Effect of Fertilizer Subsidy Expenditure on Agricultural Growth in Tanzania, 1995-2024

Noah G. Sikwese[1*], Lutengano Mwinuka[2] and Joel J. Mmasa[2]

Abstract: *Agricultural inputs are critical aspects for improving agricultural productivity and production. This paper analyses how fertilizer subsidy expenditure has impacted on agricultural growth in Tanzania from 1995 to 2024. The study used time series data utilizing Autoregressive Distributed Lag model mechanism with short-run and long-run dynamics. The data were analysed using the Augmented Dickey-Fuller unit test and the F-bound test for cointegration, revealing the existence of a long-run and short-run relationship necessary for Error Collection Model. The results indicate that for a unit percentage increase in fertilizer subsidies expenditure significantly reduces the growth percentage by 4.25 in a long run even though in short-run fertilizer subsidies expenditure has significant positive effects on agricultural growth as measured by GDP at 5 per cent level of significance due to inefficiency, misallocation, or crowding out of other agricultural investments such as irrigation schemes. Therefore, fertilizer subsidy expenditure should be correlated with advancements in agricultural technology, improvements in seeds, coordination of agro-dealers on timely distribution of fertilizer and the strengthening of research and development in the agricultural sector. The study recommends that financing for fertilizer subsidy programs should be linked with other factors of production, including agricultural technology, improved seeds, and strengthened research and development.*

Keywords: Public Expenditure, Fertilizer Subsidy, Economic Growth, Agriculture Sector.

JEL classification: Q18, Q12, H53, O13, N57, Q16

1.0 Introduction

The agricultural factors of production, including land, capital, labour, and agricultural inputs, are vital aspects in stimulating agricultural production, reducing rural poverty, and enhancing agricultural growth (Mogues, 2012). Globally, agricultural performance and growth depend on the inputs used in its productivity (FAO, 2020). Fertilizer is among the key important inputs in agricultural production, enhancing the increment of agricultural productivity (Gilbert &Jayne, 2017).

Worldwide, the use of fertilizer is increasing at a rapid rate due to low productivity of crop production. Thus, there is a correlation between the application of fertilizer in crop

[1]*Planning and Coordination Division, Rungwe District Council.*
[2]*Department of Economics, The University of Dodoma*
[*] *Correspondence E-mail: sikwese076@yahoo.co.uk*

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

production and its productivity (FAO, 2020). African countries, especially those in sub-Saharan Africa, spend 23per cent on input subsidy programs to ensure food availability and food security (FAO, 2021). Thus, fertilizer subsidy programs in Africa play a significant role in increasing agricultural productivity and stimulating economic growth (Stefan et al., 2017).

Subsidies for agricultural inputs, coupled with public investments in agricultural infrastructure such as irrigation systems, warehouses, marketing facilities, and market systems, enhance agricultural productivity and consequently foster economic growth (Zafar et al., 2023). Public spending on agricultural inputs such as fertilizer facilitate the increase in agricultural output, thereby promoting agricultural sector growth and contributing to the national economy. This, in turn, triggers a trickle-down effect to other sectors of production (FAO, 2020). Figure 1 presents the association of the pattern between agricultural expenditure and expenditure in fertilizer subsidy.

