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Public Agricultural Spending on Cowpea and Soybean Yields in Cameroon: Implications for Productivity and Sustainable Development

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Abstract

This study examines the impact of public agricultural spending on cowpea and soybean yields in Cameroon from 2000 to 2024, using time series data and Ordinary Least Squares (OLS) analysis. The results indicate that public agricultural spending, land use, agricultural labour, and fertilizer use explain 82% and 96% of the variation in soybean and cowpea yields, respectively. Findings reveal a positive and significant relationship between agricultural labour and yields for both crops, highlighting the importance of labour-intensive farming practices. Additionally, increased public agricultural spending significantly enhances cowpea yields, emphasizing the critical role of government investment in agriculture. Conversely, a 30% decrease in public spending would likely reduce yields due to diminished access to essential inputs and services. The study underscores the need for sustained public support and efficient labour use to boost agricultural productivity in Cameroon.

Keywords: cowpea yield, soybean yield, public agricultural spending, Cameroon agriculture, crop productivity.

JEL Classification: C53, E23, O11, O40, Q18, R15.

Introduction

Public agricultural spending plays a crucial role in boosting agricultural productivity in Cameroon, especially for staple crops like Cowpea, and Soybean. Government investments in agricultural infrastructure, research, and extension services have been pivotal in improving yields and supporting farmers. Studies have shown that increased public spending on agriculture positively impacts crop productivity by providing better access to inputs, technologies, and knowledge (World Bank, 2020).

For instance, in Cameroon, investments in agricultural research and development have significantly contributed to improved varieties of cowpea, and soybean, which are more resilient to pests and diseases, leading to higher yields (FAO, 2018). Furthermore, government subsidies on fertilizers and seeds have enabled farmers to adopt modern farming practices, directly enhancing the productivity of these crops (Cameroon Ministry of Agriculture, 2019).

Despite these advancements, the effectiveness of public agricultural spending is often constrained by challenges such as inadequate infrastructure, poor extension services, and limited access to credit for smallholder farmers (Njankoua, 2021). Therefore, while public spending has generally improved yields for cowpea, soybean, and beans, its full potential is yet to be realized, necessitating more targeted and efficient allocation of resources.

Conducting a study on the responses of cowpea, and soybean yields to public agricultural spending in Cameroon is crucial for several reasons. First, these crops are essential for food security and nutrition in the country, providing a significant source of protein and income for many households, particularly in rural areas (FAO, 2021). Understanding how government spending affects their productivity can help policymakers design more effective interventions to improve food security and reduce poverty.

Second, Cameroon's agricultural sector faces numerous challenges, including low productivity and limited access to modern farming inputs and technologies (World Bank, 2020). Public agricultural spending is intended to address these challenges by funding research and development, infrastructure, and extension services. However, there is a need to assess whether this spending is achieving its intended outcomes, especially for key crops like cowpea, and soybean, which are vital for the livelihoods of smallholder farmers (Ngobeni & Chiedza, 2022).

Additionally, by analysing the specific impacts of public spending on these crops, the study can identify gaps and inefficiencies in resource allocation. This can inform more targeted investments, ensuring that government funds are used effectively to boost productivity and sustainability in the agricultural sector (Cameroon Ministry of Agriculture, 2019). Moreover, as Cameroon aims to achieve the United Nations Sustainable Development Goals (SDGs), particularly those related to zero hunger and poverty reduction, it is essential to evaluate the role of public agricultural spending in supporting these goals (UNDP, 2020).

Focusing on the responses of cowpea, and soybean yields to public agricultural spending in Cameroon is not only relevant but also necessary for guiding policy decisions and enhancing the country's agricultural development.

1. Literature Review

Theoretical framework

The relationship between public agricultural spending and crop yields can be explained through the framework of agricultural production theory, particularly the input-output model. In this context, public agricultural spending serves as an essential input that enhances the availability of resources, such as improved seeds, fertilizers, extension services, and infrastructure, which are crucial for increasing agricultural productivity. According to this theory, increased government spending on agriculture should lead to higher output (i.e., crop yields) by improving the efficiency and effectiveness of farming practices (Schultz, 1964; Adegboye & Akinyele, 2022). In many developing countries, including Cameroon, the agricultural sector faces numerous challenges, such as low productivity, lack of access to credit, and inadequate infrastructure. Public spending in agriculture is essential to address these market failures by providing public goods such as research and development, extension services, and rural infrastructure (World Bank, 2020).

