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Original Article

Assessing the Impact of Reduced Subsidized Fertilizer Usage on Agricultural Productivity in Aceh Province, Indonesia

Zulfa Zulfa [a], Sofyan Syahnur [a] and Srinita Srinita [a,*]

[a] Department of Economics, Faculty of Economics and Business, Universitas Syiah Kuala, Syiah Kuala, 23111 Kota Banda Aceh, Aceh, Indonesia; ufazulfa285@gmail.com (Z.Z.), kabari_sofyan@usk.ac.id (S.S.)
* Correspondence: srinita@usk.ac.id (S.N.)

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Abstract: The agricultural sector is pivotal in Indonesia's economy, significantly contributing to the community's agricultural output. Fertilizer demand in this sector is a critical factor influencing agricultural issues, particularly concerning government policies on subsidized fertilizer distribution. This study aims to analyze the impact of restricting subsidized fertilizer usage on agricultural production in Aceh Province, focusing on how these restrictive policies affect farmers' economic aspects, productivity, and welfare. The research employs a quantitative analysis method utilizing secondary data from scientific publications, journals, books, financial reports from relevant institutions, and other measurable sources. The study uses panel data, combining time series and cross-sectional data, and applies a panel data regression model. The econometric model employs path analysis, with data processing conducted using EViews. Results indicate that limiting Urea fertilizer subsidies does not significantly affect agricultural production. Similarly, the restriction of NPP and Super Phosphate 36 (SP-36) fertilizer subsidies does not significantly impact overall agricultural production. The analysis concludes that Urea fertilizer subsidies have consistently supported agricultural production, although their significance decreases post-subsidy restrictions. NPP fertilizer subsidies, which previously had a significantly negative impact on agricultural production, lost their significance after the restrictions. SP-36 fertilizer subsidies do not show a significant impact in either period. These findings underscore the importance of adjusting fertilizer subsidy policies to optimize agricultural production in Aceh.

Keywords: Subsidized fertilizers; Agricultural productivity; Agricultural policy, Food security.

1. Introduction

The agricultural sector is crucial to Indonesia's economy and significantly contributes to the community's agricultural output. The need for fertilizers in this sector is a major factor influencing agricultural issues, particularly concerning government policies on distributing subsidized fertilizers. To maintain and enhance agricultural productivity, the appropriate use of inputs such as fertilizers is essential. Fertilizers are a vital production factor in agricultural activities. On the other hand, the government continuously strives to improve agricultural productivity to ensure the nation's food security (Dwijayanti & Hayati, 2020). This aligns with the government's policy outlined in the Minister of Trade Decree No. 70/MPP/Kep/2/2003 dated February 11, 2003. The decree regulates the procurement and distribution process of subsidized fertilizers for the agricultural sector. The Regulation of the Minister of Trade of the Republic of Indonesia No. 4 of 2023 on the Procurement and Distribution of Subsidized Fertilizers for the Agricultural Sector stipulates procedures for the procurement and distribution of government-subsidized fertilizers intended for farmers' needs based on government programs in the agricultural sector. Subsidized fertilizers are those whose procurement and distribution receive subsidies from the government to meet farmers' needs, implemented based on government programs in the agricultural sector.

Procurement is the process of providing subsidized fertilizers sourced from domestic production and/or imports. Distribution is distributing subsidized fertilizers from the producer level to farmers and/or farmer groups as the final consumers. Farmers receiving subsidized fertilizers, hereafter referred to as Farmers, are Indonesian citizens and/or their families engaged in farming activities according to the criteria for subsidized fertilizer recipients set by the minister responsible for agricultural affairs. Farmer Groups are assemblies of farmers formed based on common interests, social, economic, and resource conditions, common commodities, and familiarity to enhance and develop their members' farming enterprises. In 2020, the allocation of subsidized fertilizers saw an increase. The government allocated 80,443 tons of Urea fertilizer, 14,678 tons of SP 36 fertilizer, and a significant increase in ZA fertilizer to 61,668 tons. In 2022, the allocation for NPP fertilizer remained at 42,932 tons, reflecting an increase from the previous allocation. This indicates the government's efforts to strengthen the agricultural sector through increased fertilizer supply. The allocation of subsidized fertilizers since 2020 remained unchanged, stable at 80,443 tons of Urea fertilizer, 14,678 tons of SP 36 fertilizer, 61,668 tons of ZA fertilizer, and 42,932 tons of NPP fertilizer. This consistency demonstrates stability in the subsidized fertilizer distribution policy.

