Indonesian Treasury Review Vol.11, No.2, (2026), 123-139
P-ISSN: 2527-2721; E-ISSN: 2622-4399
https://itrev.kemenkeu.go.id

INDONESIAN TREASURY REVIEW
JURNAL PERBENDAHARAAN, KEUANGAN NEGARA DAN KEBIJAKAN PUBLIK

EVALUATING AGRICULTURAL CREDIT AND CLIMATE-RELATED GOVERNMENT EXPENDITURE EFFECT ON AGRICULTURE GDRP IN INDONESIA

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ABSTRACT

Research Originality – This research shifts from yearly national datasets to a quarterly sub-national analysis using a dual Fixed Effect Model (FEM) and output-oriented Data Envelopment Analysis (DEA) framework. It establishes an empirical benchmark for sub-national climate finance synergy, addressing a significant gap in global literature.
Research Objectives – The study aims to determine the impacts of agricultural credit and climate spending on regional GRDP, construct provincial efficiency benchmarks via DEA, and assess credit-expenditure synergy to inform performance-based fiscal management.
Research Methods – A two-stage analysis was employed. First, an FEM—validated by Chow and Hausman tests—measured input impacts on agricultural GRDP. Second, a DEA based on Variable Returns to Scale (VRS) captured structural differences and economic capacities for benchmarking.
Empirical Results – The FEM analysis shows that although credit instruments generated substantial marginal returns, the impact of climate-tagged expenditures was mixed. CA_SE demonstrated positive multipliers, while CM_SE and AGRI_LE were either non-significant or associated with negative impacts, indicating potential fiscal inefficiencies. The model had a high degree of fitness and passed the robust diagnostic tests, validating the coefficients. The analysis revealed a resource-performance gap where high-input provinces did not achieve efficient outputs, whereas eight provinces achieved an optimal resource-output efficiency ratio.
Implications – The study advocates for performance-based fiscal policies over volume-based finance. It highlights that credit access requires optimized governance to ensure effectiveness and recommends transitioning from administrative mitigation spending toward performance-based infrastructural investments.

Keywords: Agricultural Credit; Agriculture GDRP; Climate-tagged Government Budget; DEA Efficiency; Sustainable Economy.

ARTICLE INFO

Article History
Received : October 4, 2025
Revised : March 17, 2026
Accepted : May 20, 2026
Published : June 27, 2026

JEL Classification: Q14; O13; H72

How to Cite: Priambodo, A. P., & Yuniarianti, A. (2026). Evaluating agricultural credit and climate-related government expenditure effect on agriculture GDRP in Indonesia. *Jurnal Indonesian Treasury Review: Jurnal Perbendaharaan, Keuangan Negara, dan Kebijakan Publik, 11*(2), 123-139. https://doi.org/10.33105/itrev.v11i2.1428

INTRODUCTION

Indonesia has a long history of a strong economy in recent years. Still in 2024, this country's economic output is indeed substantial, with a nominal Gross Domestic Product (GDP) of about IDR 22,138.96 trillion and a real GDP growth rate of 5.03% year-on-year (yoy) (See Figure 1). However, it provides a view of Indonesia's growth (as an emerging market) and investment prospects as a stable economy.

This economic success is the result of a wide spectrum of close that varies from sectors. Over the five years from 2019 to 2024, the five sectors with the largest nominal value added were Manufacturing, Wholesale and Retail Trade, Agriculture, Construction, and Mining. In 2024, the value of the manufacturing sector reached 20.000 trillion IDR, which in 2019 had contributed 3.068,04 trillion IDR as a sector, but increased to 4.202,87 trillion IDR. As illustrated in Figure 2, the shares of the Wholesale and Retail Trade,

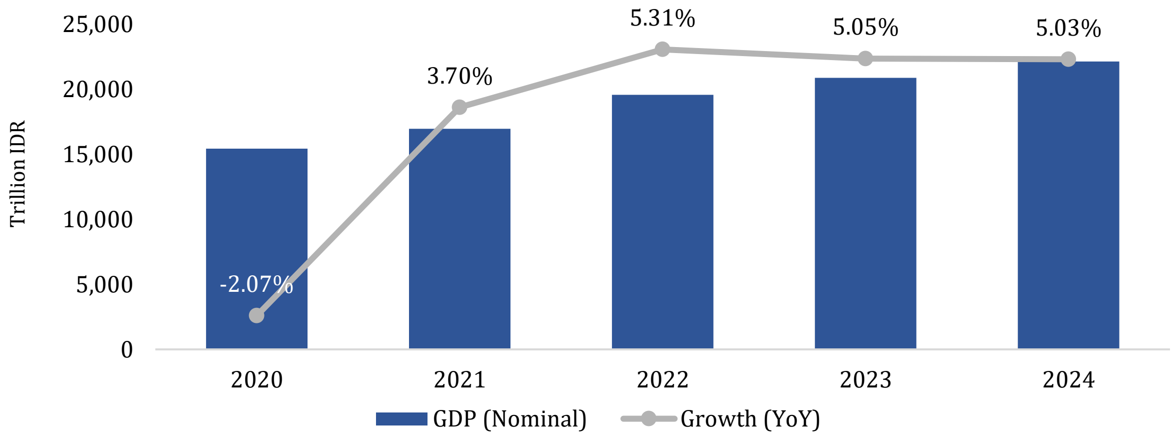
APPLICATIONS FOR PRACTICE

- Scale low-cost rural loans (BPR, KUR) and make them easier to access in remote areas to boost farm investment and incomes.
- Link climate budgets to on-the-ground needs (irrigation, seeds, extension) so spending raises farm output.
- Pair credit with training and simple insurance to ensure funds are used productively and reduce risk.
- Improve coordination between national and local governments and copy successful provincial practices to raise efficiency nationwide.

Agriculture, Construction, and Mining sectors are projected to reach 13.1%, 12.6%, 10.1% and 9.2%, respectively, in the year 2024. In addition, Table 1 shows the Share-to-Growth (STG) outputs across these five sectors. The manufacturing zone recorded an economic increase of 4.43 percent (yoy) over 2023, equivalent to approximately zero, 9 percent (yoy), weighted-in contribution out of the full financial increase in 2024. The Construction sector was also the main driver of growth in 2024, followed by Wholesale and Retail Trade, Agriculture, and Mining in third, fourth, and fifth place, respectively.

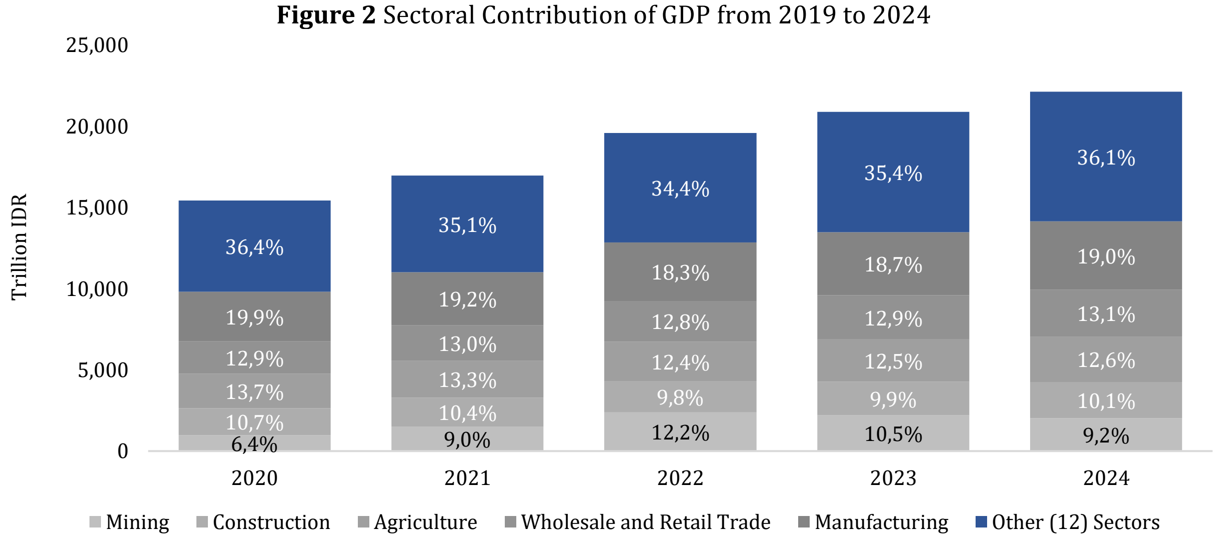
As shown in Figure 2 and Table 1, the agriculture sector, covering farming, forestry, and fishery activities, is also a major contributor to Indonesia's GDP output. This is important, as, from a provincial perspective, this sector contributed up to 39,2% of Gross Domestic Regional Product (GDRP) in 2024 especially in Sulawesi Barat/West Sulawesi (see Figure 3). Agriculture is a central aspect of economic and social development, especially in the developing parts of the world, with impacts not only on output but also on broader socio-economic concerns (Havemann et al., 2020; Kifle, 2020). In addition, inclusive economic development helped reduce poverty (Ali & Imran, 2021), ranged employment and income in rural areas (Khumalo et al., 2024), and supplied input to other value-added industries (Raihan et al., 2023).

