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Impact of Special Allocation Fund for Irrigation and Agriculture on Rice Production in Indonesia

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Abstract
Indonesia's rice production ranks among the largest in the world; however, it remained relatively stagnant, averaging 54.60 million tons per year from 2019 to 2022. One government policy aimed at increasing rice production is the Special Allocation Fund (Dana Alokasi Khusus [DAK]) for irrigation and agriculture. This fund is transferred from the central government to local governments and is intended to strengthen food security. This study aims to examine the effects of DAK for irrigation and agriculture on rice production while considering the expenditure authority of local governments across Indonesia. The units of observation comprise 441 regencies and cities that meet the criteria of having rice fields, maintaining continuous rice production, and receiving DAK for irrigation or agriculture during the 2019–2021 period. The methodology employed in this study is a fixed-effects model with panel-corrected standard errors (PCSE). The results indicate that only DAK for irrigation under regency/city authority has a positive and statistically significant effect on rice production, whereas the other examined factors do not show significant effects. Therefore, this study recommends optimizing the use of DAK for irrigation to support agricultural production. Additionally, the study recommends developing new rice-field areas outside Java; however, further technical and feasibility studies are required before new rice fields are established.

INTRODUCTION

The agricultural sector plays a strategic role in the Indonesian economy. In 2022, the agriculture, forestry, and fisheries sectors contributed 12.40% to Gross Domestic Product (GDP), making them the third-largest contributors to GDP after the manufacturing sector and the wholesale and retail trade sector. Specifically, the agricultural subsector contributed 9.22% to GDP in 2022 (BPS, 2023). One of the key commodities underpinning the agricultural sector is rice, which serves as the staple food for the majority of the population (Cao et al., 2025; Arif et al., 2024).

Indonesia is among the world's largest rice producers; however, its rice production has remained relatively stagnant (Johnson et al., 2024). According to the United States Department of Agriculture (2023), Indonesia's rice production reached 34.6 million tons in 2022, making the country the fourth-largest rice producer globally after China, India, and Bangladesh. This production is supported by an extensive rice-harvested area of 7.46 million hectares, as illustrated in Figure 1. The majority of these rice fields are located on Java Island, which accounts for 3.47 million hectares, or 46.54% of the total area. However, the Central Statistics

Agency (BPS) reported that rice production remained relatively stagnant, averaging 54.60 million tons per year from 2019 to 2022.



Figure 1 Map of Rice Fields Indonesia 2019

Source: Ministry of Agrarian Affairs and Spatial Planning/National Land Agency, Processed

Despite the substantial volume of domestic rice production, increasing output remains essential to strengthening food security. The National Food Agency (Badan Pangan Nasional [Bapanas]) identifies three fundamental pillars of food security: availability, affordability, and utilization. According to the 2022 Food Security Index published by Bapanas, nearly all regencies and cities in eastern Indonesia are experiencing food insecurity. Compared with assessments from the previous year, many regencies and cities recorded declining scores. Moreover, rice consumption is expected to increase in line with population growth. In 2023, rice consumption in Indonesia was 93.8 kg per capita (Kementerian Pertanian, 2023). By 2050, demand is projected to rise further, driven by population growth to approximately 328.9 million people, representing a 22.02% increase from the population in 2020 (BPS, 2023).

The Ministry of Agriculture is committed to increasing the availability of essential domestic food commodities, as articulated in its 2020–2024 strategic plan (2021). One of the primary strategic objectives outlined in the plan is to improve the availability, accessibility, and consumption of high-quality food. Strategies for achieving this objective include increasing agricultural production and productivity, strengthening the availability of nationally strategic food commodities, and improving the affordability and utilization of food resources. Key initiatives designed to support these strategies include the development of food estates, the expansion of new planting areas, the distribution of one million units of agricultural machinery, and the development of digital-based drip irrigation systems.