In 2023, Aceh province received a significant allocation of subsidized fertilizers, totaling 221,321 tons. The allocation details include 118,224 tons of Urea fertilizer, 97,476 tons of NPP fertilizer, and 5,620 tons of specially formulated. Although Aceh requested a higher amount, the central government only approved about 30-35 percent of the total needs submitted by the province. This indicates limitations in distribution based on budget or national priorities. From 2018 to 2023, the allocation of subsidized fertilizers experienced various changes, both increases and decreases, reflecting adjustments based on needs and agricultural strategies. A significant increase in 2023 for Aceh highlights a specific focus on the province, albeit with restrictions on the approved quota. This policy is part of ongoing efforts to support the agricultural sector and ensure food security in Indonesia. The government provides subsidized fertilizers to farmers to support national food security. This provision must adhere to six main principles known as the 6Ts: right type, right quantity, right price, right place, right time, and right quality (Permentan, 2022).

2. Literature Review

2.1. The restrictions on the use of subsidized fertilizers

In the ever-changing economic dynamics, economic policies can change, including the use of subsidized fertilizers. Based on the Working Committee (Panja) of Commission IV of the House of Representatives (DPR) recommendations on Improving the Governance of Subsidized Fertilizers, the government began restricting the use of subsidized fertilizers starting in July 2022. This restriction was implemented due to the rising prices of natural gas, the main ingredient for fertilizer production. Additionally, according to the www.dpr.go.id website on April 6, 2022, the government also limited subsidized fertilizers due to inadequate budgetary provisions, necessitating restrictions to broaden the scope of subsidy recipients. The restrictions on the use of subsidized fertilizers have evolved. Initially covering five types of fertilizers such as Urea, SP-36, ZA, NPP, and Organic, it is now limited to only two types: Urea and NPP. Also, the restrictions also apply to the types of commodities eligible for subsidized fertilizers. Currently, only nine commodities are eligible for subsidized fertilizers: rice, corn, soybeans, chilies, shallots, garlic, sugarcane, cocoa, and coffee. These nine commodities are selected based on strategic considerations and their sensitivity to inflation rates. The selection of commodities also refers to Presidential Regulation Number 59 of 2020 concerning Amendments to Presidential Regulation 71 of 2015 on the Determination and Storage of Essential Goods and Important Goods (Dahiri & Prasetyo, 2018).

The fertilizer subsidy policy aims to protect farmers, increase productivity, and enhance their economic well-being. However, fertilizer issues in Indonesia often become a significant concern that directly impacts farmers' needs and ability to manage their land sustainably. When there is a fertilizer shortage, and prices rise, farmers suffer because it becomes difficult for them to obtain fertilizer at affordable prices. This can hinder their growth and crop yields, negatively affecting their overall economic well-being. Therefore, it is crucial for the government and related parties to continuously monitor and address issues related to fertilizer distribution and pricing to ensure the sustainability of agricultural enterprises and the welfare of farmers (Notohamiprodjo Lt & Wahidin, 2012). The results of the price comparison analysis between subsidized and non-subsidized fertilizers indicate a significant price difference. This disparity can impose financial pressure on farmers, impacting the capital they need to invest (Nauly, 2019). Issues that need to be addressed regarding subsidized fertilizers include several aspects. Firstly, it is crucial to provide farmers with an understanding of the importance of limiting the use of subsidized fertilizers. This can be achieved through education and informative approaches to strengthen awareness about the significance of efficient and sustainable fertilizer use. Clear information is needed on balanced fertilizer usage to enhance crop yields. Farmers should be guided on the correct dosage and types of fertilizers suitable for specific crops to optimize yields and prevent wastage.

The government needs to enhance the ease of monitoring the distribution of subsidized fertilizers by directing distribution through farmer groups, either directly or indirectly. This approach can help ensure that fertilizers are delivered promptly, in the correct quantity, and of the right quality per farmers' requirements. The indicators of the "six rights" (right price, right target, right time, right quantity, right quality, and right type) are considered effective in ensuring the efficiency and success of this fertilizer subsidy program. By addressing these issues, the fertilizer subsidy program is hoped to support farmers and enhance overall agricultural productivity effectively (Pirngadi et al., 2023). Restrictions on the use of subsidized fertilizers can have dual impacts on farmers in Indonesia, including increased production costs and decreased crop yields. A similar situation occurs in Aceh Province, where nearly all farmers rely on fertilizers to improve agricultural yields annually. Subsidized fertilizers, in particular, are crucial in supporting agricultural productivity. However, policies limiting the use of subsidized fertilizers can have negative effects on agricultural outcomes.