Figure 1 Indonesia GDP and Yearly Economic Growth (2019 – 2024)



Source: BPS-Statistics Indonesia

Figure 2 Sectoral Contribution of GDP from 2019 to 2024



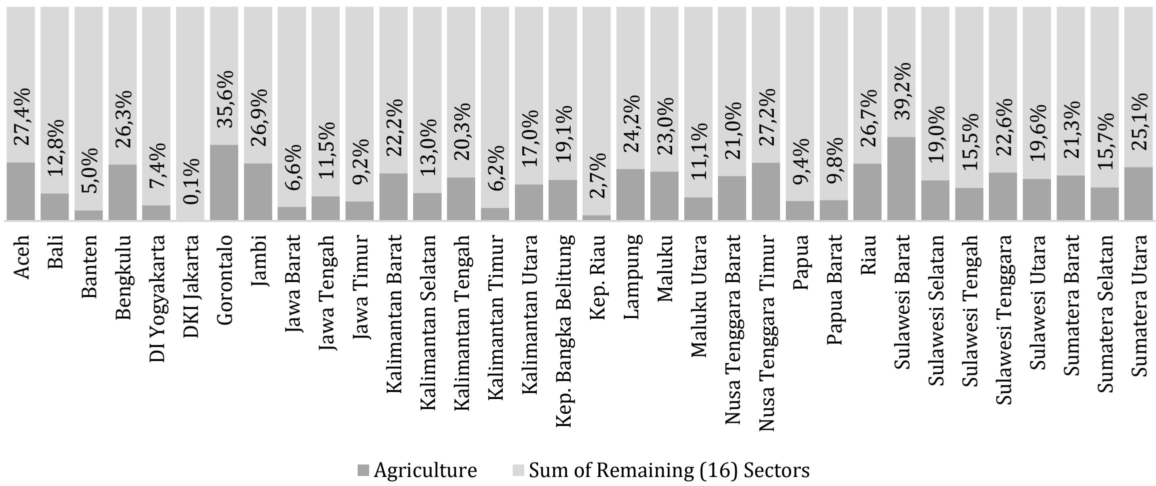
Source: BPS -Statistics Indonesia

Table 1 Sectoral Share-to-Growth to Indonesia Real GDP Change in 2019 to 2024

Sectors	2020	2021	2022	2023	2024
Growth (yoy)					
Manufacturing	-2,93%	3,39%	4,89%	4,64%	4,43%
Construction	-3,26%	2,81%	2,01%	4,91%	7,02%
Wholesale and Retail Trade	-3,79%	4,63%	5,53%	4,85%	4,86%
Mining	-1,95%	4,00%	4,38%	6,12%	4,90%
Agriculture	1,77%	1,87%	2,25%	1,31%	0,67%
Sum of Other (12) Sectors	-1,94%	4,38%	7,60%	6,40%	6,30%
Share-to-Growth					
Manufacturing	-0,61%	0,70%	1,01%	0,95%	0,90%
Construction	-0,33%	0,28%	0,20%	0,47%	0,67%
Wholesale and Retail Trade	-0,50%	0,60%	0,72%	0,63%	0,63%
Mining	-0,14%	0,29%	0,32%	0,45%	0,36%
Agriculture	0,22%	0,24%	0,28%	0,16%	0,08%
Sum of Other (12) Sectors	-0,70%	1,59%	2,77%	2,38%	2,38%
Real GDP Growth	**-2,07%**	**3,70%**	**5,31%**	**5,05%**	**5,03%**

Source: BPS -Statistics Indonesia

Figure 3 Agriculture Sector's Share of Gross Domestic Regional Product in 2024



Source: BPS -Statistics Indonesia

But climate change represents a serious threat to the agriculture sector as a lasting economic growth engine. So, changing weather patterns, extreme climate events, and shifts in pest and disease prevalence are already affecting agricultural output, lifting the likelihood of food insecurity (Fusco et al., 2020). Moreover, its tenuous growth once again emphasized the already considerable difficulties in advancing the development of Indonesia's agriculture (see again Table 1). In Indonesia, according to Abdillah et al. (2023) and Wurarah (2024), climate change is accelerating, with dire consequences such as rising sea levels and floods, increasing greenhouse gas emissions, erratic rainfall patterns, and higher surface temperatures that will result in reduced output of some crops and increased environmental risk. In line with this, it was also reported recently that the agriculture and land-use sector is one of the sectors most vulnerable to climate extremes and variability (Intergovernmental Panel on Climate Change [IPCC], 2023). Also, the continued growth of the population will only worsen this scenario if it is not properly monitored, since its effects are most strongly reaped by impoverished communities (Sylviani & Sakuntaladewi, 2024).

In light of increasing climate change risks, governments and financial institutions should prioritize targeted policy instruments to sustain agriculture's prospects as an economic driver. The government should be able to deftly provide supporting infrastructure development, such as irrigation systems and roads (Khumalo et al., 2024) improve efficiency and expand market access. Both the central and local governments can also promote investment in agricultural research, development, and extension services (Segbefia et al., 2023) and climate-smart agricultural practices (Bongay & Turay, 2024). In addition, more inclusive access to credit for small-scale farmers is crucial for maintaining the sector's sustainability (Segbefia et al., 2023). Moreover, direct engagement by governments and financial institutions in climate change mitigation and adaptation is highly beneficial for supporting the agricultural sector (Muhammad et al., 2025; Pendyala & Nainggolan, 2024; Primambudi, 2023; Wurarah & Mulyanto, 2024). Through these interventions, the agriculture sector can fulfill its dual role of driving economic growth and building resilience to climate change impacts, which ultimately supports sustainable development goals in the future (Nhemachena et al., 2018).

Nevertheless, existing studies provide limited analysis of the interaction between selected policy instruments and regional agricultural economic output. For instance, Segbefia et al. (2023) analyzed a five-country panel using annual data spanning 1990 to 2020. However, their analysis was restricted to macro-level metrics such as carbon emissions, demographic growth, and human capital. A similar reliance on macro-level, annual data characterizes the work of Khalatur et al. (2023) and Luo et al. (2024). On the other hand, qualitative examinations of climate-related interventions by Muhammad et al. (2025), Abdillah et al. (2023), Fusco et al. (2020), and Wurarah & Mulyanto (2024) provide valuable conceptual frameworks for climate-aligned agricultural development. Nevertheless, these studies omit direct, disaggregated empirical measurements regarding the efficiency and effectiveness of localized financial interventions on agricultural economic output.

Examining the effects of these instruments may help identify which combinations of variables are most influential in shaping Indonesia's agricultural sector. This paper uses some public expenditures, such as climate-related spending on mitigation and adaptation activities of the central government and agricultural spending for the agriculture subfunction conducted by the local government, along with targeted credit to farmers – People's Business Credit (KUR) for Micro, Small, and Medium Enterprises (MSME) and Rural Bank (BPR) Credit. The effectiveness of these instruments was estimated using panel data regression analysis. In addition, Data Envelopment Analysis (DEA) was conducted to assess the relative efficiency of regions in utilizing these instruments. The quarterly dataset from 34 Indonesian provinces from the year 2023 to 2024 enables authors to conduct an empirical study on the effect of selected government interventions and financial instruments on agriculture Gross Domestic Regional Product (GDRP). Furthermore, the relative efficiency of provinces in generating agricultural GDRP may serve as a benchmark for developing a more efficient agricultural economy. Although Indonesia introduced a national climate budget tagging scheme for all public expenditures in 2023, making earlier comparisons difficult, the use of quarterly data intervals enabled the study to generate 272 observations in the sample.

LITERATURE REVIEW

The agriculture sector makes the greatest contribution to GDP, employment generation, exports, and rural empowerment in many developing economies (Alromaihi & Omri, 2025). There has been an acknowledged correlation between agricultural and economic development, with food security as a key parameter (Adelaja & George, 2021). But as the new global reality brings larger, more frequent challenges such as erratic economic cycles, natural calamities, wars, and trade friction between nations, there are ever-growing operational risks for agriculture today (Berry et al., 2022; Luo et al., 2024). Uncertainties and interacting drivers necessitate strengthening resilience for the sustainable development of agriculture (Luo et al., 2024). Thus, enhancing the resilience of agricultural industries has become a primary focus globally (Luo et al., 2024).

In addition, the agricultural domain is highly vulnerable worldwide, but several challenges in this domain persist, especially in developing countries. Infrastructure gaps, including constrained fiscal space, poor transportation networks, unreliable energy supply, underdeveloped water-rainwater distribution systems, and storage locations, further hurt its development (Omit in Ngenoh et al., 2019). Economically, farmers are frequently distressed by instability in commodity prices, rising input costs, and low access to markets (Adisa et al., 2024). Limited access to credit and investment capital remains a key barrier to the adoption of new technologies and productivity enhancements (Khalatur et al., 2023).

Water scarcity, soil degradation, and increased spread of pests & diseases are among the impacts of climate change on agriculture. Moreover, both changing temperature and precipitation patterns, as well as the day-to-day recurrence of extraordinary climate occasions expand the danger of harvest disappointment and compromise occupations (Malau et al., 2024; Namozov et al., 2024). Unsustainable land and water use also negatively affects soil health, biodiversity, and therefore the provision of ecosystem services to the agricultural system (Namozov et al., 2024). Labor shortages, the aging of farming's population, succession issues, and shifting attitudes towards agriculture all combine to increase pressure on a sector already facing myriad challenges (Spiegel et al., 2020; Tahom, 2024). The sector's ability to respond rapidly to these major challenges is exacerbated by weak institutional frameworks, lack of policy integration, and limited bargaining power among farmer organizations (Tahom, 2024).

Such problems are repeating themselves in Indonesia right now, where a structural and demographic crisis threatens the longevity of its sector. The workforce on farms is heading for a crisis, with almost 60% of workers aged 45 or over as opposed to only 14.8 percent who were under the age of 35. Moreover, from 2005 onwards, the share of older workers increased from 12.6% to 21.2% in 2020. Simultaneously, the total agricultural labor force has fallen from 41.3 million to 38.22 million as younger generations increasingly turn their back on agriculture-related jobs (Alkausar et al., 2021; Ngadi et al., 2023; Guo et al. in Rambuda et al., 2025). With that, the busy transformation of land from agriculture to infrastructure and construction leads to a loss of arable lands, which range from 150,000 to 200,000 hectares annually, leading to an increasingly small area of rice fields, while real estate developers attack them (Askar in Affandi et al., 2025; Alkausar et al., 2021; Setiartiti, 2021). In addition, however, limited funding and capital investment still impede modernization; banks have a tendency to focus on the more stable and profitable sectors such as traditional products (Aziz et al., 2024; Yazid et al., 2021). With the combination of modern technology and good agricultural practice still a limited experience, it improves only product quality and not overall productivity, as the continuing economic crisis and increasing land pressures are maintained. A bottleneck to most of the progress that we have seen in agricultural development comes from this technical stagnation, which is limited by the high cost of these mechanisms, limited access, and the absence of infrastructure to put forth improvements on a large scale.

Such structural problems have exacerbated long-standing welfare and governance issues, further reducing the sector's resilience. Decreasing purchasing power due to low wage rates, land ownership, and international commodity price fluctuations leads to a disinclination towards labor force participation in the sector (Cakranegara, 2022; Setiartiti, 2021). Weaknesses at institutional level include uneven attention to human capital development since the village fund is focused on building physical infrastructure rather than that pertaining to people, low smallholder involvement in development decision-making and connection to local government mechanisms for implementing programs equitably, are among those factors that constrain the contribution of subsidies, upskilling, and infrastructure investments supposed to enhance productivity and farmers income (Novita, 2023; Penggalih et al., 2023; Tobing et al., 2024). Combined demographic aging, land loss, financing gap, slow adoption of technology, and insufficient institutional abilities signify an interconnected boundary that urges amelioration to achieve food security and sustainable agricultural growth in Indonesia.