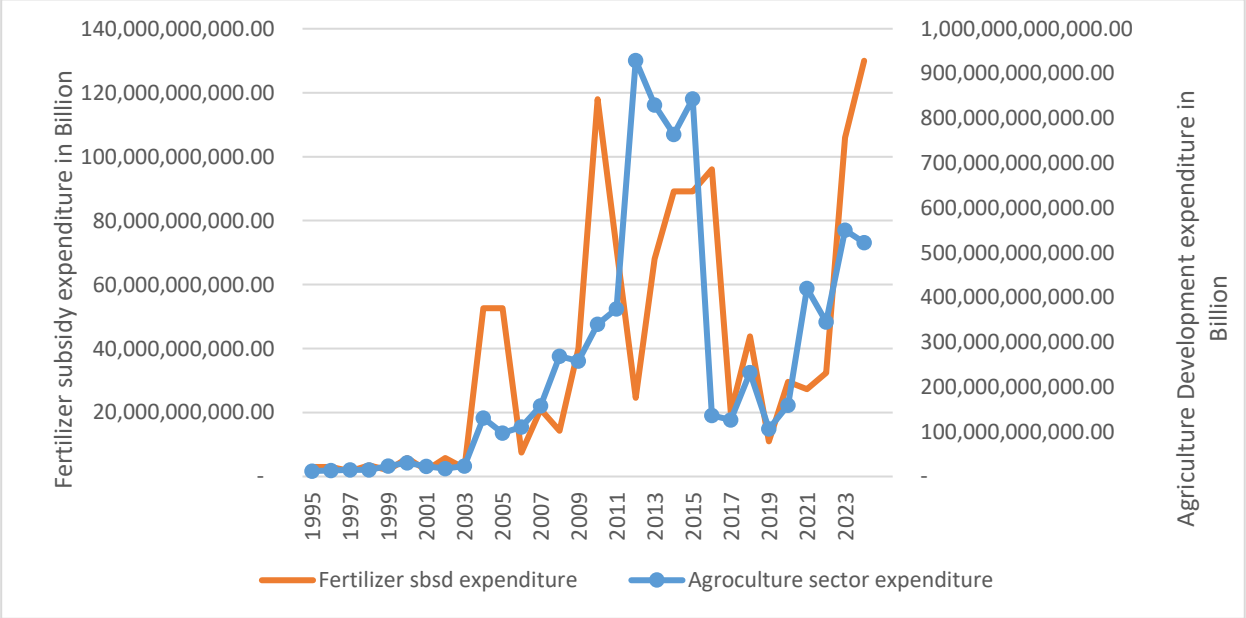


Figure 1: Trend of the Agriculture Expenditure vs Expenditure in Fertilizer Subsidy

Public expenditure in the agricultural sector is essential for promoting and enhancing agricultural growth. Both recurrent and development agricultural activities stimulated by public expenditure contribute to increased agricultural productivity and, consequently, economic growth (Benin et al., 2009). In Tanzania, the agricultural sector contributes 26.2per cent to Gross Domestic Product (GDP), provides 65per cent of industrial raw materials, and employs approximately 65.6per cent of the national labour force. Additionally, the sector enhances food reserves, reaching about 114per cent in 2022. The agricultural sector has been recognized as the backbone of Tanzania's economy since independence (URT, 2023b).

The Tanzanian Government promotes the use of fertilizer in both cash and food crop production, alongside encouraging the use of improved seeds to enhance crop production. Fertilizer application is coupled with soil testing to determine the proper requirements of fertilizer according to the ecological soil zone. Soil testing is considered as a critical aspect before the application of fertilizer in crop production (URT, 2023b). Additionally, the Tanzanian Government has established a fertilizer subsidy program to promote the performance and growth of the agricultural sector. This program aims to stimulate and encourage more Tanzanians to participate fully in agricultural sector productivity, both in food and cash crops production, through collaborations between the government and private sectors (URT, 2023a).

Recognizing the issue of low utilization of fertilizer application in agricultural production, the Tanzanian Government has undertaken efforts to promote and facilitate a fertilizer subsidy program throughout the country. For instance, an average fertilizer use by a farmer is 10 kg fertilizer per hectare in Tanzania, which is lower than the amount of fertiliser used by Malawian farmers who use 27 kg per hectare and Chinese farmers who use 279 kg per hectare. In this regard, fertilizer subsidy programme of accelerating agricultural productivity is vital. National Agricultural Input Voucher Scheme (NAIVS) was established in 2009 to enhance crop production, ensure food security and increase exportation. Recently, the Tanzanian Government integrated subsidized fertilizer with bulk procurement system and engage a wide range of stakeholders such as farmers, cooperatives, agro-dealers, and Local Government Authorities.

The system allows private sectors to broaden the supply and distribution of fertilizer subsidy to curb shortage of fertilizer particularly in remote areas hence increase productivity (URT, 2017). The system aimed to increase agricultural production, control food inflation, and ensure food availability. Tanzania has introduced and implemented this subsidy program to ensure that, all farmers have access to fertilizers and can fully engage in agricultural activities. The overarching goal is to increase agricultural production, reduce rural poverty, and stimulate agricultural growth (URT, 2022). Figure 2 presents the comparative trend between the agricultural activity growth and fertilizer subsidy expenditure.