2.2. Impact of Subsidized Fertilizer Restrictions on Agricultural Production

The agricultural sector plays a crucial role in Indonesia's economic structure and contributes significantly to the agricultural output of society. This sector provides food for basic needs and serves as a livelihood for millions across the country. Therefore, the agricultural sector's growth and prosperity directly impact society's overall welfare. The government and other stakeholders must continue developing and supporting the agricultural sector to ensure food security, increased agricultural yields, and sustainable economic growth. The quality of the production process heavily relies on effective coordination among all production factors. With skilled and experienced labor, productivity and product quality can be enhanced. This production process is designed to generate products or services that meet consumer needs through steps that transform inputs into value-added outputs. (Kandemir Kocaaslan, 2019). Menurut Kholis & Setiaji (2020), Production theory can be divided into two main parts. First is short-run production theory, where a producer utilizes production factors, some variable and others fixed. This means there are factors of production that cannot be changed in the short term, such as machinery or production facilities. In contrast, others, like labor or raw materials, can be adjusted to different production levels.

Subsidies have been a major focus of economic research, especially in the government's role in managing and influencing economic activities (Nauly, 2019). Subsidies are efforts by the government to assist the public by reducing some of the costs they would otherwise incur when engaging in transactions, whether for goods or services essential to many people (Rigi et al., 2019). Kholis & Setiaji, (2020) The policy of fertilizer subsidies is part of the government's fiscal strategy aimed at supporting farmers as a means to address economic imbalances and reduce unemployment rates. In theory, Keynes argued that subsidies can enhance the overall welfare of society, which in turn can help alleviate poverty (Krugman, 2018).

Several previous studies have made significant contributions to understanding subsidies. Taufikurahman (2021) discusses the positive effects of subsidy policies in improving farmers' welfare. Aulia et al. (2021) emphasize the market distortions that may arise from such subsidies, even though they are intended to provide economic or social support. These findings form the basis for understanding the complexity and implications of subsidy policies. Agricultural subsidies can take various forms, and these policies are often employed by many countries worldwide (Dwijayanti & Hayati, 2020). Agricultural subsidies can involve direct assistance to farmers, subsidies for inputs such as fertilizers or seeds, setting minimum prices for agricultural products, and other policies aimed at protecting and enhancing the welfare of farmers.

2.3. Policies on Limiting Fertilizer Subsidies

Restricting subsidized fertilizers is a policy a country can adopt to address various issues, including fiscal burdens, economic sustainability, and resource use efficiency. Limiting fertilizer subsidies aims to reduce fiscal burdens and government spending. By implementing these restrictions, the government hopes to encourage farmers to take more independent steps toward achieving food self-sufficiency and increasing agricultural productivity without overly relying on government support. Additionally, limiting subsidized fertilizers can prevent subsidy abuse and market distortions arising from the misuse or illegal trade of subsidized fertilizers. (Ahsani, 2021). Rahmatullah Rizieq (2019) The impact of fertilizer subsidies on farmers' welfare has several aspects that need consideration. Firstly, research indicates that the relative decrease in agricultural product prices is smaller than the decrease in fertilizer prices under significant subsidy policies, potentially improving farmers' welfare. Secondly, despite providing fertilizer subsidies, the increase in agricultural sector production is not always optimal, as evidenced by lower production increases compared to the fertilizer industry sector. Thirdly, appropriate fertilizer subsidy policies can increase Gross Domestic Product (GDP) and consumer utility and may lead to deflation.