However, several key instruments are available to address such challenges in the agricultural world. A lot of empirical evidence suggests a positive association between agricultural credit and agricultural GDP in most countries. The pattern shows that increased provision of agricultural credit leads to greater agricultural productivity in both intra-country and cross-country analyses. For instance, research in Bangladesh shows long-run relationships between bank agricultural credit, pesticides, and cropped area with agricultural output (Patwary et al., 2023). Using an Indian dataset, a 10% increase in agricultural credit increases agricultural GDP by about 2.7%. On the other hand, a U.S. study found that a one percentage-point increase in agricultural loans generates about 10% higher state-level agricultural GDP (Chakraborty & Shukla, 2020). Cross-country studies estimate that a 1% increase in agricultural credit can raise agricultural value added by approximately 0.19% in the long run. These studies also reveal a bidirectional causal relationship between credit access and agricultural value added (Ozdemir, 2024). National studies in Turkey, Nigeria, and Angola likewise document positive effects, with Turkey finding that a 1% credit increase raised agricultural output per hectare by 0.17% (0.05% direct, 0.12% spillovers) (Bahşi & Çetin, 2020). Multiple Nigerian analyses report significant positive impacts of formal bank lending and credit schemes on agricultural growth (Ajao et al., 2020; Akinniran et al., 2020; Ighoroje et al., 2021).

The government launched the subsidized Kredit Usaha Rakyat (KUR) to increase low-interest credit access for more micro, small, and medium enterprises in Indonesia. It also expands the farmer-offer program, which attempts to cut down on borrowing costs and alleviate collateral constraints, enabling farmers to purchase inputs and start commercializing more. This specialized form of lending may better convert credit into farm investments, which are more accessible. Yet a bigger pooled literature shows that simply expanding access to credit is not a foolproof recipe for perennial growth in agriculture(see Huseynov et al., 2024; Ozdemir, 2024; Sogah et al., 2024). Outcomes are contingent on program design, targeting, risk management, and the associated availability of complementary services (ag extension, accessible inputs, broader access to markets). Therefore, while KUR can be a vital tool for promoting the agricultural development sector, it will not work effectively if appropriate assistance and cross-factor pre- and post-production support are not combined with the credit.

Government spending on climate adaptation and mitigation in agriculture, particularly in irrigation, research, and development, is consistently associated with improved agricultural productivity, even as rising CO_2 emissions continue to negatively affect output (Gao et al., 2022). Empirical estimates show substantial gains from well-targeted public spending. One study reported that government agricultural expenditure raised total factor productivity by about 4% in the short run and 18.5% in the long run (Ngepah & Sunge, 2023). Climate variability compounded these impacts, with every 1% increase in average temperature and rainfall corresponding to productivity increases of 2.7% and 1.4%, respectively (Ngepah & Sunge, 2023). In addition to research focused on innovation in adaptation technologies in a particular place or sector, including precipitation, fertilizers, and improved seeds, tractors, or the diffusion of generally more innovative practices in R&D and technology adoption, can also play an important role in increasing productivity under moderate climate conditions across countries (Chandio et al., 2023; Usman et al., 2021).

Moreover, climate-driven public expenditure effects are heterogeneous and may be constrained by financial and institutional constraints. Using credit markets to fund R&D and infrastructure investments can mitigate some of the climate impacts, but not all, it finds: For example, temperature variability has a negative effect on agricultural credit supply while precipitation increases it; however, government spending did not significantly decrease those adverse effects for temperature variability only for precipitation (Dziwornu et al., 2024). Taken together, these mixed findings suggest that climate-oriented spending on agriculture is most effective when accompanied by other enabling measures, such as financial instruments and targeted credit programs, in addition to country-specific implementation strategies capable of ensuring that investments translate into lasting gains in productivity and resilience (Chandio et al., 2023; Gao et al., 2022; Ngepah & Sunge, 2023).

As an adaptation, the Indonesian government has been working with local context tools such as National Adaptation Plans (NAP's) and National Action Plan for Climate Change Adaptation (RAN-API). The perceived threats of climate change were also described. These initiatives identify farmer characteristics that influence adaptation capacity and emphasize the importance of government programs such as rice farming insurance (AUTP) (Rokhani et al., 2021). Additionally, in their study, Sekaranom et al. (2021) note the Kebumen government's response to climate adoption strategy through microfinance and agricultural insurance. However, these policies must be strengthened and more effectively integrated with financial, technical, and institutional measures to achieve their intended impact.

METHODS

This study incorporates five independent variables that are theoretically expected to influence agricultural Gross Domestic Regional Product (GDRP_AGRI): agricultural rural bank credit (BPR_AGRI), KUR financing for agricultural MSMEs (KUR_AGRI), state expenditure on climate adaptation (CA_SE), state expenditure on climate mitigation (CM_SE), and local government expenditure on the agricultural subfunction (AGRI_LE). This data source consists of official data from the Ministry of Finance, the BPS, and the Financial Services Authority (OJK). which covered quarterly data for 34 provinces in Indonesia for the years 2023-2024. The dataset consists of data from 34 provinces in Indonesia from the year 2023–2024 quarter. This specific timeframe was selected to ensure the availability and consistency of data for certain variables. More detailed information according to the research variables is provided in Table 2.

Table 2 Research Variable Information

Variable	Definition	Category	Source
GDRP_AGRI	Constant value of GDRP in agriculture sector in billion IDR	Dependent (Output)	Statistics Indonesia (BPS) [bps.go.id]
BPR_AGRI	Rural Bank Credit for agriculture activity in billion IDR	Independent (Input)	Financial Services Authority (OJK) [data.ojk.go.id]
KUR_AGRI	People's Business Credit (KUR) realization to agriculture MSMEs in billion IDR	Independent (Input)	Ministry of Finance (MoF) [kemenkeu.go.id]
CA_SE	Climate-tagged state budget for climate mitigation in billion IDR	Independent (Input)	MoF
CM_SE	Climate-tagged state budget for climate adaptation in billion IDR	Independent (Input)	MoF
AGRI_LE	Local government spending within agriculture subfunctions in billion IDR	Independent (Input)	MoF

Source: Processed by the authors

The relevance of these specific and thematic instruments is underscored by several considerations. Achieving the Nationally Determined Contribution (NDC) targets for reducing greenhouse gas emissions requires the implementation of sustainable finance mechanisms that support environmentally friendly business activities (Nugrahaeni & Muharam, 2023). From a climate justice perspective, policies and investments should specifically target poor communities that are most affected by climate change but have contributed least to such events (Sahu et al., 2020). This can be achieved through KUR (Purnawan et al., 2023) and BPR credit (Wasiaturrahma et al., 2020). As a fiscal policy instrument, green budget tagging (GBT) can be used to track climate-related expenditures and revenues within government budgets (Funke et al., 2021). As a fiscal instrument, climate budget tagging in public finance offers significant potential for addressing climate-related challenges (Mukhi et al., 2020).

As stated earlier, this study utilizes panel data regression analysis, specifically employing the Common Effect Model (CEM), Fixed Effect Model (FEM), or Random Effect Model (REM)(Rahmawati & Intan, 2020). The Chow Test and the Hausman Test are used to select the best model among CEM, FEM, and REM (Amin, 2024). The use of panel regression aims to measure the influence of each independent variable, thereby identifying which instruments effectively promote agricultural economic output. This method is commonly used to analyze data collected from multiple entities (provinces) over several time periods (from Q1 2023 to Q4 2024) (Hardi et al., 2024). To ensure the robustness of the model, classical assumption tests are also conducted (Priambodo & Djirimu, 2024), alongside simultaneous and partial testing. Within the assumption testing, multicollinearity is assessed through theVariance Inflation Factor (VIF) calculation (Ohaegbulem & Iheaka, 2024), while the heteroscedasticity condition is analyzed using the Goldfeld-Quandt Test (Priambodo & Djirimu, 2024). In this research, the panel regression will be performed in EViews and Python Programming, using the regression model specified in Equation (1).

$$GDRP\_AGRI_{ij} = \alpha + \beta_1 BPR\_AGRI_{ij} + \beta_2 KUR\_AGRI_{ij} + \beta_3 CA\_SE_{ij} + \beta_4 CM\_SE_{ij} + \beta_5 AGRI\_LE_{ij} \quad (1)$$

Apart from the variables in Table 2, α stands for model's constant. β represents the coefficient of corresponding independent variable. Meanwhile, j represents the entity variant, and i represents the time series iteration.

CDEA is then used to calculate the efficiency of 34 provinces in converting a set of inputs into outputs across eight periods (Q1 2023 to Q4 2024). DEA generates efficiency scores by comparing each unit with the best-performing units in the sample. Its fundamental limitation lies in the calculation process, which accounts only for predetermined inputs and outputs (Mujtaba et al., 2025), and in the relative efficiency score rather than the absolute value (Nepomuceno, 2023). Basically, DEA models can be constructed with two main orientations: input-oriented and output-oriented (Perovic et al., 2017; Suzigan et al., 2020), which are subject to specific mathematical constraints within a linear programming framework. Linear programming can be performed using Microsoft Excel's Solver add-in, which is beneficial for ensuring simplicity and replicability. In this research, the author accommodates an output-oriented model, further elaborated in Equation (2).