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

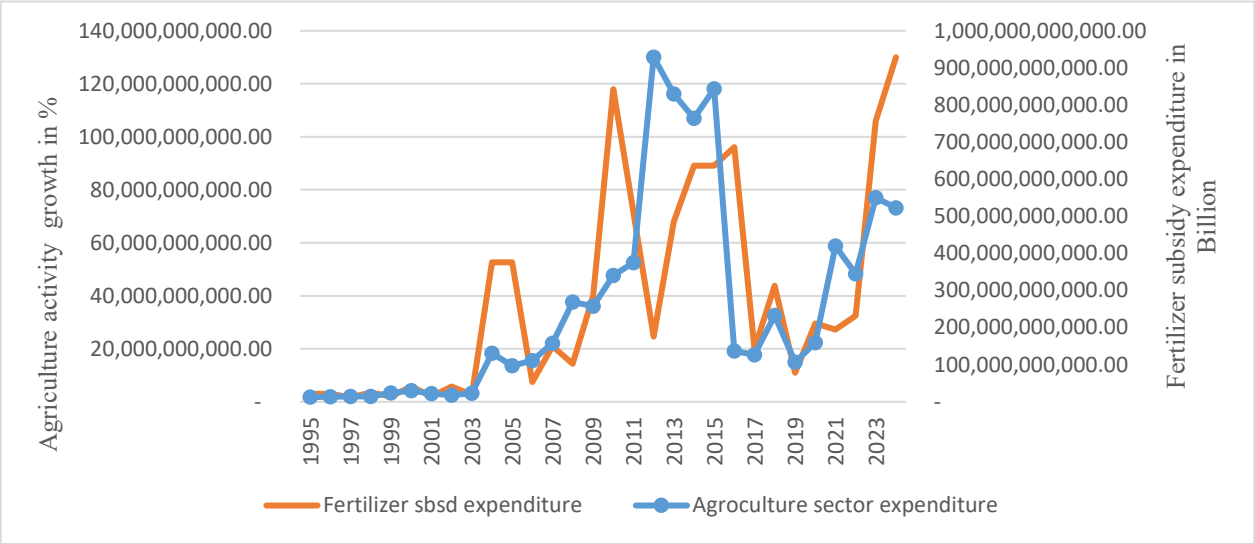


Figure 2: Trend of the Agriculture Activity Growth vs Fertilizer Subsidy Expenditure

2.0 Theoretical and Conceptual Perspective

The study is grounded in various theories related to budgetary processes and economic growth. These theories include Jones and McCaffrery's (1994) work, Musgrave and Rostow's (1989) incrementalism budgetary theory, as well as Jones's (2019) endogenous growth theory. Additionally, the study draws from empirical studies examining public expenditure on the agricultural sector.

The theory of the budgetary process, developed by Jones and McCaffery (1994), emphasizes a structured approach to budgeting that aligns with the financial plan for a given year. The theory promotes budgetary stability by focusing on incremental choices over time. This theory is highly relevant to Tanzania, as it underscores the need for the government to prioritize funding for the agricultural sector based on its strategic importance to economic development.

It was also argued by Musgrave and Musgrave (1989) that, the government plays a pivotal role in fostering development by directing substantial investments toward productive sectors and infrastructure. Increased government spending on essential infrastructure and sectors such as agriculture can propel the economy to higher levels of growth and development.

Additionally, the public expenditure theory, attributed to Paul Romer (1990, as cited in Jones, 2019), highlights the importance of increasing public investment in knowledge, human capital, and physical infrastructure to boost sectoral productivity. Public

expenditure is a critical driver in enhancing the performance of productive sectors such as agriculture. Greater government investment in these areas amplifies their contribution to overall economic growth.