Widowati et al. (2014) Based on the research findings, the elimination of fertilizer subsidies generally does not have a significant negative impact on the adoption of technology in farming practices, except when there is a decrease in the use of SP36 resulting in a decrease in rice productivity by about 1 ton per hectare. Dwijayanti & Hayati (2020) indicate that the distribution of fertilizer subsidies based on land area yields progressive results. However, in the first group, farmers with less than 5000 square meters of land only receive 2.2% of the total subsidies provided. However, the results tend to be regressive in terms of distributing benefits based on the level of agricultural productivity per cropping season. Lestary & Yasin (2023) showed that fertilizers significantly influence agricultural yields. This is evidenced by the calculations obtained from interviews with informants, where the average rice farmer's yield before the scarcity of subsidized fertilizers occurred. Susila, (2018) The positive and negative impacts of fertilizer subsidy policies reveal several significant findings. Positively, these policies have helped increase fertilizer availability for farmers, which can enhance agricultural productivity and national food security. However, there are challenges associated with these policies. Issues such as unfair and mis-targeted distribution of fertilizers and market dualism suggest that the benefits of fertilizer subsidies may not be evenly distributed among farmers and may not reach those who need them most directly.

3. Materials and Methods

This study employs a quantitative approach using econometric path analysis, with data processing conducted through EViews software. The analysis applies panel data regression models, specifically the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Diagnostic tests such as the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test are performed to identify the most appropriate model for panel data analysis. Classical assumption tests, including checks for normality, multicollinearity, heteroscedasticity, and autocorrelation, are also carried out to ensure the reliability and validity of the regression results. The independent variable, Restriction of Subsidized Fertilizer Use, includes policies that regulate or limit the quantity, type, and application methods of subsidized fertilizers such as Urea, NPK, and SP-36. The dependent variable, Agricultural Production, measures the output of agricultural activities, including crop and plantation yields, expressed in tonnage units. This study uses secondary panel data, which combines time series data from 2017 to 2022 with cross-sectional data covering 23 districts/cities in Aceh Province. The data are sourced from reputable publications, including reports from the Agricultural Office of Aceh Province, the Central Statistics Agency of Aceh Province, scientific journals, books, and other relevant documents. By analyzing the impact of reduced subsidized fertilizer utilization on agricultural production, this study provides insights into the consequences of fertilizer subsidy restrictions across Aceh's agricultural sector.

4. Results

Several tests were conducted in the panel data analysis to determine the most appropriate model. The Chow Test yielded a probability (Prob) > 0.05, suggesting the use of the Common Effect Model (CEM). This result indicates that the fixed effects model does not significantly outperform the general effects model. The Hausman Test, however, produced a probability (Prob) < 0.05, favoring the Fixed Effect Model (FEM). This outcome suggests that the fixed effect model is superior to the random effect model, implying a correlation between the independent variables and individual effects. The Lagrange Multiplier Test also resulted in a probability (Prob) < 0.05, which typically supports the use of the Random Effect Model (REM). This result indicates that the random effect model is more suitable than the Common Effect Model. After considering the outcomes of the Chow Test, Hausman Test, and Lagrange Multiplier Test, the Fixed Effect Model (FEM) was determined to be the most appropriate for this study. Detailed information regarding the model selection process is presented in Table 1.

Table 1. Result of Selected Model

Test Statistics	Effects Test	Statistic	d.f	Prob.	Decision
Uji Chow	Cross-section F	27.680050	(21,85)	0.0000	FEM
	Cross-section Chi-square	226.496634	21	0.0000	
Uji Hausman	Cross-section random	18.495573	3	0.0003	FEM
Uji Lagrange Multiplier	Breusch-Pagan	124.2531 (0.0000)	2.151186 (0.1425)	126.4042 (0.0000)	REM

The results of the model selection process are presented in Table 1. Based on the outcomes of both the Chow Test and the Hausman Test, which consistently support the Fixed Effect Model (FEM), this study has determined that the FEM is the most suitable approach. This decision is substantiated because two out of three tests indicate significant differences between individuals or groups in the panel data, necessitating their incorporation into the model. The FEM's ability to control distinct fixed effects for each individual or group renders it particularly appropriate for this analysis. This approach is expected to yield more precise results that accurately reflect the inherent characteristics of the dataset under examination.

4.1. Urea Fertilizer Subsidy Restriction on Agricultural Production

Implementing restrictions on urea fertilizer subsidies in agricultural production seeks to maintain consistent usage patterns among participants in the agricultural and plantation sectors. This policy regulates the quantity and accessibility of subsidies provided to farmers, enabling them to procure urea fertilizer at more affordable rates. The primary objectives of these restrictions are to ensure equitable and efficient distribution of subsidized fertilizers, prevent stockpiling or misappropriation, and guarantee that subsidies reach farmers with genuine needs. The empirical data pertaining to the effects of urea fertilizer subsidy restrictions can be observed in Table 2.