One funding instrument that can be used to support this objective is the Special Allocation Fund (Dana Alokasi Khusus [DAK]). According to Law No. 1 of 2022 concerning Financial Relations between the Central Government and Regional Governments (Hubungan Keuangan antara Pemerintah Pusat dan Pemerintahan Daerah [HKPD]), DAK is a transfer from the Central Government to Regional Governments whose use is predetermined by the Central Government. The objectives of this policy are to support national priorities and stimulate regional economic growth. Two types of DAK specifically support efforts to increase rice production: DAK for irrigation and DAK for agriculture.

DAK for irrigation encompasses several categories of activities. In accordance with Presidential Regulation No. 7 of 2022, eligible activities under DAK for irrigation include the construction of irrigation systems, the improvement or rehabilitation of existing irrigation infrastructure, and the development of flood-control infrastructure. The allocation of DAK for irrigation is governed by Regulation of the Minister of Public Works and Public Housing (PUPR) No. 14/PRT/M/2015, which establishes the criteria and determination of irrigation-area status, as well as Regulation No. 04/PRT/M/2015, which specifies the criteria and determination of river areas. Provincial governments are authorized to manage irrigation areas ranging from 1,000 to 3,000 hectares, as well as irrigation areas that extend across multiple

regencies or cities. Irrigation areas covering less than 1,000 hectares fall under the authority of regency or city governments.

The activity categories and division of authority under DAK for agriculture have also been revised. For regency and city governments, eligible activities include the construction of water sources, agricultural roads, community food barns, the renovation of agricultural extension centers, and the provision of supporting facilities. In 2022, several additional activities were introduced, including the development of postharvest facilities and infrastructure for food crops; postharvest facilities, infrastructure, and processing facilities for plantation commodities; the construction or renovation of slaughterhouses and animal health centers; the provision of supporting facilities; the development of precision agriculture facilities and infrastructure; and the development of animal feed-processing facilities. Meanwhile, activities under the authority of provincial governments included the construction and rehabilitation of Regional Technical Implementation Unit (Unit Pelaksana Teknis Daerah [UPTD]) seed centers; food crop, horticulture, and plantation protection centers; and UPTD, centers, or institutions responsible for seeds, forage, and animal feed, including the provision of supporting facilities. However, these activity categories were discontinued in 2022.

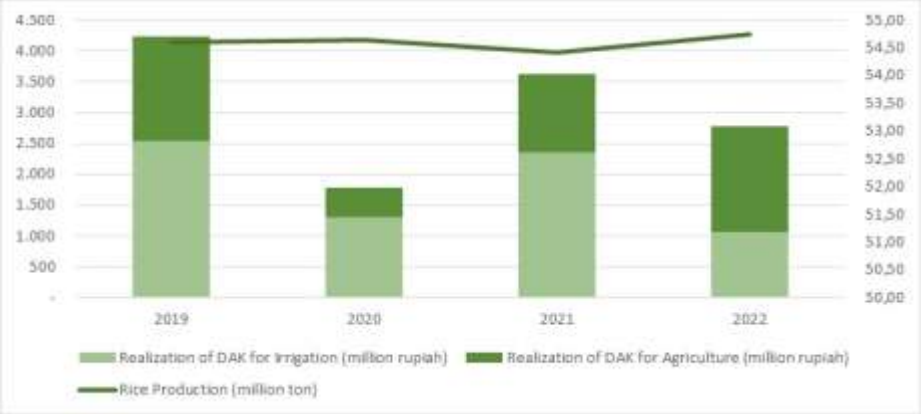


Figure 2 Rice Production and Realization of DAK for Irrigation and agriculture 2019 – 2022
Source: BPS, Kemenkeu, processed

This study aims to examine the effects of DAK for irrigation and agriculture on rice production. Figure 2 illustrates the relationship between rice production and the implementation of DAK for irrigation and agriculture from 2019 to 2022. Based on the figure, there is evidence of a lagged effect of DAK implementation on rice production. In 2020, a decline in the realization of DAK for irrigation and agriculture was followed by a decrease in rice production in 2021. Subsequently, an increase in DAK for irrigation and agriculture in 2021 was followed by an increase in rice production in 2022. This pattern suggests that the effect of DAK on rice production may not be immediate but may emerge after a lag of approximately one year. This study also considers the expenditure authority of local governments across Indonesia, which constitutes a novel aspect of the research (S. Zhang et al., 2025). By explicitly examining the differential effects of DAK under provincial and regency/city authority, this study provides new insights into how the decentralization of expenditure authority influences the effectiveness of fiscal transfers for the agricultural sector (Deng et al., 2021; Tao et al., 2024).