These theories provide insight into the relationship between public expenditure on agriculture and its influence on economic growth, particularly concerning the contribution of agriculture to the GDP. The current study investigates the relationship between public expenditure on agriculture, which is treated as the independent variable, and its impact on agricultural growth, which is considered as the dependent variable. By leveraging these theoretical frameworks and empirical evidence, the study seeks to provide a comprehensive understanding of how public investment in the agricultural sector affects overall economic growth, particularly through its contributions to the GDP.

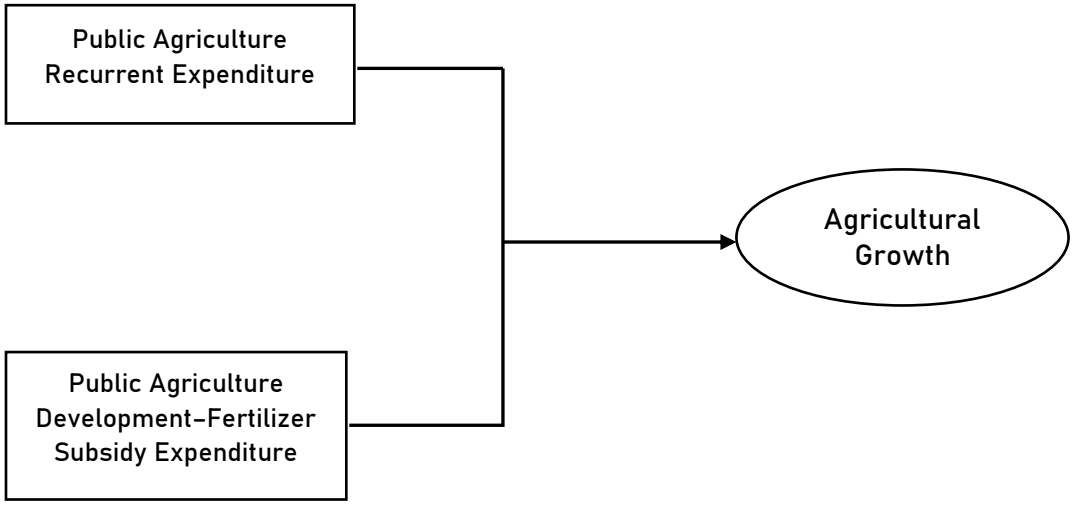


Figure 3: Conceptual Framework

3.0 Methodology

3.1 Methods and Data Collection

The study employed time series data covering 30 years from the financial year1994/95 to 2023/24 on public expenditure on agriculture, both recurrent and development, including the specific fertilizer subsidy expenditure, were collected. These data were published by the Ministry of Finance and Planning and the Ministry of Agriculture and National Bureau of Statistics. To analyse the relationship between independent and dependent variables, the study used the Error Correction Model (ECM) for allowing for a comprehensive examination of the factors influencing the outcomes of the topic under investigation.

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

3.2 Unit Root Test

Time series data often exhibit characteristics such as varying mean, variance, and covariance over time, indicating the presence of a Unit Root. This implies a non-stationary process, which can render the data unstable for forecasting or lead to spurious regression if not properly addressed. To assess the stationarity of the series, each series was tested with the Augmented Dickey Fuller (ADF) test, including optimal lags selected by AIC to control for autocorrelation. This test helps to determine whether a unit root is present in the data and whether the series can be considered stationary, which is crucial for conducting accurate analyses and making reliable forecasts.
The test specification for ADF is as follows:

$$\Delta Y_t = \beta_0 + (\rho - 1)Y_{t-1} + \sum_{i=1}^{m} \Delta Y_{t-i} + u_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

If $(\rho - 1) = 0$ meaning statistically not significantly different from zero it implies that $\rho = 1$ and then we fail to reject the null hypotheses of the presence of unit root problem (Y_t series is not-stationary).

3.3 Autoregressive Distribution Lags (ARDL) Approach

The Autoregressive Distribution Lags approach was adopted to capture the first model involving public agriculture recurrent expenditure, agricultural development investment expenditure and agricultural growth. Then after the second model was split into irrigation, research and development, and fertilizer subsidy expenditure.