Table 2. Result of Restriction of Urea Fertilizer Subsidy

Data Sample: 2018-2021

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	10.63211	1.153439	9.217745	0.0000
UREA	0.156519	0.153424	1.020173	0.3114
R-squared	0.963276	Mean dependent var		11.80795
Adjusted R-squared	0.950846	S.D. dependent var		1.865551
S.E. of regression	0.413604	Akaike info criterion		1.291964
Sum squared resid	11.11946	Schwarz criterion		1.939450
Log likelihood	-33.84643	Hannan-Quinn criter.		1.552820
F-statistic	77.49814	Durbin-Watson stat		1.475255
Prob(F-statistic)	0.000000			

Data Sample: 2018-2022

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	10.54846	0.908120	11.61571	0.0000
UREA	0.166710	0.120815	1.379876	0.1712
R-squared	0.947200	Mean dependent var		11.80000
Adjusted R-squared	0.933848	S.D. dependent var		1.845749
S.E. of regression	0.474728	Akaike info criterion		1.531459
Sum squared resid	19.60689	Schwarz criterion		2.096105
Log likelihood	-61.23027	Hannan-Quinn criteria.		1.760483
F-statistic	70.94163	Durbin-Watson stat		1.265770
Prob(F-statistic)	0.000000			

Data analysis before the restriction of urea fertilizer subsidies revealed that the urea variable coefficient was 0.156519 (standard error: 0.153424), with a t-statistic of 1.020173 and a probability of 0.3114. These results suggest that the urea variable's influence on agricultural production was not statistically significant. The model's intercept (10.63211) was highly significant ($p < 0.0001$). The R-squared value of 0.963276 indicated that the model explained approximately 96.33% of the variability in agricultural production, while the Adjusted R-squared (0.950846) confirmed the model's robustness. The standard error of the regression (0.413604) suggested low prediction errors, and the F-statistic (77.49814, $p < 0.000001$) demonstrated the model's overall significance in explaining agricultural production variability. Following the restriction of urea fertilizer subsidies (2018-2022), the urea variable coefficient increased slightly to 0.166710 (standard error: 0.120815), with a t-statistic of 1.379876 and a probability of 0.1712.

Despite this increase, the effect of the urea variable on agricultural production remained statistically insignificant. The model's intercept (10.54846) maintained high significance ($p < 0.0001$). The R-squared value decreased to 0.947200, explaining approximately 94.72% of the variability in agricultural production. The Adjusted R-squared (0.933848) continued to indicate a strong model fit. The standard error of regression increased to 0.474728, suggesting a slight rise in prediction errors. The F-statistic (70.94163, $p < 0.000001$) confirmed the model's overall significance in explaining agricultural production variability. Comparing the two periods, the urea variable coefficient increased marginally from 0.156519 to 0.166710, yet its influence on agricultural production remained statistically insignificant. After the restriction, the slight decrease in both R-squared and Adjusted R-squared values indicated a minor reduction in the model's explanatory power. Nevertheless, both models maintained overall significance, as evidenced by the high F-statistic values and low probabilities.

4.2. Nitrogen, Phosphorus, and Potassium (NPP) Fertilizer Subsidy Restriction on Agricultural Production

The impact of restricting Nitrogen, Phosphorus, and Potassium (NPK) fertilizer subsidies on agricultural production represents a significant concern in agricultural policy and sustainability. NPK fertilizer subsidies typically form part of governmental initiatives to support farmers in enhancing agricultural yields at reduced costs. However, the implementation of restrictions on these subsidies can have substantial effects on agricultural output. Table 3 presents the findings of the tabulation data analysis regarding the restriction of NPK fertilizer subsidies. These results provide valuable insights into the potential consequences of such policy changes on agricultural productivity and sustainability.