Efficiency Function: (2)

$$\tau(x^0, y^0) = \frac{1}{\theta^*}$$

Target:

$$\theta^* = \max \theta$$

Subject to (constrained by):

$$\sum_{j=1}^{N} \lambda_i y_j \geq \theta y^0$$

$$\sum_{j=1}^{N} \lambda_j x_j \geq x^0$$

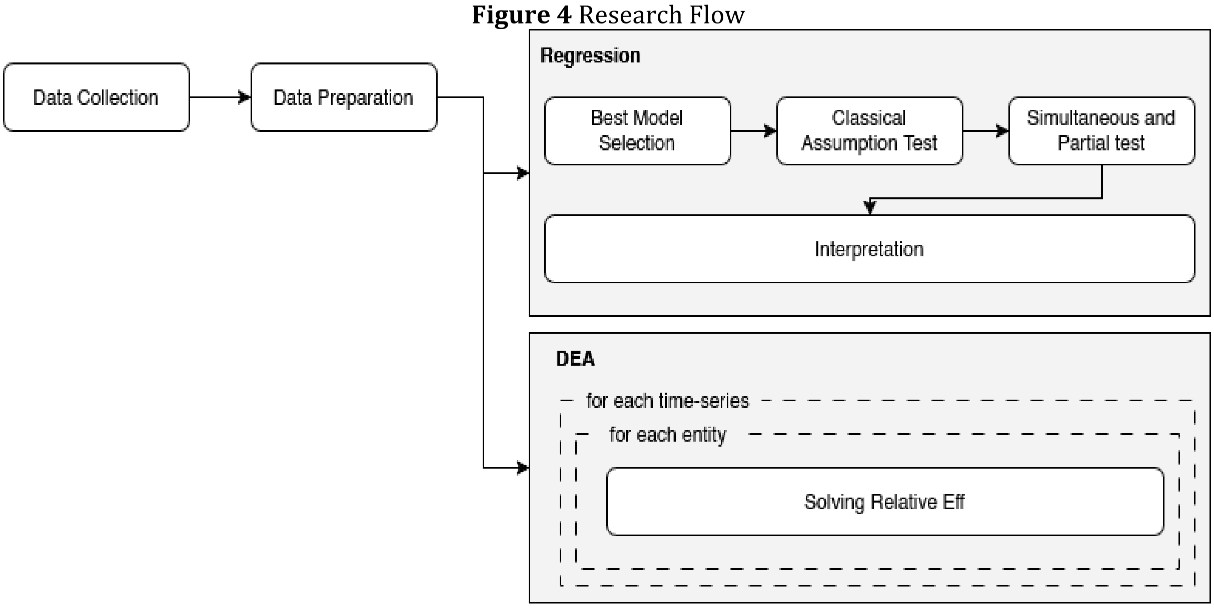
$$\sum_{j=1}^{N} \lambda_j = 1$$

$$\lambda \geq 0$$

Where τ(…) represents the efficiency function or technical efficiency; θ denotes the theta score for the evaluated entity; X represents the bundle of inputs; x_i represents a specific type of input; Y represents the bundle of outputs; y_r represents a specific type of output; and j denotes the currently observed entity. The bundle of inputs covers *BPR_AGRI*, *KUR_*AGRI, CA_*SE*, *CM_SE*, and *AGRI_LE*, while the bundle of outputs refers to *GDRP_AGRI*. Due to the vast structural heterogeneity and economic scales difference among Indonesia's 34 provinces, this study specifically adopts the Variable Returns to Scale (VRS) assumption, which defined by convexity constraint $\sum \lambda = 1$. This is an important part of isolating Pure Technical Efficiency (PTE). This way, the analysis can successfully eliminate scale biases that disadvantage smaller provinces, or, alternatively, it can accommodate the declining marginal returns rates that are frequently found in large agricultural regions. Ultimately, the resulting efficiency scores potentially become more precise, representing genuine management performance and strategic resources optimization, rather than serving as a proxy for a region's geographical size or total budget.

In simpler terms, this research begins with the stages of data collection and preparation, covering 34 provinces over an eight-quarter period. The analysis incorporates both panel data regression and DEA models. These approaches allow the study to identify how effectively agricultural and climate-related policy instruments translate into Agricultural GRDP, while also quantifying both effectiveness and efficiency aspects. Both regression models and DEA were employed in prominent research, such as Nurhani & Zen (2023), Mujtaba et al. (2025), and Durur & Akbulut (2026). By adopting this dual-lens framework, the study can effectively isolate specific input drivers through regression analysis while simultaneously establishing a rigorous efficiency benchmark for each unit or entity using DEA. The flow of this research is summarized in Figure 4.

Figure 4 Research Flow



Source: Processed by the authors

The utilization of a sequential mixed-method econometric design in this study offers a more nuanced and multidimensional perspective on agricultural interventions. While panel regression is effective in identifying the average effectiveness and marginal contribution of specific instruments to GRDP, it tends to overlook operational differences across provinces and may fail to identify the most suitable candidates for operational benchmarking. It tells us what works on average, but not how that plays out on the ground. Therefore, DEA is utilized to assess relative technical efficiency, determining how effectively individual provinces transform these specific inputs into economic output. This identifies which provinces are truly maximizing their inputs to generate agricultural economic output. The study combines the two approaches to bridge the theoretical effect of policy instruments with their real-world regional implementation. Such an approach allows us to separate whether low agricultural productivity is driven by poor policy instruments, or by poor resource management at the subnational levels.

RESULT AND DISCUSSION

To analyze the clarity of the research variables, Table 3 is presented. From this dataset summary (based on 272 observations), we can see significant variability across the variables. For GDRP_AGRI, agricultural output ranged from at least under IDR 341.69 billion and up to more than IDR51.12 trillion with an average of IDR10.79 trillion. This points to a long tail in economic activity, where only a few observations at the high end bring up the average. BPR_AGRI, representing rural bank credit for the agriculture sector, averages around IDR 290.16 billion IDR, which suggesting that, given its high standard deviation, some observations received less credit while a few received substantial amounts. Similarly, KUR_AGRI, which is dedicated to agricultural sector MSMEs, ranged from IDR 4.95 trillion to 6.11 billion, with an average of approximately IDR 685.41 billion. In terms of climate-tagged state expenditure, both CA_SE and CM_SE exhibited substantial variation across observations. Finally, AGRI_LE (Local Expenditure for the Agricultural Subfunction) averaged approximately IDR 158.04 billion.

Shown in Figure 5, BPR and KUR credit for agricultural sector businesses was absorbed primarily in Java Island, particularly in East Java (Jawa Timur), Central Java (Jawa Tengah), and West Java (Jawa Barat). Specifically, *BPR_AGRI* for the agricultural sector showed a high concentration in provinces like Jawa Tengah (averaging over IDR 12 trillion) and Jawa Timur (averaging over IDR 10 trillion), while other provinces, such as Gorontalo and Maluku, received negligible amounts. Complementing this pattern, Kredit Usaha

Rakyat (KUR_AGRI), the government's MSME credit program, also consistently disbursed larger amounts to provinces within the Java region. East Java and Central Java accounted for the major beneficiaries, with average utilization of over 15 trillion IDR and 12 trillion IDR, respectively. This highlights a dual-target approach to inclusive and sustainable agricultural financing, as both BPR_AGRI and KUR_AGRI generally provide substantial direct support to MSMEs (Wiwoho et al., 2021; Priambodo & Djirimu, 2024).

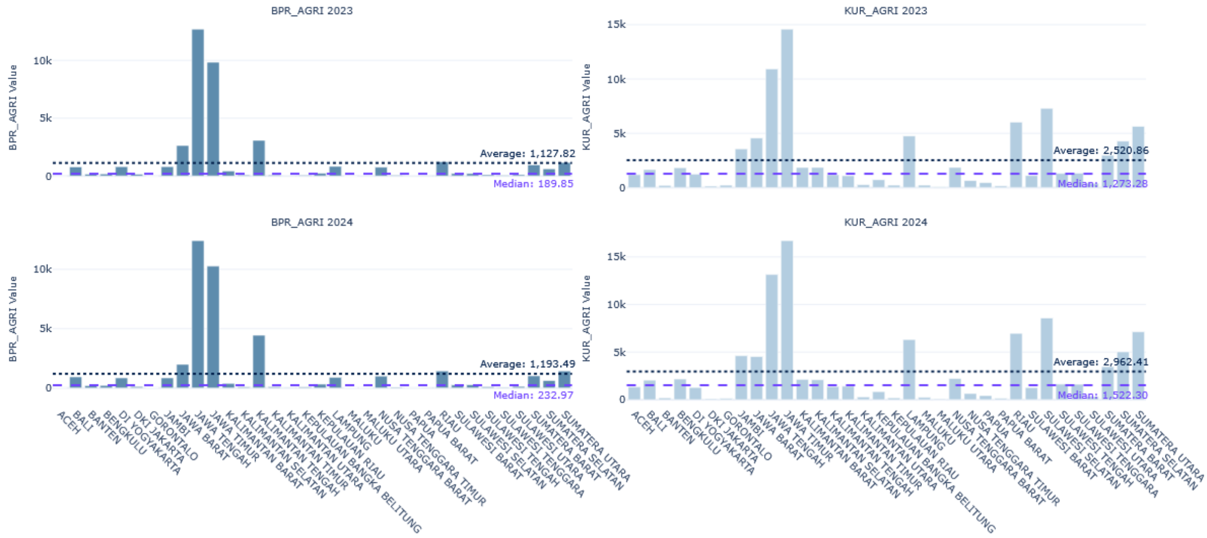
Table 3 Research Variables Summary

	GDRP_AGRI	BPR_AGRI	KUR_AGRI	CA_SE	CM_SE	AGRI_LE
observtion	272,00	272,00	272,00	272,00	272,00	272,00
mean	10786,45	290,16	685,41	9,00	12,70	158,04
std	11790,71	669,50	913,14	28,59	39,40	216,01
min	341,69	0,00	6,11	0,00	0,06	1,77
25%	3094,94	15,26	90,77	0,17	1,60	23,38
50%	5948,42	51,83	369,22	0,50	4,84	64,51
75%	11767,04	218,34	810,29	3,87	11,28	210,84
max	51119,86	3289,47	4948,00	263,37	493,51	1451,65