According to the theory of agricultural growth, public investments in agriculture can lead to increased productivity through several channels. First, spending on agricultural research and development leads to the creation of improved crop varieties that are more resistant to pests, diseases, and climatic variations. Second, investments in extension services ensure that farmers adopt new technologies and practices, thereby increasing their productivity. Finally, public spending on infrastructure such as roads, irrigation, and storage facilities reduces transaction costs and post-harvest losses, which directly impacts yields and farm incomes (Schultz, 1964; Evenson & Pray, 1991).

Public spending on agricultural research and development (R&D) is particularly significant, as it generates new technologies and farming methods that improve crop resilience to pests, diseases, and environmental stresses. This is especially important for crops like cowpea, soybean, and beans, which are vital for food security in Cameroon. The theory of induced innovation posits that government interventions, such as subsidies and investments in agricultural R&D, can lead to technological innovations that enhance crop productivity (Hayami & Ruttan, 1985).

In the context of cowpea, and soybean, public investments can enhance the availability and affordability of improved seeds, fertilizers, and other inputs, leading to higher yields. Additionally, government-funded programs that promote sustainable farming practices can help maintain soil fertility and reduce environmental degradation, further supporting productivity growth (FAO, 2018). Several empirical studies have examined the impact of public agricultural spending on crop yields, both globally and within the African context. In a study by Fan et al. (2008), public spending on agriculture was found to have a significant positive impact on agricultural productivity and poverty reduction in developing countries, including those in Africa. The study highlights the importance of government investments in rural infrastructure, agricultural research, and extension services in boosting crop yields. Moreover, a cross-country analysis by Mogues et al. (2012) found that public spending on agriculture had a significant impact on agricultural productivity in Sub-Saharan Africa, including Cameroon. The study concluded that investments in agricultural research, extension services, and infrastructure were critical for improving yields of crops like cowpea and soybean. However, the study also highlighted the importance of addressing governance issues to ensure the efficient use of public funds.

Another study by Nkamleu et al. (2010) focused on the impact of agricultural spending on food security in Cameroon. The findings revealed that public investments in agricultural extension services and input subsidies positively influenced the productivity of staple crops like beans, contributing to enhanced food security. The study also emphasized the need for better-targeted spending to maximize the impact on crop yields.

2. Research Methodology

Study area

Cameroon, located in Central Africa, is geographically positioned between latitudes 2° and 13°N and longitudes 8° and 16°E. It shares borders with Nigeria to the west, Chad to the northeast, the Central African Republic to the east, and Equatorial Guinea, Gabon, and the Republic of the Congo to the south. The country extends from the Atlantic Ocean coastline in the southwest to the more arid regions in the north, offering a diverse range of climatic zones from equatorial rainforests to savannahs and semi-arid landscapes (Neba, 1999). Cameroon's diverse geographical landscape supports a range of agricultural activities, with maize being a dominant staple crop and rice gaining importance, particularly in the irrigated zones. The variability in climatic conditions across the country significantly influences the distribution and productivity of these crops.

Data sources

Annual time series data covering a period of 24 years (2000-2023) were obtained from secondary sources. Specifically, data for public agricultural spending were obtained from the ministry of agriculture and rural development; data on land, fertilizer consumption, Soybean and Cowpea yields were obtained from the FAO website; data on agricultural labour were obtained from international labour organization.

Techniques of data analysis

Augmented Dickey fuller test, Breusch-Godfrey Serial Correlation LM Test and ordinary least square were used to analyse the data.

Model specification

Ordinary Least Squares (OLS) is widely used in time series analysis, especially after confirming stationarity, because it provides several advantages in estimating the relationships between variables. According to Wooldridge (2013), OLS estimators are best linear unbiased estimators (BLUE) under the Gauss-Markov assumptions, which include homoscedasticity and no autocorrelation, conditions that are more likely met in stationary series. In non-stationary series, autocorrelation (correlation of a variable with its past values) often violates OLS assumptions, leading to inefficient and biased estimates. However, once stationarity is achieved, the autocorrelation structure of the time series is more stable, allowing OLS to provide more accurate and efficient estimates (Enders, 2014). Following Djomo et al. (2022), the effect of public agricultural research and development expenditure can be specified as follow:

$$Soybean/Cowpea\ Yields_t = \beta_0 + \beta_1 Public\ Agricultural\ Spending_t + \beta_2 Fertilizer_t + \beta_3 Labour_t + \beta_4 Land_t + \varepsilon_t \quad (1)$$

where: soybean/cowpea yield is measured in metric tons; public agricultural spending is measured in FCFA; fertilizer is measured in kg/ha; labour is measured by the number of people involved into agriculture; and land is measured in hectares of cultivated surface.