Table 3. Result of Restriction of Nitrogen, Phosphorus, Potassium, and Fertilizer Subsidies

Data Sample: 2018-2021

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.42533	0.797831	15.57388	0.0000
NPP	-0.087108	0.112396	-0.775013	0.4411
R-squared	0.963030	Mean dependent var		11.80795
Adjusted R-squared	0.950517	S.D. dependent var		1.865551
S.E. of regression	0.414990	Akaike info criterion		1.298651
Sum squared resid	11.19406	Schwarz criterion		1.946136
Log likelihood	-34.14063	Hannan-Quinn criteria.		1.559506
F-statistic	76.96198	Durbin-Watson stat		1.545101
Prob(F-statistic)	0.000000			

Data Sample: 2018-2022

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.64148	0.779786	14.92907	0.0000
NPP	0.022407	0.110034	0.203635	0.8391
R-squared	0.946070	Mean dependent var		11.80000
Adjusted R-squared	0.932432	S.D. dependent var		1.845749
S.E. of regression	0.479780	Akaike info criterion		1.552633
Sum squared resid	20.02645	Schwarz criterion		2.117279
Log likelihood	-62.39480	Hannan-Quinn criteria.		1.781656
F-statistic	69.37251	Durbin-Watson stat		1.296860
Prob(F-statistic)	0.000000			

Data analysis before and after the restriction of NPP fertilizer subsidies on agricultural production revealed interesting findings. Before the restriction (2018-2021), Table 3 indicated that the NPP coefficient was -0.087108 (SE = 0.112396). However, the t-statistic (-0.775013) and p-value (0.4411) suggested that NPP's effect on agricultural production was not statistically significant. This model explained approximately 96.30% of the variability in agricultural production (R-squared = 0.963030). Following the restriction (2018-2022), the NPP coefficient was 0.022407 (SE = 0.110034). The t-statistic (0.203635) and p-value (0.8391) again indicated that NPP did not significantly influence agricultural production during this period. The model maintained a high explanatory power, accounting for about 94.61% of the variability in agricultural production (R-squared = 0.946070). Thus, the analysis suggests that restricting NPP fertilizer subsidies did not significantly impact agricultural production before or after implementation. While the overall regression models demonstrated statistical significance, the NPP variable itself did not contribute significantly to changes in agricultural production within the analyzed data.

4.3. Super Phosphate 36 (SP-36) Fertilizer Subsidy Restriction on Agricultural Production

The impact of restricting subsidies for Super Phosphate 36 on agricultural production requires careful examination within the framework of agricultural policy and sustainability. Super Phosphate 36 is crucial as a phosphate fertilizer in enhancing soil fertility and promoting plant growth. The following findings, derived from panel data analysis, warrant consideration when evaluating the potential consequences of subsidy restrictions for Super Phosphate 36 on agricultural output:

Table 4. Result of Panel Data Regression Before and After Restriction of Subsidies for SP-36 on Agricultural Production

Data Sample: 2018 2021				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.81022	0.377352	31.29758	0.0000
SP36	-0.000363	0.060022	-0.006043	0.9952
R-squared	0.962688	Mean dependent var		11.80795
Adjusted R-squared	0.950059	S.D. dependent var		1.865551
S.E. of regression	0.416902	Akaike info criterion		1.307848
Sum squared resid	11.29749	Schwarz criterion		1.955334
Log likelihood	-34.54533	Hannan-Quinn criteria.		1.568704
F-statistic	76.23031	Durbin-Watson stat		1.517233
Prob(F-statistic)	0.000000			
Data Sample: 2018-2022				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.68190	0.207161	56.39039	0.0000
SP36	0.020407	0.034915	0.584465	0.5604
R-squared	0.946255	Mean dependent var		11.80000
Adjusted R-squared	0.932664	S.D. dependent var		1.845749
S.E. of regression	0.478955	Akaike info criterion		1.549190
Sum squared resid	19.95764	Schwarz criterion		2.113836
Log likelihood	-62.20547	Hannan-Quinn criteria.		1.778214
F-statistic	69.62535	Durbin-Watson stat		1.300517
Prob(F-statistic)	0.000000			

This study utilized panel data to examine the effects of Super Phosphate 36 (SP-36) subsidy restrictions on agricultural production across two distinct periods. In the pre-restriction phase (2018-2021), the SP-36 coefficient was -0.000363 (SE: 0.060022), with a t-statistic of -0.006043 and a probability of 0.9952, indicating no significant influence on agricultural production. The regression model demonstrated high explanatory power, with an R-squared of 0.962688, accounting for 96.27% of the variability in agricultural production. During the post-restriction period (2018-2022), the SP-36 coefficient was 0.020407 (SE: 0.034915), with a t-statistic of 0.584465 and a probability of 0.5604, again suggesting no significant impact on agricultural production. The model maintained high explanatory power, with an R-squared of 0.946255, explaining 94.63% of the variability in agricultural production. The panel data analysis results indicate that SP-36 subsidy restrictions did not significantly affect agricultural production in either period. Despite the overall significance of the regression models, the SP-36 variable did not substantially contribute to changes in agricultural production during the observed timeframes.