The First Model:

$$\begin{aligned}\Delta Agr_gdp_t = {} & \alpha_0 + \alpha_{11} Agr_gdp_{t-1} + \alpha_{21} Agr_rcrnt_{t-1} + \alpha_{31} Agr_dvlp_{t-i} \\ & + \sum_{i=1}^{p} \alpha_{4i} \Delta Agr_gdp_{t-i} + \sum_{i=0}^{q_1} \alpha_{5i} \Delta Agr_rcrnt_{t-i} + \sum_{i=0}^{q_2} \alpha_{6i} \Delta Agr_dvlp_{t-i} \\ & + e_{1t} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)\end{aligned}$$

The Second Model:

$$\begin{aligned}\Delta Agr_gdp_t = {} & \gamma_0 + \gamma_{11} Agr_gdp_{t-1} + \gamma_{21} Agr_rcrnt_{t-1} + \gamma_{31} lnirrgtn_{t-i} + \gamma_{41} lnR\&D_{t-i} \\ & + \sum_{i=1}^{p} \gamma_{5i} \Delta Agr_gdp_{t-i} + \sum_{i=0}^{q_1} \gamma_{6i} \Delta Agr_rcrnt_{t-i} + \sum_{i=0}^{q_2} \gamma_{7i} \Delta lnirrgtn_{t-i} \\ & + \sum_{i=0}^{q_2} \gamma_{8i} \Delta lnR\&D_{t-i} + \sum_{i=0}^{q_2} \gamma_{8i} lnfertliser\&subs_{t-i}\, e_{+1t} \dots\dots\dots\dots\dots\dots\dots\dots (3)\end{aligned}$$

Where p and q_i are selected lags, α_0 *and* γ_0 are the interrupts, e_{1t} is the white noise term. The remaining coefficients describe short-run and long-run relations. Since $\alpha_{11}, \alpha_{21}, and\ \alpha_{31}$ for the first model matching long-run coefficients

while $\gamma_{11}, \gamma_{21}, \gamma_{31}\ and\ \gamma_{41}$ for the second model matching long-run coefficients, the short-run effects are captured by the coefficients for the first differenced variables such as, $\alpha_{4i}, \alpha_{5i}\ and\ \alpha_{6i}$ in Model I while $\gamma_{5i}, \gamma_{6i}, \gamma_{7i}\ and\ \gamma_{8i}$are the corresponding short-run coefficients for Model II respectively. The point as to why other independent variables in their level forms are in lags instead of contemporaneous is because during the long-run $Y_{t-i} = Y_t\ and\ X_{t-i} = X_t$ all the indicators were in their steady states that did not change.

3.4 F-Bounds Test for Cointegration

In this study, to explore the existence of a long-run linear relationship between the variables of interest, the F-Bounds Test for Co-integration by Pesaran, Shin, and Smith (2001) was employed. This test helps to determine if the series are co-integrated, regardless of whether their integration orders are homogeneous or not. This is in contrast to Johansen's co-integration test, which requires all series to be integrated of order one (I(1)).

By utilizing the F-Bounds Test for Co-integration, it becomes possible to test a combination of I(0) and I(1) series for co-integration. This flexibility enables the application of the Error Correction Mechanism (ECM) if the series are co-integrated or use a short-run Autoregressive Distributed Lag Model (ARDL) if series are not co-integrated. Thus, this approach allows for a comprehensive analysis of both long-run and short-run relationships between the variables under investigation.

The F-Bounds test for co-integration conditional on ARDL (p, q) can be expressed as follows;

Hypothesis:

$$H_0: \alpha_{1i} = \alpha_{2i} = 0, \quad \text{(Where, } i = 1, 2\text{)}$$
$$H_1: \alpha_{1i} \neq \alpha_{2i} \neq 0$$

$$\Delta Y_t = \alpha_{01} + \alpha_{11} Y_{t-1} + \alpha_{21} X_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta X_{t-i} + e_{1t} \dots\dots\dots\dots\dots\dots\dots (3)$$

$$\Delta X_t = \alpha_{02} + \alpha_{12} Y_{t-1} + \alpha_{22} X_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=0}^{q_1} \alpha_{2i} \Delta X_{t-i} + e_{2t} \dots\dots\dots\dots\dots\dots\dots (4)$$

In this scenario, if the estimated F-statistic from the bound test is lower than the lower bound I(0) critical value at a given significance level (typically 5%), it indicates that there is no co-integration equation present. Consequently, the analysis would proceed with a short-run model, such as the ARDL model.