Numerous studies have examined the effects of DAK for irrigation and agriculture. (Darmawan, 2016) reported that DAK for agriculture positively influences rice production. Consistent with Darmawan's findings, (Zainuddin, 2021) also found that DAK for irrigation and agriculture has a positive effect on rice production. Furthermore, Zainuddin's research confirmed that DAK for irrigation and agriculture can improve the food security index. In contrast, Ahasani (2021) found that DAK for agriculture has a negative but statistically

insignificant effect on rice production, attributing this finding to the fact that demand for physical agricultural facilities and infrastructure does not arise annually and that existing infrastructure primarily requires maintenance. (Pancarini, 2016) and (Sukwadi, 2018) examined the effects of DAK for agriculture on rice productivity and concluded that DAK for agriculture positively affects rice productivity. Other studies have examined the effects of DAK for irrigation and agriculture on macroeconomic indicators. Mukhiwihando (2020) identified a positive relationship between DAK for agriculture and agricultural GDP. Similarly, Qomariyah (2017) found that DAK for irrigation contributes to an increase in agricultural Gross Regional Domestic Product (GRDP) and a reduction in the Gini index. Several studies have also investigated the appropriateness of DAK allocations for irrigation and agriculture. (Sirait, 2019) argued that DAK for irrigation and agriculture should be allocated to regional governments with high levels of rice production but limited fiscal capacity. Conversely, (Hakim, 2022) contended that the allocation of DAK for irrigation and agriculture was appropriate because it targeted regions with high food security index scores. Despite this body of research, the literature has not sufficiently examined the differential effects of DAK according to provincial versus regency/city expenditure authority. This study addresses that gap by explicitly incorporating differences in expenditure authority into the analysis.

RESEARCH METHODS

The dependent variable in this study was rice production, with data obtained from BPS. The independent variables were DAK for irrigation and DAK for agriculture, classified according to provincial and regency/city authority, with data obtained from the Ministry of Finance and measured in rupiah. DAK under provincial authority was assumed to be distributed across the regencies and cities within the respective province. The control variables included rice field area, irrigation infrastructure, agricultural tools and machinery, and a non-Java regional dummy variable. Data on rice field area were obtained from BPS, while data on irrigation infrastructure and agricultural tools and machinery were obtained from the Ministry of Agriculture. Rice field area and agricultural production inputs were included based on previous studies demonstrating their relevance to rice production (Ahsani, 2021; Zainuddin, 2021). The non-Java dummy variable was included to capture differences in rice production between regions located on and outside Java Island.

The study used panel data. Based on the lagged relationship illustrated in Figure 2, rice production data covered the period from 2020 to 2022, while DAK and the relevant control variables covered the period from 2019 to 2021. The sample consisted of regencies and cities that had rice fields, continuously produced rice, and received DAK for irrigation or agriculture during 2019–2021. The analysis employed a fixed-effects model with panel-corrected standard errors (PCSE). PCSE was applied to address heteroskedasticity and autocorrelation in the panel data (Hoechle, 2007). Based on the available data and the empirical frameworks of (Pancarini, 2016), (Sukwadi, 2018), (Ahsani, 2021), and (Zainuddin, 2021), the regression model was specified as follows.

$$\begin{aligned}\text{Lnprod}_{it} = \alpha + \beta_1 \text{lndakir_kk}_{it-1} + \beta_2 \text{lndakir_p}_{it-1} + \beta_3 \text{lndakper_kk}_{it-1} + \\ \beta_4 \text{lndakper_p}_{it-1} + \beta_5 \text{lnsawah}_{it} + \beta_6 \text{lnpupuk}_{it} + \beta_7 \text{lnirigasi}_{it} + \\ \beta_8 \text{lnalsintan}_{it} + \beta_9 \text{nonjawa}_{i} + \varepsilon_{it}\end{aligned}$$