Fertilizer subsidy restrictions can significantly affect the agricultural sector and the broader economy. Governments often implement these subsidies to support farmers by providing affordable or free fertilizers, aiming to reduce input costs, enhance productivity, and improve farmers' welfare. The impacts of subsidy restrictions can vary considerably depending on factors such as fertilizer type, crop variety, and farmers' economic and social conditions. These findings highlight the complex relationship between fertilizer subsidies, agricultural productivity, and sustainable farming practices. Policymakers must carefully consider the economic implications of subsidy reductions concerning long-term environmental and food security objectives when formulating agricultural policies. The specific findings regarding the impacts of fertilizer subsidy restrictions are presented in the referenced Table 5.

Table 5. Result of Before and After Fertilizer Subsidy Restriction on Agricultural Production

Data Sample: 2018-2021				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.30122	1.151994	8.942078	0.0000

UREA	0.549469	0.222005	2.475027	0.0160
NPP	-0.405387	0.169609	-2.390130	0.0198
SP36	0.040369	0.061913	0.652035	0.5168
R-squared	0.966340	Mean dependent var		11.80795
Adjusted R-squared	0.953517	S.D. dependent var		1.865551
S.E. of regression	0.402212	Akaike info criterion		1.250304
Sum squared resid	10.19179	Schwarz criterion		1.954093
Log likelihood	-30.01339	Hannan-Quinn criteria.		1.533843
F-statistic	75.36025	Durbin-Watson stat		1.507397
Prob(F-statistic)	0.000000			

Data Sample: 2018-2022

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.62244	0.924682	11.48768	0.0000
UREA	0.359815	0.183402	1.961888	0.0530
NPP	-0.241104	0.169191	-1.425042	0.1578
SP36	0.031454	0.035919	0.875669	0.3837
R-squared	0.948587	Mean dependent var		11.80000
Adjusted R-squared	0.934070	S.D. dependent var		1.845749
S.E. of regression	0.473929	Akaike info criterion		1.541199
Sum squared resid	19.09177	Schwarz criterion		2.154945
Log likelihood	-59.76596	Hannan-Quinn criteria.		1.790138
F-statistic	65.34471	Durbin-Watson stat		1.251597
Prob(F-statistic)	0.000000			

Table 5 illustrates the impact of fertilizer subsidy restrictions on agricultural production across two time periods. Before implementing UREA fertilizer subsidy restrictions, a statistically significant positive correlation was observed between UREA usage and agricultural output. Specifically, a one-unit increase in UREA corresponded to a 0.549469 unit increase in agricultural production ($p < 0.05$). Conversely, the restriction on NPP fertilizer subsidies demonstrated a significant negative impact, with each unit increase in NPP resulting in a 0.405387 decrease in agricultural production ($p < 0.05$). However, the restriction on SP36 fertilizer subsidies did not yield a statistically significant impact on agricultural production ($p > 0.05$). The regression model accounted for 96.63% of the variability in agricultural production, with the F-statistic's p-value indicating overall model significance.

During the 2018-2022 period, following the implementation of subsidy restrictions, the impact of UREA fertilizer on agricultural production remained positive but approached the threshold of statistical significance. Each unit increase in UREA corresponded to a 0.359815 increase in agricultural production ($p \approx 0.05$). In contrast, neither NPP nor SP36 fertilizer subsidy restrictions significantly impacted agricultural production during this period ($p > 0.05$ for both). The regression model for this period explained 94.86% of the variability in agricultural production, with the F-statistic's p-value again indicating overall model significance. Comparing the two periods reveals a shift in the impact of fertilizer subsidy restrictions. UREA maintained a positive influence on agricultural production across both periods, although its statistical significance decreased in the latter period. The NPP fertilizer subsidy restriction transitioned from having a significant negative impact in 2018-2021 to a non-significant impact in 2018-2022. The SP36 fertilizer subsidy restriction consistently showed no significant impact on agricultural production in either period. These findings suggest that implementing fertilizer subsidy restrictions altered the relationship between fertilizer usage and agricultural production, with UREA retaining a positive influence and NPP's negative impact diminishing over time.