On the other hand, if the F-statistic exceeds the upper bound I(1) critical value at the chosen significance level, the null hypothesis is rejected, indicating the existence of a

long-run (co-integration) relationship. This allows for the combination of short-run impacts with the speed of adjustment towards long-run equilibrium through the ECM, as an extension to the ARDL model.

In cases where the F-statistic falls between the lower bound I(0) and upper bound I(1), the test outcome is inconclusive, and further analysis may be required to determine the appropriate model. Moreover, ARDL model approach follows the following settings:

$$Y_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i \Delta Y_{t-i} + \sum_{i=1}^{q_1} \alpha_i \Delta X_{t-i} + \sum_{i=1}^{q_2} \varphi_i \Delta Z_{t-i} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

3.5 Error Correction Model

The model (ECM) was used to capture both short-run and long-run impacts on agricultural-grown contribution to GDP. Given the existence of co-integration, all terms in ECM are now stationary, thus the standard regression techniques with their associated statistical inferences are valid (Green, 2003). The Granger representation theorem (Granger, 1983; Engle & Granger, 1987) states that if a set of variables such as Y_t and X_t are co-integrated, then there exists a valid error correction representation of the data. The ECM under the Autoregressive distributed lag process can be expressed as follows

$$\Delta Y_t = \alpha_0 + \alpha_1 \sum_{i=1}^{p} \Delta Y_{t-i} + \alpha_2 \sum_{i=0}^{q} \Delta X_{t-i} + \delta ECT_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Whereby, α_1: Short-run elasticity of dependent variable on its lagged value,
α_2: Short-run elasticity or effects of other variables and
δ: Speed of adjustment of short-run disequilibrium toward long-run equilibrium.

Also, $ECT_{t-1} = (Y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 X_{t-1})$ considering that in the long-run all the variables are in their steady state regardless of lag length presentation. Though the natures of these budgetary series are subjected to lag effects rather than contemporaneous effects in the short-run, implying that there is no direct effect of $X_t on\, Y_t$ in the same period, the effects of present shocks are realized in the next periods.

In this study, the corresponding model (ECM) equations can be expressed as follows:
The First Model: With Aggregated Agriculture Development Budget

$$\Delta Agr_gdp_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{4i} \Delta Agr_gdp_{t-i} + \sum_{i=0}^{q_1} \alpha_{5i} \Delta Agr_rcrnt_{t-i} + \sum_{i=0}^{q_2} \alpha_{6i} \Delta Agr_dvlp_{t-i} + \delta ECT_{t-1} + e_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The Second Model: With Disaggregated Agriculture Development Budget

$$\Delta Agr_gdp_t = \gamma_0 + \sum_{i=1}^{p} \gamma_{5i} \Delta Agr_gdp_{t-i} + \sum_{i=0}^{q_1} \gamma_{6i} \Delta Agr_rcrnt_{t-i} + \sum_{i=0}^{q_2} \gamma_{7i} \Delta lnirrgtn_{t-i} + \sum_{i=0}^{q_2} \gamma_{8i} \Delta lnR\&D_{t-i} + \sum_{i=0}^{q_2} \gamma_{8i} lnfertlisersubs_{t-i} + \varphi ECT_{t-1} + e_{1t} \ldots (8)$$

Where δ *and* φ are the corresponding speeds of adjustment terms toward long-run equilibrium for the respective Model I and Model II.

3.5. Diagnostic Checks

To obtain robust results, the diagnostic checks were done to ensure all necessary preferred conditions for the suggested models are adhered such as serial correlation by Breusch-Godfrey, Test for heteroskedasticity through Cameron and Trivedi's decomposition IM-test, and Cumulative Sum (CUSUM) test for parameter stability on the estimated model.