The dependent variable, lnprod, represented rice production measured in tons of dry milled grain (GKG). The independent variables were lndakir_kk, lndakir_p, lndakper_kk, and lndakper_p, all measured in rupiah. The variables lndakir_kk and lndakir_p represented DAK for irrigation under regency/city and provincial authority, respectively, while lndakper_kk and lndakper_p represented DAK for agriculture under regency/city and provincial authority, respectively. The control variables included lnsawah for rice field area, lnpupuk for subsidized fertilizer realization, lnirigasi for constructed irrigation infrastructure, lnalsintan for the

provision of agricultural tools and machinery, and nonjawa, a dummy variable coded 1 for regencies or cities outside Java and 0 for those located in Java (Q. Zhang et al., 2023; Joseph et al., 2023).

The regression model was estimated using two specifications to assess the robustness of the results. The first specification included only the dependent and independent variables, while the second incorporated the control variables. The hypotheses tested were as follows: (1) DAK for irrigation under regency/city authority (lndakir_kk) had a positive and statistically significant effect on rice production; (2) DAK for irrigation under provincial authority (lndakir_p) had a positive and statistically significant effect on rice production; (3) DAK for agriculture under regency/city authority (lndakper_kk) had a positive and statistically significant effect on rice production; and (4) DAK for agriculture under provincial authority (lndakper_p) had a positive and statistically significant effect on rice production.

RESULTS AND DISCUSSION

Table 1 Descriptive Statistics

Variable	Unit	N	Mean	St.Dev	Max	Min
Prod	Tons GKG	1,323	123,703	188,500	1,482,256	15
Dakir_kk	Million rupiah	1,323	3,886.69	4,135.14	48,265.93	0
Dakir_p	Million rupiah	1,323	695.40	1,160.22	12,556.34	0
Dakper_kk	Million rupiah	1,323	2,094.75	1,891.74	13,655.23	0
Dakper_p	Million rupiah	1,323	367.82	435.96	2,249.71	0
Sawah	Thousand hectares	1,323	16.90	21.92	174.41	0.01
Pupuk	Thousand ton	1,323	18.03	17.89	63.78	0.05
Irrigasi	Unit	1,323	2.73	1.54	6.75	0
Alsintan	Unit	1,323	5.30	3.67	13.97	0

Source: author's data processing

A total of 441 regencies and cities meet the specified criteria, which include the presence of rice fields, the implementation of continuous rice production, and the receipt of DAK for irrigation or agriculture during the period from 2019 to 2022. The distribution of these regencies and cities is as follows: 147 in the Sumatra region, 102 in the Java region, 41 in the Bali-Nusa Tenggara region, 54 in the Kalimantan region, 73 in the Sulawesi region, 11 in the Maluku region, and 13 in the Papua region. Table 1 presents the descriptive statistics of the variables utilized in this study. Most of the variables exhibit a wide distribution, as indicated by the standard deviation being greater than the mean value.

There is a significant correlation between rice production (**prod**) and rice field area (**sawah**), evidenced by a correlation coefficient of 0.92, as shown in Table 2. Moreover, Table 3 demonstrates that both variables display a comparable distribution pattern. According to (Zainuddin, 2021) and (Sukwadi, 2018), rice fields are essential for rice production. The findings presented in both tables indicate that the rice production process is predominantly focused on maximizing the use of the available rice field area. According to data from BPS, the five provinces with highest rice production in 2022 are East Java, Central Java, West Java, South Sulawesi, and South Sumatera.