3. Results and Discussion

Responses of cowpea and soybean yields to public agricultural spending in Cameroon

The findings of the responses of Cowpea and Soybean yields to public agricultural spending is shown in Table 1. The coefficients of determination (R^2) for Soybean and Cowpea yields equations are 0.82 and 0.96 respectively indicating that 82% and 96% of the variation in Soybean and Cowpea yields respectively are explained by public agricultural spending, Land Use, Agricultural Labour, and Fertilizer Use. For Soybean yield equation, the positive and significant relationship between agricultural labour and soybean yield implies that as the amount of labour employed in soybean cultivation increases, the yield of soybean also increases. This suggests that labour-intensive farming practices are beneficial for soybean production, likely because more labour allows for better crop management, including timely planting, weeding, and harvesting (Sadiq et al., 2021). The availability of sufficient labour may also facilitate the adoption of more precise and careful farming techniques, leading to higher productivity (Adeoye & Oni, 2020). This finding indicates that policies aimed at improving labour availability or efficiency could have a direct positive impact on soybean yields. For the Cowpea yield equation, the positive and significant relationship between Cowpea yield and public agricultural spending implies that increased government investment in agriculture, such as through subsidies, research, and infrastructure development, leads to higher cowpea yields. This underscores the importance of sustained public support in enhancing agricultural productivity (Eke & Onyekwere, 2020). The positive relationship with land use indicates that expanding the area under cowpea cultivation, possibly through land allocation reforms or better land management practices, results in increased yield. Furthermore, the positive and significant relationship with agricultural labour suggests that, similar to Soybean, Cowpea production benefits from labour-intensive farming practices. This finding supports the argument for policies that promote labour availability and efficiency in rural farming communities (Umeh & Nwachukwu, 2018).

Table 1. The responses of Cowpea and Soybean yields to public agricultural spending in Cameroon

Variables	Soybean Yield		Cowpea Yield	
	Coefficient	t-Statistic	Coefficient	t-Statistic
Public agricultural spending	0.02	0.32	0.08***	3.87
Land Use	3.33	1.09	5.28***	4.83
Agricultural Labour	1.49***	3.06	0.72***	4.14
Fertilizer Use	-0.47*	-1.77	-0.14	-1.48
C	-41.42	-1.29	-56.88	-4.94
R-squared	0.82		0.96	
Adjusted R-squared	0.78		0.95	
S.E. of regression	0.17		0.06	
Sum squared resid	0.56		0.07	
Log likelihood	10.87		35.49	
F-statistic	21.99		135.02	
Prob(F-statistic)	0.000001		0.000000	
Mean dependent var	9.21		11.83	
S.D. dependent var	0.372		0.30	
Akaike info criterion	-0.48		-2.54	
Schwarz criterion	-0.24		-2.29	
Hannan-Quinn criterion	-0.42		-2.47	
Durbin-Watson stat	1.510		1.63	

Notes: ***, and * are significant respectively at 1% and 10% respectively. Source: Data analysis, 2024

Breusch-Godfrey Serial Correlation LM Test

The Breusch-Godfrey Serial Correlation LM test presented in Table 2 shows that there is no Serial Correlation for both Soybean and Cowpea yields equation.