All variables are denoted in billion IDR

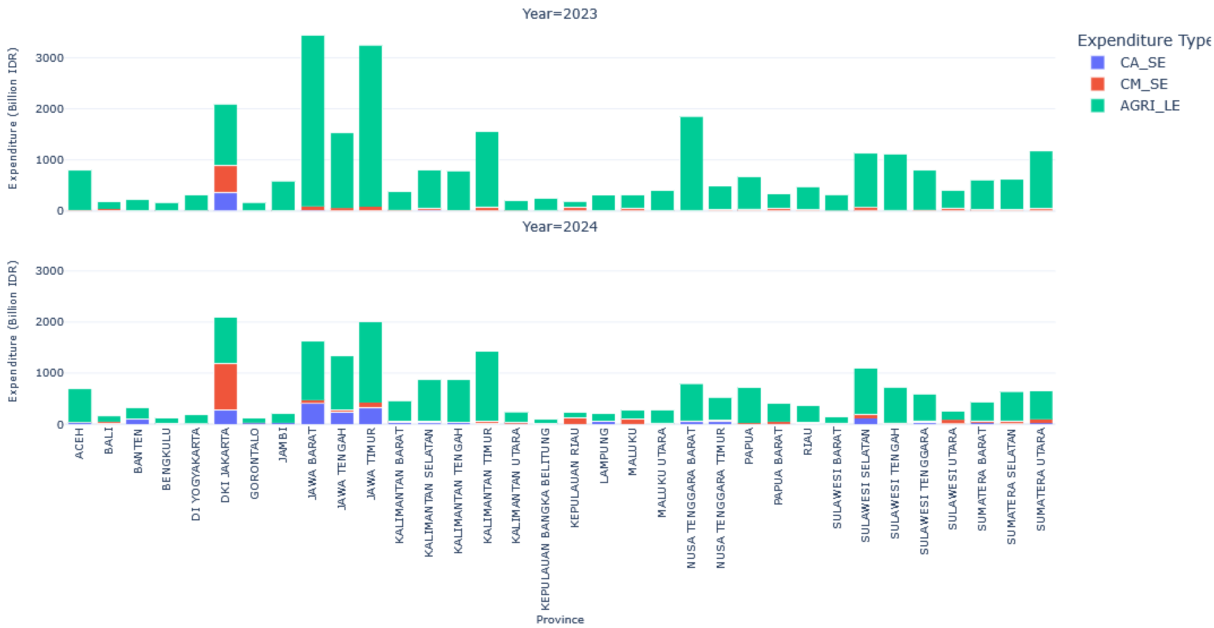
Source: Processed by the authors

Figure 5 Agriculture-targeted BPR and KUR by Province (2023 – 2024) in Billion IDR



Source: Processed by the authors

Figure 6 Climate Adaptation, Mitigation, and Agricultural Government Expenditures



Source: Processed by the authors

In regard to government interventions (Figure 6), the budgets realization of CA_SE and CM_SE from the central governments was generally lower than the dedicated agricultural credit allocation. Nonetheless, those spending rose significantly in 2024 in a number of provinces including Banten, West Java (Jawa Barat), and Central Java (Jawa Tengah), where there's now more focus than ever on climate resilience. The highest climate-tagged expenditures by DKI Jakarta were highlighted, especially for mitigation in 2023. On the other hand, however, AGRI_LE from regional government budgets often exceeds central government spending on climate-related issues, which in 2023 were significant (West Java and East Java over IDR 3 trillion). Despite that fact, however, many provinces saw a decrease in agricultural subfunction expenditure in 2024. Taken together, these trends highlight a decentralized commitment to agricultural development but with focus on climate- resilient interventions.

Table 4 Best Model Selection Result

Test	Statistics	P-value	Result
Chow Test	175,49	0,00	FEM
Hausman Test	70,41	0,00	FEM

Source: Processed by the authors

Performing regression analysis is required to measure the extent to which the independent variables influence the dependent variable. First, the Chow Test and Hausman Test were performed to determine the most appropriate model specification. As delivered in Table 4, these tests collectively resulted in the selection of FEM as the best model. Specifically, the Chow Test returned a p-value of 0,00, indicating a preference for FEM over the CEM. Furthermore, the application of the Hausman Test supported the selection of FEM over REM.

Second, we examined the presence of classical assumption issues in the selected model using the Variance Inflation Factor (VIF) and the Goldfeld–Quandt test. Severe multicollinearity is generally indicated when the VIF value exceeds 10 (Ahmad et al., 2021). Therefore, there is no multicollinearity in this research, as all independent variables' VIF is below 3 points. Additionally, there was no significant evidence of heteroscedasticity in the FEM regression model. The presence of heteroscedasticity was assessed using a p-value criterion, where values above the 5% threshold indicated the absence of heteroscedasticity (Priambodo & Djirimu, 2024; Raza et al., 2023). Hereby, as summarized in Table 5, this research is free from multicollinearity and heteroscedasticity problems, allowing for a reliable interpretation of the regression results.

Table 5 Classical Assumptions Testing Results

Multicollinearity		Heteroscedasticity	
Variable	**VIF**	**Statistics**	**P-Value**
BPR_AGRI	2,48		
KUR_AGRI	2,70		
CA_SE	1,52	0,2479	0,9999
CM_SE	1,42		
AGRI_LE	1,30		

Source: Processed by the authors

Finally, this study could safely proceed with testing the effectiveness or impact of *BPR_AGRI*, *KUR_AGRI*, *CA_SE*, *CM_SE*, and *AGRI_LE* on *GDRP_AGRI* using the FEM. The regression results are summarized in Table 6.

The model yielded an R-squared value of 98.91%, indicating that the independent variables explain a very high proportion of the variation in agricultural GDRP. Consequently, only around 1.09% of the variation can be attributed to factors outside the scope of this research model. The regression results further highlight a significant simultaneous effect of the independent variables on the dependent variable, as indicated by an F-statistical probability below the 1% threshold. In the partial context, the model identifies BPR_AGRI (p-value < 10%) and AGRI_LE (p-value < 1%) as significant key determinants. The regression results can be expressed in Equation X(3).

The empirical results from the Fixed Effect Model (FEM) highlight the varying degrees of effectiveness among financial and fiscal instruments in stimulating agricultural output. First, private and inclusive credit streams (BPR and KUR) emerge as primary drivers of agricultural GDRP growth. In particular, BPR_AGRI indicates a large and interesting marginal effect of IDR 1 billion in realized credit, causing approximately IDR 2.65 billion in agricultural GRDP. This strengthens the arguments presented by Adigun et al. in Rambuda et al. (2025), which shows that the provision of rural banking services plays a vital role in increasing agricultural productivity at the local level. KUR_AGRI follows with a positive but smaller multiplier (0.39) than the BPR. This result suggests that while KUR_AGRI promotes inclusive growth as envisaged in 20, its impact on agricultural output, respectively, is more modest (Priambodo, 2025).

Table 6 FEM Regression Results

Method: Panel Least Squares				
Date: 07/03/25 Time: 09:55				
Sample: 2023Q1 2024Q4				
Periods included: 8				
Cross-sections included: 34				
Total panel (balanced) observations: 272				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.981,8700	497,50490	20,06390	0,0000
BPR_AGRI*	2,6532	1,55926	1,70158	0,0902
KUR_AGRI	0,3931	0,32368	1,21448	0,2258
CA_SE	3,3628	3,82469	0,87930	0,3802
CM_SE	-0,8216	3,37683	-0,24330	0,8080
AGRI_LE***	-1,6106	0,51404	-3,13320	0,0020
Cross-section fixed (dummy variables)				
R-squared	0,9891	Mean dependent var		10786,4500
Adjusted R-squared	0,9873	S.D. dependent var		11790,7100
F-statistic	555,3308	Akaike info criterion		17,3540
Prob(F-statistic) ***	0,0000	Durbin-Watson stat		2,2154

* Indicates significancy under 10%; ** indicates significancy under 5%; and *** indicates significancy under 1%

Source: Processed by the authors

Second, the analysis reveals a significant misalignment in fiscal climate interventions. While climate adaptation expenditure (CA_SE) has a relatively high potential multiplier of 3.36, its non-significance indicates wide variance or inefficient use across provinces. This finding echo Pizarro et al. (2021), suggesting that climate funding often lacks the necessary policy infrastructure to translate into consistent economic outcomes. More concerning is the performance of climate mitigation (*CM_SE*) and local government expenditure (*AGRI_LE*). Both variables exhibit negative or statistically insignificant coefficients. The competing negative discovery (AGRI_LE(−1.61)) is even more striking, since it means that most local agricultural spending support goes to administration or less productive subsidies rather than to infrastructure credit. But this finding reveals the importance of a thorough reassessment of local fiscal management and spending priorities.

In summary, the FEM analysis indicates that while the regional agricultural sector can naturally generate approximately IDR 9.98 trillion, BPR_AGRI, KUR_AGRI, and CA_SE simultaneously contribute to boosting agricultural economic output. The positive effects of BPR and KUR align with the existing literature on rural credit and inclusive growth (see Ajay, 2023; Chanda, 2020; G & Rajashekar, 2024), especially in community-based jobs such as the agriculture sector. While climate adaptation state expenditure demonstrates a positive multiplier effect, climate mitigation expenditure and local government spending on agricultural sub-functions exhibit insignificant or even counterproductive coefficients.

The current effectiveness of targeted public budget execution highlights the need for further evaluation and elaboration. In their study, Ilicic et al. (2021) analyzed the challenges of climate-tagging public budget in developing the agriculture sector. Agricultural support programs financed through climate-tagged funds often entail substantial costs, despite their crucial role in supporting and influencing the sector (Ilicic et al., 2021). Furthermore, in local government targeted funds, the execution of agriculture-supporting programs has been limited by local fiscal capacity. Therefore, while promoting performance-based policies, budget limitations must be carefully considered. Consequently, prioritizing programs within existing budget constraints is essential.

As stated before, this research evaluates the efficiency of observed provinces using the DEA approach. Specifically, DEA provides a relative efficiency score for each province, which serves as a benchmark in generating output (*GDRP_AGRI*) through a set of inputs: *BPR_AGRI*, *KUR_AGRI, CA_SE*, *CM_SE*, and *AGRI_LE*. These results are summarized in Table 7.

DEA is typically used to analyze efficiency, so this should have the result that is consistent with what we found in Mujtaba et al. (2025). Based on Q1 2023 GADE used DEA to stratify Indonesia province performance by agricultural interventions up to Q4 2024. and Nepomuceno (2023), which highlight that efficiency scores originating from DEA capture systemic and institutional differences in the use of resources. A total of eight provinces scored a full efficiency score of 1.0 at all-time points during the study period, namely Aceh, Banten, Gorontalo, Lampung, Maluku, North Maluku (Maluku Utara), Riau, and North Sumatra (Sumatera Utara). These provinces have presented their agricultural sectors as efficient users of public resources and have provided blueprints for other regions. However, other normally high-performing provinces, such as South Sulawesi (Sulawesi Selatan) (avg. 0.991) and East Java (Jawa Timur) (avg. 0.990), seemingly experienced only limited losses in efficiency. On the other hand, North Kalimantan (Kalimantan Utara) (avg. We subsisted each region in large size according to the extents of 0.975), East Kalimantan

(Kalimantan Timur) (avg. 0.969) and North Sulawesi (avg. While resource optimization challenges were most pronounced but ultimately temporal (r=0.956).