5. Discussion

The impact of government policies on fertilizer subsidies is crucial in determining agricultural sustainability and economic development (Guo et al., 2021). These subsidies are designed to reduce input costs for farmers and increase crop yields, thereby enhancing agricultural productivity and rural livelihoods (McArthur & McCord, 2017). However, restricting such subsidies can significantly change agricultural outcomes and economic impacts (Lencucha et al., 2020; Van Kooten et al., 2018; Wunderlich & Kohler, 2022). This analysis examines the effects of policy measures on agricultural production, focusing on the impacts of Urea, NPP, and SP-36 fertilizers over two distinct periods. During the pre-subsidy restriction period (2018-2021), Urea fertilizer demonstrated a statistically significant positive effect on agricultural production, highlighting its effectiveness in boosting crop yields under subsidized conditions. However, in the subsequent period (2018-2022), although Urea continued to influence production positively, the statistical significance of its impact decreased. This suggests that factors external to the subsidy program may have altered Urea's efficacy in enhancing agricultural output.

In contrast, NPP fertilizer significantly negatively impacted agricultural production before the subsidy restrictions were implemented, indicating that subsidized NPP adversely affected crop yields during that timeframe. Following the subsidy restrictions, this negative impact became statistically non-significant, implying that farmers potentially adjusted their agricultural practices or adopted alternative input strategies in response to changes in subsidy availability. SP-36 fertilizer did not significantly impact agricultural production in either period studied, suggesting that its influence on crop yields may be less pronounced compared to Urea and NPP fertilizers. This observation highlights the variability in how different fertilizer types interact with agricultural systems and responds to policy adjustments. This analysis underscores the dynamic nature of agricultural inputs and their complex interactions with policy interventions. It emphasizes the importance of carefully managing fertilizer subsidy policies to optimize agricultural productivity while ensuring sustainable economic and environmental outcomes. These insights are invaluable for policymakers and stakeholders seeking to support resilient agricultural systems and foster sustainable development in rural areas. By understanding these dynamics, policymakers can better navigate the complexities of agricultural policy to promote long-term agricultural sustainability and economic growth.

6. Conclusion

This study concludes that the implementation of fertilizer subsidy restrictions has significantly altered the impact of subsidized fertilizers on agricultural production in Aceh. Prior to the restrictions, subsidized Urea had a significant positive impact on agricultural production, while subsidized NPP had a negative effect. Subsidized SP-36 did not demonstrate a significant influence. However, following the implementation of restrictions, the positive impact of subsidized Urea diminished, and subsidized NPP ceased to have a significant effect, resulting in decreased agricultural productivity. Subsidized SP-36 continued to show no significant impact. The consistent significant impact of fertilizer subsidies on agricultural production underscores the importance of refining subsidy policies to optimize productivity. To address the issue of fertilizer scarcity resulting from restrictions and subsidy withdrawals, it is crucial to enhance the capacity of farmer groups as both producers and consumers of organic fertilizers. This can be achieved through training programs, guidance on environmentally friendly organic fertilizer production methods, and the provision of fertilizer processing equipment.

Implications and Recommendations: Stakeholders in Aceh's agricultural sector should carefully consider factors related to the restriction of NPP, Urea, and SP-36 fertilizer subsidies when formulating policy and implementing strategies aimed at enhancing agricultural production. The restrictions or withdrawal of fertilizer subsidies warrant re-evaluation, given that nearly all agricultural commodities, particularly export-quality plantation crops that significantly contribute to the country's foreign exchange, depend on fertilization. To mitigate fertilizer scarcity resulting from subsidy restrictions and withdrawals, it is essential to bolster the capacity of farmer groups as both producers and consumers of organic fertilizers. This can be accomplished through training initiatives, guidance on environmentally friendly organic fertilizer production methods, and the provision of fertilizer processing equipment. Further research is necessary to identify additional factors influencing agricultural production outcomes, thereby enhancing the understanding of agricultural production dynamics in Aceh. A more comprehensive analysis of variables related to NPP, Urea, and SP-36 fertilizer subsidy restrictions should be conducted to determine their specific contributions. This will provide more precise insights into the impact of these subsidy policies on agricultural productivity and sustainability in the region.

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