Table 2. Breusch-Godfrey Serial Correlation LM Test

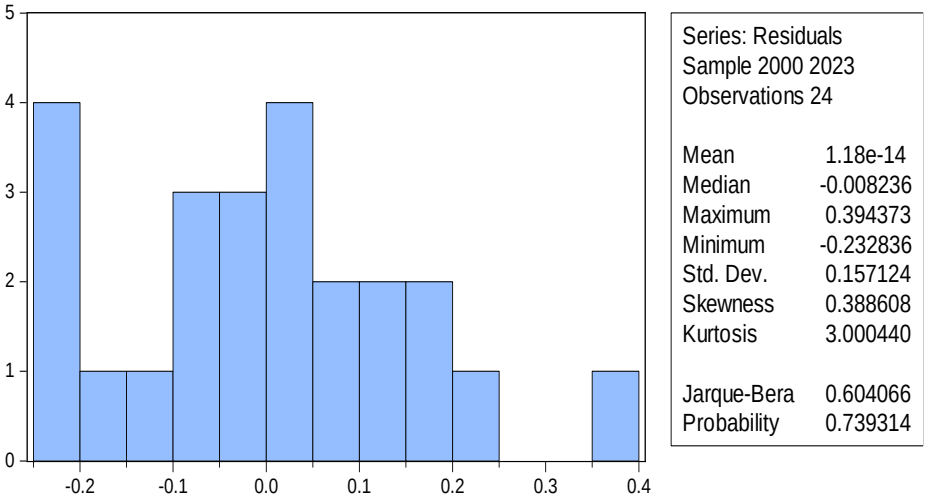
	Soybean yield	Cowpea yield
F-statistic	1.27	0.34
Obs*R squared	1.58	0.44
Prob. F(1,18)	0.27	0.56
Prob. Chi-Square(1)	0.20	0.50

Source: Data analysis, 2024

Normality Test

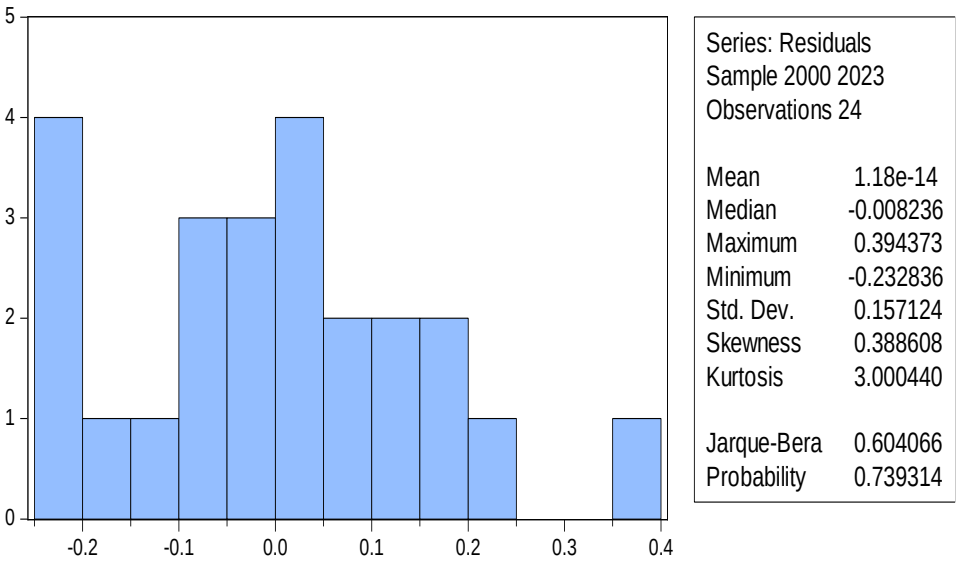
The normality test presented in Figures 1 and 2 shows that the sets equations for Soybean and Cowpea yields are normally distributed.

Figure 1. Normality test for Soybean yield equation



Source: Data analysis, 2024

Figure 2. Normality test for Cowpea yield equation



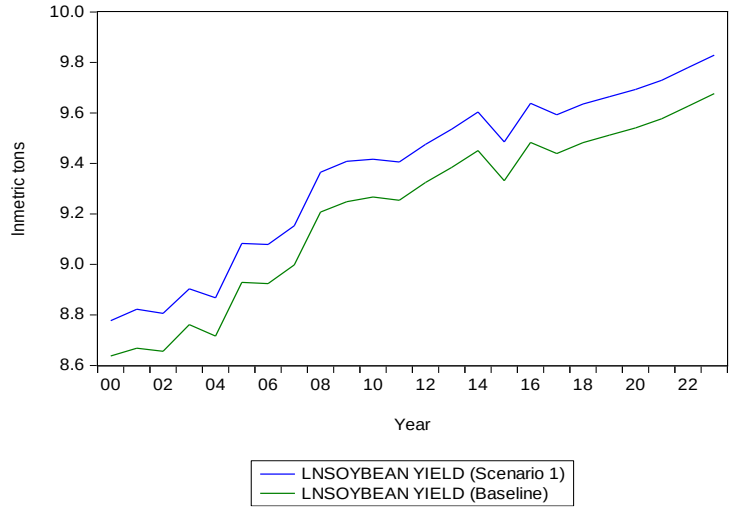
Source: Data analysis, 2024

Responses of Cowpea and Soybean yields to 30% changes in public agricultural spending

The responses of cowpea and soybean to 30% changes in public agricultural spending presented in Figures 3, 4, 5 and 6 highlight the critical role of government investment in supporting agricultural productivity. A 30% increase in public agricultural spending (Figures 3 and 4) is likely to lead to significant improvements in both cowpea and soybean yields. This is because increased public spending typically enhances the availability of agricultural inputs, such as improved seeds, fertilizers, and modern farming equipment, which are essential for boosting crop productivity (Omonona & Oyekale, 2018).