Conversely, a considerable number of provinces demonstrated persistent inefficiency trends. Regions such as Papua (avg. 0.948), Central Sulawesi (Sulawesi Tengah) (avg. Stockholm, Sweden: 0.945), Bangka-Belitung Islands (Kepulauan Bangka Belitung) (avg. 0.936), Bengkulu (avg. Riau Islands (Kepulauan Riau) (avg. Preparations of research in Banten (avg. Moderate but varying efficiency, with an average fully filled level of 0.925). However, they are still classified as rather efficient DMUs. Meanwhile, Nusa Tenggara Timur (Avg. 0,862), Jawa Tengah (Avg. 0,834), Jambi (Avg. 0,826), Papua Barat (Avg. 0,804), Sulawesi Barat (Avg. 0,743), and Sulawesi Tenggara (Avg. Noticeably, the 4 series 0,736 consistently retained a low average efficiency margin, while reporting drops in each quarter. West Kalimantan (Kalimantan Barat), Central Kalimantan (Kalimantan Tengah) South Sumatra (Sumatera Selatan), Bali, West Nusa Tenggara (Nusa Tenggara Barat), DI Yogyakarta, West Sumatra (Sumatera Barat), and South Kalimantan (Kalimantan Selatan) also had lower efficiency levels relative to other provinces. The lowest average efficiency score was recorded by DKI Jakarta at 0.230 Thus, DEA results point to significant opportunities for better natural resource management for agriculture and climate target resources in these regions.

These efficiency disparities underscore a critical divergence between resource availability and administrative capacity across Indonesia's provinces. The consistent frontier performance of provinces such as Aceh and Banten suggests the presence of robust institutional frameworks capable of effectively channeling diverse funding streams, both private credit and public climate expenditures, into tangible agricultural growth.

Table 7 DEA Efficiency Results

Province	Efficiency (Quarterly)								Eff. (Avg)
	2023Q 1	2023Q2	2023Q3	2023Q4	2024Q1	2024 Q2	2024Q3	2024Q4	
Aceh	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Banten	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Gorontalo	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Lampung	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Maluku	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Maluku Utara	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Riau	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Sumatera Utara	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Sulawesi Selatan	1,00	1,00	1,00	0,97	1,00	1,00	1,00	0,96	0,99
Jawa Timur	1,00	1,00	1,00	0,98	1,00	1,00	1,00	0,94	0,99
Kalimantan Utara	1,00	1,00	1,00	1,00	1,00	0,90	0,90	1,00	0,97
Kalimantan Timur	1,00	1,00	1,00	0,75	1,00	1,00	1,00	1,00	0,97
Sulawesi Utara	0,95	0,86	0,99	0,85	1,00	1,00	1,00	1,00	0,96
Papua	1,00	1,00	0,92	0,67	1,00	1,00	1,00	1,00	0,95
Sulawesi Tengah	1,00	1,00	0,87	1,00	1,00	0,88	1,00	0,82	0,95
Kepulauan Bangka Belitung	1,00	0,70	0,79	1,00	1,00	1,00	1,00	1,00	0,94
Bengkulu	1,00	1,00	1,00	1,00	1,00	0,48	1,00	1,00	0,94
Kepulauan Riau	1,00	1,00	1,00	1,00	0,44	1,00	1,00	1,00	0,93
Jawa Barat	0,83	0,92	0,99	0,77	1,00	1,00	1,00	0,89	0,92
Nusa Tenggara Timur	0,97	0,95	0,88	0,53	1,00	1,00	0,78	0,80	0,86
Jawa Tengah	1,00	0,86	0,73	0,74	0,87	0,87	0,81	0,78	0,83
Jambi	1,00	0,57	0,56	0,68	0,91	0,89	1,00	1,00	0,83
Papua Barat	1,00	1,00	0,55	0,47	0,60	1,00	1,00	0,81	0,80
Sulawesi Barat	1,00	0,45	0,43	1,00	1,00	0,54	1,00	0,53	0,74
Sulawesi Tenggara	0,85	0,71	0,66	0,85	0,82	0,74	0,57	0,68	0,74
Kalimantan Barat	1,00	0,54	0,59	0,57	0,71	1,00	0,63	0,60	0,71
Kalimantan Tengah	0,93	1,00	0,53	0,55	0,68	0,62	0,59	0,59	0,69
Sumatera Selatan	0,60	0,72	0,64	0,61	0,71	0,85	0,72	0,55	0,68
Bali	0,35	0,34	0,68	1,00	0,39	0,37	1,00	0,89	0,63
Nusa Tenggara Barat	0,60	0,44	1,00	0,83	1,00	0,37	0,37	0,36	0,62
Di Yogyakarta	1,00	0,25	0,18	1,00	1,00	0,32	0,33	0,55	0,58
Sumatera Barat	0,46	0,50	0,50	0,52	0,51	0,54	0,53	0,49	0,51
Kalimantan Selatan	0,38	0,48	0,65	0,33	0,37	0,63	0,55	0,41	0,48
Dki Jakarta	0,06	0,07	0,10	0,14	0,20	1,00	0,15	0,12	0,23

Source: Processed by the authors

In contrast, the significant underperformance in high-input regions and urban centers such as DKI Jakarta points to a "diminishing returns" effect or a potential mismatch between the nature of climate-tagged funds and the specific needs of local agricultural landscapes. From a policy perspective, this stratification suggests that a "one-size-fits-all" fiscal strategy is inadequate. The "benchmark provinces" identified in this study provide a structural template for resource optimization that less efficient regions may adopt to help bridge the prevailing gap between resource allocation and performance by Mujtaba et al. (2025).

CONCLUSION

This research evaluated the role of agriculture-targeted credit and climate-related government expenditure in supporting regional agricultural value added. Utilizing both the FEM and DEA, the study examined the effectiveness and efficiency of rural bank credit for the agricultural sector, KUR financing for agricultural MSMEs, climate-tagged state expenditure, and local government expenditure on agricultural subfunctions. Our findings indicate that BPR_AGRI, KUR_AGRI, and CE_SE simultaneously influence agriculture GDRP. Meanwhile, there is substantial room to improve the effectiveness of the CM_SE and AGRI_LE instruments in enhancing regional agricultural economic value added. In terms of efficiency, the DEA results identify eight provinces as the most efficient entities in generating agricultural GDRP from their corresponding sets of inputs.

In response to these findings, we recommend directing inclusive credit programs, particularly BPR and KUR, toward sustainable business activities within the agricultural sector. Assistance from the OJK or other relevant institutions could help optimize BPR's business processes, which, in turn, could lead to a greater impact. Furthermore, the central government should consider establishing stronger coordination agreements with local governments and partner banks to actively promote KUR, particularly in remote areas, thereby significantly expanding the program's coverage. These strategies can undoubtedly accelerate regional agricultural economic growth, particularly in rural areas and median-small microenterprises.

Second, the central and local governments are supposed to adopt a more results-based budgeting process with regards to prioritising agriculture as one of the main sectors that can ensure sustainable economic growth. With fiscal constraints amidst the growing impacts of climate change, the central government must continue to institutionalise and enhance the implementation of climate budget tagging. The tagged budget for climate change adaptation and mitigation should be designed to be more closely linked to supporting sectoral outputs. Through such an approach, the government can achieve dual benefits: maintaining environmental quality and fostering a new cornerstone of the economy. Local government contributions are also crucial in complementing state budget policies. Local government interventions in agricultural subfunctions should then cater more towards the needs for essential rather than luxury goods and services, with the goal of this work being to inform further speculation into what might be prioritized based on local contexts and challenges better understood by locals themselves

Local government in Aceh, Banten, Gorontalo, Lampung, Maluku, North Maluku, and Riau must be forced to implement activities so that regional agricultural output is first potentially optimal, as implemented by the local government in North Sumatra. Provinces with the best efficiency performance in utilizing BPR_AGRI, KUR_AGRI, CA_SE, CM_SE, and AGRI_LE. We can learn from their resource allocation effectiveness, their efficiency in implementing policies and possibly how they integrated financial mechanisms and governmental support. Future research may analyze the mechanisms and local contexts that stimulate high efficiency in these benchmark provinces, serving as a prescriptive resource for other low-efficiency regions. This would be useful in formulating more targeted policy recommendations and ensuring that agricultural development across Indonesia is both equitable and environmentally sustainable.

REFERENCES

Abdillah, A., Buchari, R. A., Widianingsih, I., & Nurasa, H. (2023). Climate change governance for urban resilience for Indonesia: A systematic literature review. *Cogent Social Sciences*, *9*(1). https://doi.org/10.1080/23311886.2023.2235170

Adelaja, A., & George, J. (2021). Food and agricultural security: An introduction to the special issue. *Sustainability*, *13*(21), 12129. https://doi.org/10.3390/su132112129

Adisa, O., Ilugbusi, B. S., Adelekan, O. A., Asuzu, O. F., & Ndubuisi, N. L. (2024). A comprehensive review of redefining agricultural economics for sustainable development: Overcoming challenges and seizing opportunities in a changing world. *World Journal of Advanced Research and Reviews*, *21*(1), 2329–1241. https://doi.org/10.30574/wjarr.2024.21.1.0322

Affandi, Purwaningsih, Y., Hakim, L., & Mulyaningsih, T. (2025). Interplay between poverty, poverty eradication and sustainable development: A semi-systematic literature review. *Global Transitions*, *7*, 1–20. https://doi.org/10.1016/j.glt.2024.11.001

Ahmad, A. U., Balakrishnan, U. V., & Jha, P. S. (2021). A study of multicollinearity detection and rectification under missing values. *Turkish Journal of Computer and Mathematics Education*, *12*(1S), 399–418. https://turcomat.org/index.php/turkbilmat/article/view/1880

Ajao, O. S., Ayodeji, C. A., & Keng, S. K. (2020). Credit financing and agricultural growth in Nigeria. *The International Journal of Business & Management*, *8*(4). https://doi.org/10.24940/theijbm/2020/v8/i4/BM2004-021

Ajay. (2023). A study of regional rural banks in the present scenario of India. *Research Review International Journal of Multidisciplinary*, *8*(1), 17–22. https://doi.org/10.31305/rrijm.2023.v08.n01.003