Table 2 Correlation between Variables

Variable	Prod	Dakir_kk	Dakir_p	Dakper_kk	Dakper_p	Sawah	Pupuk	Irigasi	Alsintan
Prod	1	0.16	-0.02	0.35	-0.12	0.92	0.53	0.15	0.47

Dakir_kk	1	0.13	0.36	0.17	0.20	0.06	0.11	0.07
Dakir_p		1	0.08	0.16	0.00	-0.07	0.04	-0.02
Dakper_kk			1	0.24	0.35	0.22	0.14	0.23
Dakper_p				1	-0.12	-0.18	0.36	-0.15
Sawah					1	0.48	0.12	0.41
Pupuk						1	0.15	0.71
Irigasi							1	0.39
Alsintan								1

Source: author's data processing

The allocation of DAK for irrigation and agriculture is effectively distributed among local governments. As demonstrated in Table 3, the distribution of DAK for these sectors is not exclusively concentrated in the Java region, which is characterized by extensive rice field areas, but is also equitably distributed across other regions. This distribution aligns with one of the objectives of DAK, as stipulated in Law No. 1 of 2022 concerning Financial Relations between the Central Government and Regional Governments (HKPD), which aims to accelerate regional development. Furthermore, (Mukiwihando, 2020) and (Qomariyah et al., 2017) have confirmed that DAK for irrigation and agriculture have a positive and significant impact on regional development.

Table 3 Distribution of Variables

Variable	Sumatera	Jawa	Bali-Nusra	Kalimantan	Sulawesi	Maluku	Papua
Prod	20.58	56.12	5.03	4.42	13.16	0.25	0.44
Dakir_kk	31.38	22.27	11.12	11.56	18.87	2.42	2.38
Dakir_p	16.93	20.53	13.49	17.95	15.60	13.63	1.88
Dakper_kk	27.58	30.00	9.65	8.68	18.33	3.10	2.66
Dakper_p	25.15	15.16	10.19	12.34	24.23	4.17	8.77
Sawah	23.54	46.49	6.19	9.71	13.06	0.42	0.59
Pupuk	21.78	58.18	4.96	3.70	11.00	0.12	0.26
Irrigasi	22.01	26.62	11.97	7.63	25.52	3.48	2.76
Alsintan	19.48	39.78	9.94	6.66	19.45	2.87	1.81

Source: author's data processing

The initiative to accelerate regional development is further evidenced by the distribution of control variables, as illustrated in Table 3. The distribution of subsidized fertilizer (**Pupuk**) exhibits a pattern analogous to that of rice field area (**Sawah**), as it is allocated directly to farmers in accordance with the area of their rice fields. In contrast, the distribution patterns of constructed irrigation infrastructure (**Irigasi**) and the provision of agricultural tools and machinery (**Alsintan**) doesn't follow the distribution pattern of rice field area (**Sawah**), as both are aimed at achieving equity in agricultural facilities and infrastructure.

Table 4 Panel Data Regression Estimation Results with Panel-Corrected Standard Error Estimation

Variable	(1)	(2)
DAK for irrigation – regency/citiy auth.	0.0686***	0.0037*
(**lndakir_kk**)	(.0173)	(0.0020)
DAK for irrigation – provincial auth.	-0.0248	0.0006
(**lndakir_p**)	(0.0187)	(0.0015)
DAK for agriculture – regency/city auth.	0.0607**	-0.0017
(**lndakper_kk**)	(0.0284)	(0.0017)
DAK for agriculture – provincial auth.	0.0262	0.0053
(**lndakper_p**)	(0.02334)	(0.0034)

Rice field area (**lnsawah**)	-	1.0631*** (0.0089)
Fertilizer (**lnpupuk**)	-	0.2702*** (0.0355)
Irrigation (**lnirigasi**)	-	0.0655* (0.0403)
Agricultural equipment and machinery (**lnalsintan**)	-	0.0499** (0.0229)
Non-Java (**nonjawa**)	-	0.1237*** (0.1257)
Constant	8.1105*** (0.9602)	7.4512*** (0.1257)
N	1,323	1,323
R-sq	0.1996	0.9134

Note: * P<0,1; ** P<0.05; *** P<0,01

Source: author's data processing

The results of the regression analysis are presented in Table 4. The regression was conducted under two scenarios: without control variables and with control variables. The table indicates an increase in the R-squared value from 0.1996 to 0.9134. The R-squared value reflects how well the independent variables explain the variability of the dependent variables. The increase in the R-squared value suggests that the independent variables alone are insufficient to explain the dependent variables. Additionally, there are changes in the coefficients of the independent variables; they are decreasing and becoming less significant than before. This indicates that the control variables have a greater and more significant impact on the dependent variables than the independent variables.