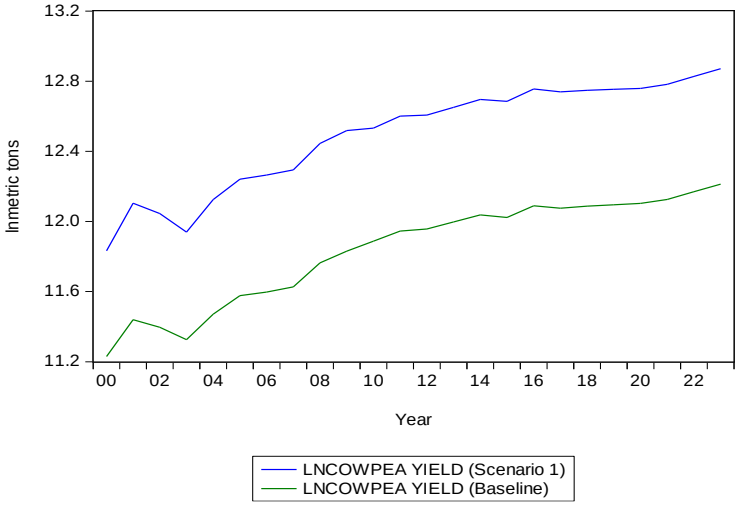
Additionally, higher public expenditure often results in better access to agricultural extension services, research and development, and infrastructure improvements like irrigation and roads, all of which contribute to higher yields (Olomola, 2020). Therefore, a substantial increase in public agricultural spending would likely translate into higher yields for both cowpea and soybean as farmers gain access to better resources and knowledge.

Figure 3. Response of Soybean yield to 30% increase in public agricultural spending



Source: Data analysis, 2024

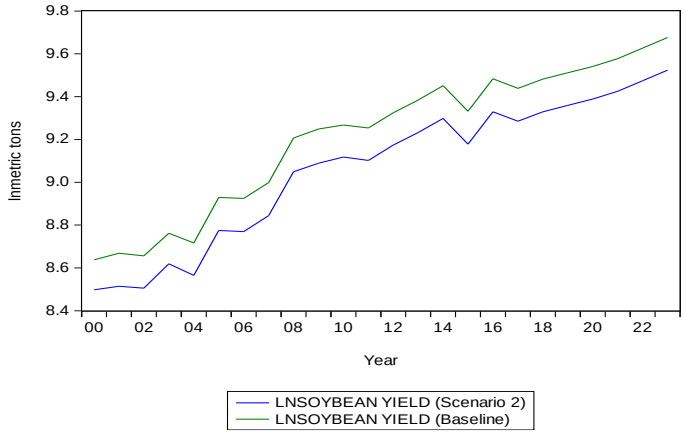
Figure 4. Response of Cowpea yield to 30% increase in public agricultural spending



Source: Data analysis, 2024

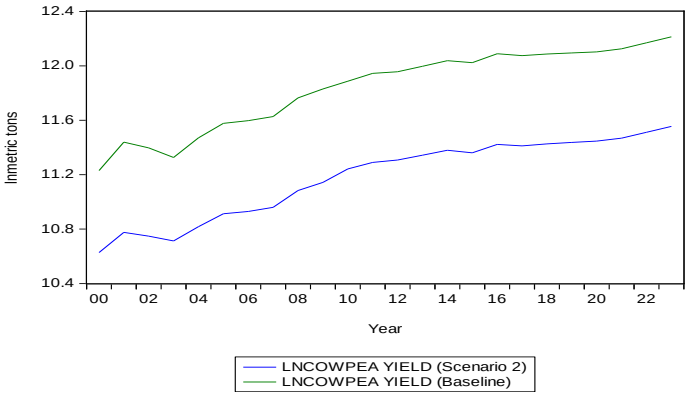
Conversely, a 30% decrease in public agricultural spending (Figures 5 and Figure 6) would likely have a detrimental impact on cowpea and soybean yields. Reduced government investment could lead to a decline in the availability of critical agricultural inputs and services, thereby limiting farmers' capacity to maintain or enhance productivity (Eboh, 2019). For instance, a cut in public spending might reduce the distribution of subsidies or limit the reach of extension services, both of which are vital for ensuring that farmers can access the necessary inputs and knowledge to optimize their yields. This decrease in support would likely result in lower yields for both crops, as farmers struggle to cope with reduced access to essential resources and support systems (Ajibefun, 2021).