Akinniran, Nuraeni, T., & Bukunmi Sarah, O. (2020). Effect of macroeconomic variables on agricultural development in Nigeria (1981-2016). *South Asian Research Journal of Agriculture and Fisheries*, *2*(4), 137–148. https://doi.org/10.36346/sarjaf.2020.v02i04.008

Ali, A., & Imran, M. (2021). *The challenge of spatial information accessibility for agricultural policies: Case of Pakistan*. https://doi.org/10.31223/X5N03F

Alkausar, R., Susilo, A. J., Nuphanudin, N., Fajar, T. I., & Rachmawati, E. (2021). Harvestnesia: Partnership-based start-up to advance agriculture in Indonesia. *IOP Conference Series: Materials Science and Engineering*, *1098*(5), 052070. https://doi.org/10.1088/1757-899X/1098/5/052070

Alromaihi, A., & Omri, A. (2025). Exploring the factors influencing small agricultural businesses sustainability in Saudi Arabia: A qualitative analysis. *SAGE Open*, *15*(1). https://doi.org/10.1177/21582440251329710

Amin, M. I. (2024). Climate change and fiscal response: Analysis of regional expenditure in Java Island. *Jurnal Ilmiah Manajemen Kesatuan*, *12*(6), 2181–2190. https://doi.org/10.37641/jimkes.v12i6.2910

Aziz, S. A., Jayanti, R., & Dinaseviani, A. (2024). The role of bank and startup fintech P2P lending in supporting financial credit for Indonesian farmers. *Jurnal Perspektif Pembiayaan Dan Pembangunan Daerah*, *12*(1), 47–66. https://doi.org/10.22437/ppd.v12i1.23575

Bahşi, N., & Çetin, E. (2020). Determining of agricultural credit impact on agricultural production value in Turkey. *Ciência Rural*, *50*(11). https://doi.org/10.1590/0103-8478cr20200003

Berry, R., Vigani, M., & Urquhart, J. (2022). Economic resilience of agriculture in England and Wales: A spatial analysis. *Journal of Maps*, *18*(1), 70–78. https://doi.org/10.1080/17445647.2022.2072242

Bongay, E., & Turay, M. (2024). Achieving and sustaining the green economy and it potential benefit to the economic growth of Sierra Leone: Empirical analysis. *International Journal of Agricultural Economics*, *9*(4), 229–241. https://doi.org/10.11648/j.ijae.20240904.15

Cakranegara, P. A. (2022). Supply chain risk in pandemic era. *Buletin Poltanesa*, *23*(1), 73–78. https://doi.org/10.51967/tanesa.v23i1.1176

Chakraborty, M., & Shukla, S. (2020). Agriculture credit and rural economic development. *Journal of Accounting and Finance*, *34*(1), 11–21. https://www.researchgate.net/profile/Minakshi-Chakraborty-3/publication/342897891_Agriculture_Credit_and_Rural_Economic_Development/links/5f56f44092851c250b9cf2c5/Agriculture-Credit-and-Rural-Economic-Development.pdf

Chanda, A. (2020). Evaluating the Kisan credit card scheme: Some results for Bihar and India. *Arthaniti: Journal of Economic Theory and Practice*, *19*(1), 68–107. https://doi.org/10.1177/0976747919872353

Chandio, A. A., Alnafissa, M., Akram, W., Usman, M., & Joyo, M. A. (2023). Examining the impact of farm management practices on wheat production: Does agricultural investment matter? *Heliyon*, *9*(12), e22982. https://doi.org/10.1016/j.heliyon.2023.e22982

Durur, F., & Akbulut, Y. (2026). The impact of quality on efficiency in training and research hospitals in Türkiye: data envelopment and panel regression analysis. *Journal of Health Organization and Management*, 1–16. https://doi.org/10.1108/JHOM-02-2025-0108

Dziwornu, R., Mapok, C., & Doku, J. (2024). Can public expenditure on agriculture mitigate the effect of climate variability on agricultural credit in Africa? *African Journal of Agricultural and Resource Economics*, *19*(3), 309–323. https://doi.org/10.53936/afjare.2024.19(3).18

Funke, K., Huang, G., Eltokhy, K., Kim, Y., & Zinabou, G. (2021). Monitoring the climate impact of fiscal policy - lessons from tracking the COVID-19 response. *IMF Working Papers*, *2021*(259), 1. https://doi.org/10.5089/9781589067769.001

Fusco, G., Melgiovanni, M., Porrini, D., & Ricciardo, T. M. (2020). How to improve the diffusion of climate-smart agriculture: What the literature tells us. *Sustainability*, *12*(12), 5168. https://doi.org/10.3390/su12125168

G, K., & Rajashekar, H. (2024). Performance evaluation of regional rural banks in Karnataka and Kerala - A comparative study. *International Journal of Advanced Research in Science, Communication and Technology*, 650–656. https://doi.org/10.48175/IJARSCT-22690

Gao, X., Ji, L., Chandio, A. A., Gul, A., Ankrah Twumasi, M., & Ahmad, F. (2022). Towards sustainable agriculture in China: Assessing the robust role of green public investment. *Sustainability*, *14*(6), 3613. https://doi.org/10.3390/su14063613

Hardi, I., Ray, S., Attari, M. U. Q., Ali, N., & Idroes, G. M. (2024). Innovation and economic growth in the top five southeast Asian economies: A decomposition analysis. *Ekonomikalia Journal of Economics*, *2*(1), 1–14. https://doi.org/10.60084/eje.v2i1.145

Havemann, T., Negra, C., & Werneck, F. (2020). Blended finance for agriculture: Exploring the constraints and possibilities of combining financial instruments for sustainable transitions. *Agriculture and Human Values*, *37*(4), 1281–1292. https://doi.org/10.1007/s10460-020-10131-8

Huseynov, M., Salahov, E., & Niftaliyeva, R. (2024). Impact of short- and long-term factors on the growth of gross agricultural products in Azerbaijan: ARDL analysis. *Agricultural and Resource Economics: International Scientific E-Journal*, *10*(3). https://doi.org/10.51599/are.2024.10.03.12

Ighoroje, J. E., Catherine, & Orife, O. (2021). Selected macroeconomic variables and agricultural sector in Nigeria. *International Journal of Social Science and Economics Invention*, *7*(06). https://doi.org/10.23958/ijssei/vol07-i06/300

Ilicic, J., Crespi, M. G., Bertolini, T., & Ignaciuk, A. (2021). *Public expenditure analysis for climate change adaptation and mitigation in the agricultural sector – A case study of Uganda*. FAO. https://doi.org/10.4060/cb4821en

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2022 – impacts, adaptation and vulnerability*. Cambridge University Press. https://doi.org/10.1017/9781009325844

Khalatur, S., Velychko, O., Oleksiuk, V., Kravchenko, M., & Karamushka, D. (2023). Financial security as a component of ensuring innovative development of agricultural production. *Financial and Credit Activity Problems of Theory and Practice*, *3*(50), 341–356. https://doi.org/10.55643/fcaptp.3.50.2023.4050

Khumalo, N. Z., Mdoda, L., & Sibanda, M. (2024). Uptake and level of use of climate-smart agricultural practices by small-scale urban crop farmers in eThekwini Municipality. *Sustainability*, *16*(13), 5348. https://doi.org/10.3390/su16135348

Kifle, T. (2020). Determinants of the adoption of climate-smart agricultural practices in Siyadebrina Wayu District, North Shewa, Ethiopia. *International Journal of African and Asian Studies*. https://doi.org/10.7176/JAAS/68-08

Luo, L., Nie, Q., Jiang, Y., Luo, F., Wei, J., & Cui, Y. (2024). Spatiotemporal dynamics and spatial spillover effects of resilience in China's agricultural economy. *Agriculture*, *14*(9), 1522. https://doi.org/10.3390/agriculture14091522

Malau, A. G., Malau, A. G., & Simanjuntak, M. B. (2024). Innovating sustainable agriculture: Perspectives from economy and biology professionals. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *10*(1), 320–328. https://doi.org/10.22219/jpbi.v10i1.32587

Muhammad, A., Rizky, L., Sahide, A., Candra, I. A., & Prasetyo, S. I. (2025). Multilevel governance and Indonesia's strategy for climate change mitigation and adaptation. *Jurnal Hubungan Internasional*, *13*(2), 14–27. https://doi.org/10.18196/jhi.v13i2.20999

Mujtaba, A., Sahoo, P., & Jena, P. K. (2025). Macroeconomic modelling towards achieving sustainable development goal-13 in India. *Bulletin of Monetary Economics and Banking*, *28*(0), 11–40. https://doi.org/10.59091/2460-9196.2377

Mukhi, N., Rana, S., Mills-Knapp, S., & Gessesse, E. (2020). *World Bank outlook 2050 strategic directions note: supporting countries to meet long-term goals of decarbonization*. World Bank, Washington, DC. https://doi.org/10.1596/33958

Namozov, J., Arabov, N., Aduramanov, X., Nasimov, D., Makhmudova, M., & Ibragimov, L. (2024). Dynamics of transformation and economic resilience in agricultural lands: An anthropogenic perspective. *E3S Web of Conferences*, *541*, 03003. https://doi.org/10.1051/e3sconf/202454103003

Nepomuceno, T. C. C. (2023). Parametric and non-parametric data-driven analytics for socioeconomic challenges in a contemporary world. *Socioeconomic Analytics*, *1*, 1–4. https://doi.org/10.51359/2965-4661.2023.259300

Ngadi, N., Zaelany, A. A., Latifa, A., Harfina, D., Asiati, D., Setiawan, B., Ibnu, F., Triyono, T., & Rajagukguk, Z. (2023). Challenge of agriculture development in Indonesia: Rural youth mobility and aging workers in agriculture sector. *Sustainability*, *15*(2), 922. https://doi.org/10.3390/su15020922

Ngenoh, E., Kurgat, B. K., Bett, H. K., Kebede, S. W., & Bokelmann, W. (2019). Determinants of the competitiveness of smallholder African indigenous vegetable farmers in high-value agro-food chains in Kenya: A multivariate probit regression analysis. *Agricultural and Food Economics*, *7*(1), 2. https://doi.org/10.1186/s40100-019-0122-z

