0.5210	0.2603	-0.2697	0.0165	1

Note: KP = Food Security; IAF = Islamic Agricultural Financing; CAL = Conventional Agricultural Lending; NTP = Farmer's Exchange Rate; TKP = Farmer Labor Force; BA = Natural Disasters; HDI = Human Development Index

The empirical analysis in this study employs panel data regression using three main approaches, namely the Pooled Least Squares (PLS), Fixed Effects Model (FEM), and Random Effects Model (REM). The selection of the most appropriate model is conducted through a series of specification tests, including the Chow Test, Breusch–Pagan Lagrange Multiplier (LM) Test, and Hausman Test. The test results indicate that both the Chow Test and LM Test are statistically significant, while the probability value of the Hausman Test exceeds 0.05. These findings suggest that the Random Effects Model (REM) is the most suitable specification for estimating the relationship between Islamic Agricultural Financing and food security in Sumatra. The REM is preferred as it captures cross-provincial variation while maintaining estimation efficiency under the assumption that individual effects are not correlated with the explanatory variables.

Based on the REM estimation results; Islamic Agricultural Financing exhibits a positive and statistically significant effect on food security at the 10% significance level. Quantitatively, a 1% increase in agricultural financing disbursed by Islamic banks is associated with an increase of approximately 1.15% in the Food Security Index. This finding indicates that Shariah-compliant agricultural financing plays a strategic role in enhancing agricultural production capacity and food availability in Sumatra. This is also in line with a previous study which indicates that agricultural financing in Nigeria is essential in assisting farmers from the planting stage through the harvesting period (Doha, 2024).

In addition to the main explanatory variable, several control variables also demonstrate statistically significant effects. The Farmer Exchange Rate (FER) and Agricultural Labor (AL) show positive and significant relationships with food security at the 5% significance level. These results confirm that improvements in farmers' welfare and the availability of agricultural labor directly contribute to food security by enhancing purchasing power, food access, and agricultural productivity (Srnita, 2018).

From a conceptual perspective, these findings reinforce the argument that Islamic Agricultural Financing, grounded in principles of equity, sustainability, and social welfare, is effective in supporting food security in regions that are highly dependent on agriculture and natural resources, such as Sumatra Island. The results are also consistent with prior studies emphasizing the critical role of agricultural financing in mitigating food insecurity (Osabohien et al., 2018; Osabohien et al., 2020; Egwu, 2016).

Table 5. Panel Regression Estimation Results of the Islamic Agricultural Financing Model on Food Security in Sumatra

Variable	Food Security in Sumatra		
	(1) PLS	(2) FEM	(3) REM
<i>IAF</i>	1.0213 [0.1561]	0.3635 [0.6328]	1.1567* [0.0558]
NTP	0.0442 [0.3947]	0.0832 [0.1330]	0.1014** [0.0379]
TKP	0.4043*** [0.0002]	0.1365 [0.5988]	0.3949** [0.0178]
BA	1.0367 [0.2823]	0.1837 [0.8032]	0.6272 [0.3576]
IPM	-0.4053 [0.3947]	2.0772* [0.0568]	0.5296 [0.4151]
Constant	51.5159	-103.1968	-20.8454
R-Squared (R^2)	0.4465	0.8396	0.3963
Adj. R-Squared	0.3836	0.7755	0.3277
F/Wald Test	7.0983***	13.0887** *	5.7773***
Model Specification Test			
Chow Test			24.1129(0.000)
LM Test			9.5335(0.000)
Hausman Test			7.0700(0.2155)
Note: ***, **, and * are significant at the 1%, 5%, and 10% levels.			

The estimation of the impact of Conventional Agricultural Lending on food security is also conducted using the PLS, FEM, and REM approaches. Based on statistically significant results from the Chow Test and Breusch–Pagan Lagrange Multiplier (LM) Test, along with an insignificant Hausman Test ($p\text{-value} > 0.05$), the Random Effects Model (REM) is once again selected as the most appropriate estimation model. The REM estimation results indicate that Conventional Agricultural Lending has a positive and statistically significant effect on food security at the 5% significance level. A 1% increase in agricultural credit disbursed by conventional banks is associated with an improvement in food security ranging from 1.29% to 2.18%. This finding reflects the crucial role of conventional banking in supporting agricultural financing, particularly through enhanced working capital, production investment, and efficiency in regional food distribution.

Among the control variables, Agricultural Labor continues to exhibit a positive and significant effect on food security, indicating that the availability of agricultural labor remains a fundamental factor in sustaining food production. Meanwhile, the Human Development Index (HDI) shows a significant effect in the FEM specification, highlighting the importance of human capital quality in supporting long-term food security through improvements in education, health, and overall productivity. The relatively high values of the coefficient of determination (R^2) across all three models suggest that the independent variables included in the model adequately explain variations in food security across provinces on Sumatra Island. These findings are consistent with previous studies emphasizing the critical role of banking sector financing in strengthening agricultural performance and food security (Osabohien et al., 2018; Osabohien et al., 2020).