Figure 5: Response of Soybean yield to 30% decrease in public agricultural spending



Source: Data analysis, 2024

Figure 6. Response of Cowpea yield to 30% decrease in public agricultural spending



Source: Data analysis, 2024

The summary statistics of the scenarios of increasing and decreasing public agricultural spending is presented in Table 3. Scenario 1 implies the increase in public agricultural spending while scenario 2 implies the decrease in public agricultural spending.

Table 3. Summary statistics

	Soybean Yield			Cowpea Yield		
	Baseline	Scenario 1	Scenario 2	Baseline	Scenario 1	Scenario 2
Mean	9.212388	9.364540	9.060234	11.83599	12.49222	11.17976
Median	9.296015	9.446082	9.145948	11.95115	12.60346	11.29884
Maximum	9.676347	9.829015	9.523679	12.21316	12.87161	11.55471
Minimum	8.637470	8.777150	8.497790	11.23020	11.83263	10.62777
Std. Dev.	0.338100	0.339669	0.336573	0.300289	0.308482	0.292937
Skewness	-0.503941	-0.515478	-0.492785	-0.610082	-0.702031	-0.524342
Kurtosis	1.878633	1.892232	1.866306	1.987148	2.199011	1.803313
Jarque-Bera	2.273288	2.290020	2.256608	2.514670	2.612973	2.531798
Probability	0.320894	0.318221	0.323582	0.284411	0.270770	0.281986
Sum	221.0973	224.7490	217.4456	284.0637	299.8132	268.3143
Sum Sq. Dev.	2.629165	2.653629	2.605476	2.073990	2.188704	1.973671
Observations	24	24	24	24	24	24

Source: Authors' compilation

Conclusion and Recommendations

The study on the responses of cowpea and soybean yields to public agricultural spending in Cameroon from 2000 to 2024 reveals significant insights into the determinants of agricultural productivity. The high coefficients of determination (R^2 values of 0.82 for Soybean and 0.96 for Cowpea) indicate that public agricultural spending, land use, agricultural labour, and fertilizer use are critical factors explaining the variations in yields for these crops. The findings suggest that both cowpea and soybean yields are positively influenced by increased public agricultural spending and agricultural labour, underscoring the importance of government investment and labour-intensive practices in enhancing crop productivity. The study also highlights the potential adverse effects of reduced public agricultural spending, which could lead to lower yields due to decreased access to essential inputs and services. It is recommended that:

- Given the positive impact of public agricultural spending on both Cowpea and Soybean yields, the government of Cameroon should consider increasing its investment in the agricultural sector. This could include funding for subsidies, research and development, infrastructure improvements, and extension services to support farmers.
- Since labour-intensive farming practices are beneficial for both Soybean and Cowpea production, policies aimed at improving labour availability and efficiency should be prioritized. This could involve training programs, mechanization support, and incentives to retain labour in rural farming communities.
- The positive relationship between land use and Cowpea yield suggests that expanding and optimizing land use is crucial. Land allocation reforms, sustainable farming practices, and better land management strategies should be encouraged to maximize agricultural output.
- The findings indicate that improper fertilizer use may negatively impact Soybean yields. It is essential to provide farmers with guidance on the appropriate types and quantities of fertilizer to use, tailored to specific crops and local soil conditions, to avoid nutrient imbalances and maximize productivity.
- To prevent fluctuations in crop yields, it is crucial to stabilize agricultural funding. The government should avoid cuts in public agricultural spending, as such reductions can significantly harm productivity by limiting farmers' access to necessary resources and services.

Credit Authorship Contribution Statement

First author was responsible for the conceptualization, project administration, supervision and writing. Second author was responsible review and editing and the third author was responsible for the formal analysis. All the authors were involved in data curation, investigation, methodology, visualization, writing – original draft.

Conflict of Interest Statement

We, the authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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