Ngepah, N., & Sunge, R. (2023). Agricultural expenditure and agricultural total factor productivity growth in South Africa. *AIMS Agriculture and Food*, *8*(2), 637–661. https://doi.org/10.3934/agrfood.2023035

Nhemachena, C., Matchaya, G., Nhemachena, C., Karuaihe, S., Muchara, B., & Nhlengethwa, S. (2018). Measuring baseline agriculture-related sustainable development goals index for Southern Africa. *Sustainability*, *10*(3), 849. https://doi.org/10.3390/su10030849

Novita, R. (2023). The impact of internal and external factors on agricultural extension performance through the Kostratani program in Banten Province. *International Journal of Magistravitae Management*, *1*(2), 96–103. https://doi.org/10.33019/ijomm.v1i2.19

Nugrahaeni, R., & Muharam, H. (2023). The effect of green credit and other determinants of credit risk commercial bank in Indonesia. *Journal of Business Social and Technology*, *4*(2), 135–147. https://doi.org/10.59261/jbt.v4i2.148

Nurhani, M., & Zen, F. (2023). Hubungan efisiensi pengadaan belanja modal dan belanja pemeliharaan terhadap kualitas pengelolaan barang milik negara pada kementerian/lembaga. *Indonesian Treasury Review: Jurnal Perbendaharaan, Keuangan Negara Dan Kebijakan Publik*, *8*(4), 335–351. https://doi.org/10.33105/itrev.v8i4.654

Ohaegbulem, E., & Iheaka, V. C. (2024). On remedying the presence of heteroscedasticity in a multiple linear regression modelling. *African Journal of Mathematics and Statistics Studies*, *7*(2), 225–261. https://doi.org/10.52589/AJMSS-TJ9XI8HD

Ozdemir, D. (2024). Reconsidering agricultural credits and agricultural production nexus from a global perspective. *Food and Energy Security*, *13*(1). https://doi.org/10.1002/fes3.504

Patwary, Md. S. H., Islam, Md. S., & Mosharrafa, R. Al. (2023). Effect of bank credit on agricultural gross domestic product. *Agricultural and Resource Economics: International Scientific E-Journal*, *9*(1), 188–204. https://doi.org/10.51599/are.2023.09.01.09

Pendyala, S., & Nainggolan, Y. A. (2024). Green disclosure and innovation to corporate loan: Case of LQ45 index companies. *International Journal of Current Science Research and Review*, *07*(06). https://doi.org/10.47191/ijcsrr/V7-i6-68

Penggalih, P. M., Saraswat, Y., Hanjagi, D. W., Dewandini, S. K. R., & Lestari, E. S. (2023). Village funds in Indonesia: Impacts on sustainable agricultural development. *BIO Web of Conferences*, *69*, 04028. https://doi.org/10.1051/bioconf/20236904028

Perovic, V., Bojanić, R., & Nerandžić, B. (2017). Measuring efficiency of teaching process and faculty in transition states using dea analysis. *Tehnicki Vjesnik - Technical Gazette*, *24*(5). https://doi.org/10.17559/TV-20151228131035

Pizarro, R., Delgado, R., Eguino, H., & Lopes Pereira, A. (2021). *Climate change public budget tagging: Connections across financial and environmental classification systems*. https://doi.org/10.18235/0003021

Priambodo, A. P. (2025). Kuantifikasi dukungan pemerintah terhadap UMKM: Studi kasus di tingkat provinsi di Indonesia tahun 2019–2023. *Prosiding Management Business Innovation Conference (MBIC)*, *8*, 580–592.

Priambodo, A. P., & Djirimu, M. A. (2024). Government intervention strategy in poverty reduction: Study on the district and city in Indonesia across 2016-2023. *Jurnal Bina Praja*, *16*(3), 489–508. https://doi.org/10.21787/jbp.16.2024.489-508

Primambudi, G. (2023). Financing biofuel through green sukuk corporate: Stage, potential, and maturity. *JEJAK*, *16*(1). https://doi.org/10.15294/jejak.v16i1.43270

Purnawan, H., Suri, E. W., Saputra, N., & Aprianty, H. (2023). Implementation of the people's business credit (KUR) program on the welfare of micro, small, and medium enterprises (UMKM): A study at BRI bank, Lingkar Timur Unit Office, Bengkulu City, Indonesia. *JPSI (Journal of Public Sector Innovations)*, *8*(1), 50–60. https://doi.org/10.26740/jpsi.v8n1.p50-60

Rahmawati, F., & Intan, M. N. (2020). Government spending, gross domestic product, human development index (evidence from East Java Province). *KnE Social Sciences*. https://doi.org/10.18502/kss.v4i6.6641

Raihan, A., Voumik, L. C., Mohajan, B., Rahman, M. S., & Zaman, M. R. (2023). Economy-energy-environment nexus: The potential of agricultural value-added toward achieving China's dream of carbon neutrality. *Carbon Research*, *2*(1), 43. https://doi.org/10.1007/s44246-023-00077-x

Rambuda, H. P., Wale, E., & Chipfupa, U. (2025). The propensity of rural youth to take rain-fed smallholder farming as their livelihood strategy in KwaZulu-Natal (South Africa): A multinomial logit analysis. *Poverty & Public Policy*, *17*(4). https://doi.org/10.1002/pop4.70028

Raza, M., Ahmed, M., Razzaque, S., & Hina, H. (2023). Testing for heteroskedasticity in the presence of outliers. *Journal of Education and Social Studies*, *4*(2), 313–329. https://doi.org/10.52223/jess.2023.4209

Rokhani, Rondhi, M., Suwandari, A., Asrofi, A., Fatikhul Khasan, A., Mori, Y., & Kondo, T. (2021). Improving the efficacy of climate policy in the Indonesian rice sector: The potential use of perceived-impact measures in targeting policy beneficiaries. In *Recent Advances in Rice Research*. IntechOpen. https://doi.org/10.5772/intechopen.94004

Sahu, G., Rout, P. P., Mohapatra, S., Das, S. P., & Pradhan, P. P. (2020). Climate smart agriculture: A new approach for sustainable intensification. *Current Journal of Applied Science and Technology*, 138–147. https://doi.org/10.9734/cjast/2020/v39i2330862

Segbefia, E., Dai, B., Adotey, P., & Sampene, A. K. (2023). A step towards food security: The effect of carbon emission and the moderating influence of human capital. Evidence from Anglophone countries. *Heliyon*, *9*(12), e22171. https://doi.org/10.1016/j.heliyon.2023.e22171

Sekaranom, A. B., Nurjani, E., & Nucifera, F. (2021). Agricultural climate change adaptation in Kebumen, Central Java, Indonesia. *Sustainability*, *13*(13), 7069. https://doi.org/10.3390/su13137069

Setiartiti, L. (2021). Critical point of view: The challenges of agricultural sector on governance and food security in Indonesia. *E3S Web of Conferences*, *232*, 01034. https://doi.org/10.1051/e3sconf/202123201034

Sogah, E., Tuffour, J. K., Mawutor, J. K. M., & Gborse, F. C. (2024). The relationship between external debt and agriculture GDP growth in Ghana: An ARDL cointegrating bound testing approach. *Cogent Economics & Finance*, *12*(1). https://doi.org/10.1080/23322039.2024.2330426

Spiegel, A., Soriano, B., de Mey, Y., Slijper, T., Urquhart, J., Bardají, I., Vigani, M., Severini, S., & Meuwissen, M. (2020). Risk management and its role in enhancing perceived resilience capacities of farms and farming systems in Europe. *EuroChoices*, *19*(2), 45–53. https://doi.org/10.1111/1746-692X.12284

Suzigan, L. H., Peña, C. R., & Guarnieri, P. (2020). Eco-efficiency assessment in agriculture: A literature review focused on methods and indicators. *Journal of Agricultural Science*, *12*(7), 118. https://doi.org/10.5539/jas.v12n7p118

Sylviani, & Sakuntaladewi, N. (2024). Adaptation, mitigation and resilience: Learning from the coastal and surrounding communities' forest. *IOP Conference Series: Earth and Environmental Science*, *1323*(1), 012008. https://doi.org/10.1088/1755-1315/1323/1/012008

Tahom, U. (2024). Advancing Thai agriculture: Strategic proposals for a young smart farmer in Thailand. *International Journal of Religion*, *5*(12), 774–785. https://doi.org/10.61707/zverf949

Tobing, I. F., Batubara, M., & Yusrizal, Y. (2024). The role of the agricultural sector in increasing economic growth from an Islamic economic perspective: A study in Deli Serdang Regency, North Sumatera Province, Indonesia. *Journal of Islamic Economics Lariba*, *10*(2), 927–950. https://doi.org/10.20885/jielariba.vol10.iss2.art17

Usman, M., Hameed, G., Saboor, A., Almas, L. K., & Hanif, M. (2021). R&D Innovation adoption, climatic sensitivity, and absorptive ability contribution for agriculture TFP growth in Pakistan. *Agriculture*, *11*(12), 1206. https://doi.org/10.3390/agriculture11121206

Wasiaturrahma, S, R., Ajija, S. R., Salama, S. C. U., & Hudaifah, A. (2020). Financial performance of rural banks in Indonesia: A two-stage DEA approach. *Heliyon*, *6*(7), e04390. https://doi.org/10.1016/j.heliyon.2020.e04390

Wiwoho, J., Saputro, N., Pamungkas, P., Trinugroho, I., Ariefianto, M. D., & Goestjahjantie, F. S. (2021). Rural bank and regional economic development: Evidence from Indonesia. *International Journal of Business and Society*, *22*(2), 818–827. https://doi.org/10.33736/ijbs.3761.2021

Wurarah, R. N. (2024). Indonesia's economic and environmental resilience in the face of climate change: Analysis and implementation strategies. *Calamity: A Journal of Disaster Technology and Engineering*, *2*(1). https://doi.org/10.61511/calamity.v2i1.2024.940

Wurarah, R. N., & Mulyanto, M. (2024). Effective government strategies to deal with climate change impacts in the West Papua Region: Budget optimization for mitigation and adaptation. *Jurnal Bina Praja*, *16*(2), 235–249. https://doi.org/10.21787/jbp.16.2024.235-249

Yazid, F., Kamello, T., Nasution, Y., & Ikhsan, E. (2021). Sharia based economics in support of Indonesia's sustainable agricultural sector. *IOP Conference Series: Earth and Environmental Science*, *782*(3), 032040. https://doi.org/10.1088/1755-1315/782/3/032040