Table 6. Panel Regression Estimation Results of the Conventional Agricultural Lending Model on Food Security in Sumatra

Variable	Food Security in Sumatra		
	(1) PLS	(2) FEM	(3) REM
CAL	1.2939** [0.0367]	1.6964 [0.4001]	2.1859** [0.0170]
NTP	0.0248 [0.6309]	0.0738 [0.1888]	0.0785 [0.1151]
TKP	0.3725*** [0.0003]	0.1617 [0.5342]	0.3842** [0.0157]
BA	1.2519	0.1559	0.5779

Variable	Food Security in Sumatra		
	(1) PLS	(2) FEM	(3) REM
	[0.1072]	[0.8315]	[0.3906]
IPM	-0.0752	1.9932*	1.0898
	[0.8821]	[0.0534]	[0.1037]
Constant	26.1482	-110.6231	-70.0117
R-Squared (R^2)	0.4756	0.8418	0.4192
Adj. R-Squared	0.416	0.7786	0.3532
F/Wald Test	7.9817***	13.3069***	6.3510***
Model Specification Test			
Chow Test			9.0049(0.000)
LM Test			19.7675(0.000)
Hausman Test			6.8691(0.2306)
Note: ***, **, and * are significant at the 1%, 5%, and 10% levels.			

The results of this study indicate that agricultural financing, whether provided by Islamic banks or conventional banks, has a positive and statistically significant impact on food security in the Sumatra region. The selection of the Random Effects Model (REM) in both estimations strengthens the empirical evidence that agricultural financing within a dual banking system framework contributes meaningfully to improvements in the Food Security Index across all provinces on Sumatra Island. Quantitatively, a 1% increase in Islamic Agricultural Financing is associated with a 1.15% increase in food security, while a 1% increase in Conventional Agricultural Lending leads to an improvement in food security ranging from 1.29% to 2.18%. These findings underscore that access to agricultural financing is a key determinant in enhancing production capacity, supply stability, and the overall sustainability of regional food systems.

The differing characteristics of financing between the two banking systems are reflected in their underlying principles and operational mechanisms. Islamic Agricultural Financing, grounded in principles of equity, sustainability, and social welfare (maslahah), has the potential to promote more inclusive agricultural development and improve farmers' well-being. In contrast, Conventional Agricultural Lending places greater emphasis on economic efficiency and productivity enhancement through credit-based mechanisms. Despite these differing approaches, the empirical results demonstrate that both banking systems are complementary in supporting food security in Sumatra.

Beyond financing factors, socio-economic variables such as Agricultural Labor, the Farmer Exchange Rate, and the Human Development Index (HDI) also play significant roles in

strengthening food security. This indicates that food security is not determined solely by capital availability, but also by farmers' welfare and the quality of human resources. Accordingly, strengthening food security in Sumatra requires an integrated policy approach that combines the expansion of agricultural financing, improvements in farmers' welfare, and sustained human development. This is consistent with previous studies emphasizing the importance of a policy hotspot framework, in which synergy among key stakeholders—regulators, Islamic financial institutions, and business actors—is essential for achieving sustainability (Kian *et al.*, 2026).

CONCLUSION AND SUGGESTIONS

This study concludes that agricultural financing within a dual banking system framework, encompassing both Islamic and conventional banks, plays a significant role in strengthening food security across Sumatra. Although food security levels remain uneven among provinces, agricultural financing from both banking systems is empirically shown to contribute positively and significantly to regional food security by enhancing production capacity, supply stability, and access to agricultural resources. In addition to financing, socio-economic factors such as agricultural labor, the Farmer Exchange Rate, and the Human Development Index are also found to be critical determinants, underscoring that food security is shaped not solely by production factors but by the simultaneous interaction of financing access, farmers' welfare, and human capital quality. Future research is encouraged to adopt more granular measurements of agricultural financing—such as financing for sustainable agriculture, region-based agro-industrial development, or high value-added agricultural subsectors—and to employ more advanced methodological approaches, including dynamic panel models or spatial analysis, to better capture regional heterogeneity in food security outcomes.

From a policy perspective, both Islamic and conventional banking institutions should increase the scale and effectiveness of agricultural financing as part of a long-term strategy to strengthen food security in Sumatra, while government policies should focus on enhancing farmers' skills, improving labor quality, and supporting favorable Farmer Exchange Rates. Greater integration between agricultural financing policies, human capital development, and institutional strengthening is therefore essential to achieving inclusive and sustainable food security across all provinces on Sumatra Island.

ACKNOWLEDGEMENTS

The authors would like to express their deepest gratitude for the academic collaboration between the Department of Islamic Economics, Faculty of Economics and Business, Universitas Airlangga, Surabaya, Indonesia & R-Square Research Consulting, Bogor, Faculty of Islamic Economics and Business, Universitas Islam Negeri Ar-Raniry, Banda Aceh, Faculty of Islamic Economics and Business, UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Padangsidimpuan and Hungarian University of Agriculture and Life Sciences (MATE), Godollo, Hungary. This joint effort has significantly enriched perspectives and the quality of the research. The authors sincerely appreciate the continuous support, constructive feedback, and intellectual exchange made possible through this international academic partnership.

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