Based on the results, the independent variable that have significant impact on rice production is only DAK for irrigation under regency/city authority (**lndakir_kk**). This implies that only one of the four hypotheses tested has been validated: (1) DAK for irrigation under the jurisdiction of regency/city authorities (**lndakir_kk**) has a positive and significant effect on rice production. DAK for irrigation is specifically designed to enhance rice production, whereas DAK for agriculture encompasses a broader focus, including plantations, horticulture, and livestock. DAK for irrigation under regency/city authority exerts a more significant effect than that at the provincial authority because according to the Regulation of the Minister of Public Works and Public Housing (PUPR) No. 14/PRT/M/2015, the irrigation area under regency/city authority (47.71%) is larger than provincial authority (17.89%). This observation is consistent with the findings of (Zainuddin, 2021), which suggest that the significance of the DAK variables in his research is predominantly attributed to DAK for irrigation. (Ahsani, 2021) further supports these results, indicating that DAK for agriculture does not have a significant impact on rice production. However, these findings are at odds with those of (Darmawan, 2016), (Pancarini, 2016), and (Sukwadi, 2018), who reported that DAK for agriculture has a positive and significant effect on rice production (Yu et al., 2024).

All control variables have a positive and significant impact on rice production. These findings are consistent with the research conducted by (Zainuddin, 2021), (Pancarini, 2016), (Sukwadi, 2018), and (Ahsani, 2021). The results indicate that rice fields remain a crucial component for increasing rice production, despite the ongoing land use changes affecting these fields. Furthermore, subsidized fertilizers, irrigation, and the provision of agricultural tools and machinery also have a positive and significant impact on rice production. All of these factors are integral to the Ministry of Agriculture's policies, which should be sustained. The significance of the Non-Java variable suggests that the agricultural sector is not solely dependent on Java Island, highlighting the substantial potential for developing rice production outside of Java.

Conclusion

The agricultural sector plays a vital role in Indonesia's economy, contributing 12.40% to GDP in 2022, with the agricultural subsector alone accounting for 9.22%. Rice is one of the country's primary agricultural commodities, and Indonesia ranks as the world's fourth-largest rice producer, producing 34.6 million tons from 7.46 million hectares of rice fields. Despite this substantial production, Indonesia continued to import rice, totaling 429 thousand tons in 2022. The government has sought to increase rice production through strategies outlined in the Ministry of Agriculture's 2020–2024 strategic plan, with an emphasis on strengthening food security and improving agricultural productivity through intensification and extensification. The Special Allocation Fund (Dana Alokasi Khusus [DAK]) for irrigation and agriculture constitutes part of the fiscal support for these initiatives. However, despite substantial DAK allocations amounting to 7.25 trillion rupiah for irrigation and 5.15 trillion rupiah for agriculture between 2019 and 2022, rice production remained relatively stagnant, averaging 54.60 million tons per year. This study therefore examines the effects of DAK for irrigation and agriculture on rice production while considering differences in expenditure authority across local governments in Indonesia (Ma et al., 2025).

This study employed panel data to examine the effects of DAK on rice production. Rice production was treated as the dependent variable, while DAK for irrigation and agriculture, categorized according to provincial and regency/city authority, served as the independent variables. The control variables included rice field area, constructed irrigation infrastructure, the provision of agricultural tools and machinery, and a non-Java regional dummy variable. Rice production and the relevant control variables covered the period from 2020 to 2022, while DAK variables covered the period from 2019 to 2021 to account for the lagged effect indicated in Figure 2. The units of observation comprised 441 regencies and cities that had rice fields, continuously produced rice, and received DAK for irrigation or agriculture during 2019–2021. To address potential heteroskedasticity and autocorrelation, the analysis employed a fixed-effects model with panel-corrected standard errors (PCSE).

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