Table 1. Description of Key Variables

Variable	Description
Agr_gdp	Agriculture contribution to GDP (in percent)
Agr_rcrnt	Recurrent expenditure in agriculture (Tanzania shilling in billion)
$lnirrgtn$	Irrigation expenditure in agriculture (Tanzania shilling in billion)
$lnR\&D$	Research and development in agriculture (Tanzania shilling in billion)
$lnfertlisersubs$	Agriculture fertilizer subsidy expenditure (Tanzania shilling in billion)
ECT	Error Correction Term

4.0 Results and Discussion

4.1. Unit Root Test

The ADF was used to determine the series of characteristics of the variables used. Table 2 reports that the unit root test of agricultural recurrent expenditure is stationary *I(0)* while agricultural growth, irrigation, research and development, fertilizer subsidy were not stationary at their levels but become stationary and integrated of order one *I(I)* where by in absolute values, their T-statistics are greater than the critical value at 5per cent level of significance.

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

Table 2: Results of Unit Root Test

Variables	Levels		First Difference		Integration Order
	Test Statistics	Critical Value	Test Statistics	Critical Value	
Agr_gdp	-2.048	-2.989	-5.215***	-2.992	I(1)
Agr_rcrnt	-4.054***	-2.989	-8.586***	-2.992	I(0)
$lnirrgtn$	-1.944	-2.989	-8.708***	-2.992	I(1)
$lnR\&D$	-1.960	-2.989	-6.397***	-2.997	I(1)
$lnfertliser\&subs$	-2.080	-2.989	-8.085***	-2.992	I(1)

Source: Author's Calculations from Data

Note: ** "0.05" and *** "0.01" indicates the rejection regions of null hypothesis at respective levels of significance

4.2. Co-integration Results

Given the fact that the series were integrated of different orders such as the combination of I(0) and I(1) from ADF unit root test statistics, then the next step was to check whether the series were bound together in the long-run or simply whether there were any long-run relationships among the series by using Bounds co-integration test developed by Pesaran, Shin and Smith (2001). This was done through ARDL approach, which can even serve the purpose of error correction model for different lag length and different integration order compared to the Vector Autoregressive (VAR) approach such as Vector Error Correction Mechanism (VECM). As a rule of thumb, co-integration analysis requires an optimal homogeneous lag length through the selection criteria. On this case, with Autoregressive Distributed Lag ARDL mechanism, which allows multiple lag length, the test was done by using Akaike Information Criteria (AIC) and Schwarz Bayesian Information Criteria (SBIC) where the optimal lags for the first and second Models.

The first model lags were 1, 2, 0 where by GDP 1, agricultural recurrent expenditure 2 and agricultural investment expenditure 0. In the second Model lags were 2, 0, 2, 2, 3 where by GDP 2, agricultural recurrent expenditure 0, irrigation expenditure 2, research and development 2 and fertilize subsidy expenditure 3. In addition, there was extension in the second model where agricultural development investment expenditure was split into irrigation expenditure, research and development and fertilize subsidy expenditure respectively. Therefore, the Bounds co-integration test was employed by using these optimal lags lengths and the test results are displayed on Table 3 for Model I and Table 4 for Model II.

Table 3: F-Bounds Test for Co-integration Model I

Null Hypothesis	F-Statistic	Critical Value		t-Statistic	Critical Value	
		Lower bound $I(0)$	Upper bound $I(1)$		Lower bound $I(0)$	Upper bound $I(1)$
$k = 2$	5.032***	3.79	4.85	-3.549***	-2.86	-3.53

Source: Author's Calculations from Data
Note: ** and *** indicate the rejection regions of null hypothesis at 0.05 and 0.01 levels of significance, respectively.

Based on Table 3, the Bounds test of co-integration on the Model indicates the existence of a long-run relationship between the series, given that, the model's F-statistic is greater than the critical values of the lower and upper bounds (i.e. $I(0)$ & $I(1)$) at 0.05 level of significance. However, the case on t-statistic is indecisive since the test statistic lay between the lower and upper bounds but we can rely on F-statistic at 0.05 level of significance enabling us to reject the null hypothesis of no co-integration. This is the case since in the ARDL framework, the F-test is preferred because it jointly tests the significance of the lagged-level coefficients. Moreover, Table 4 reports that fertilizer subsidy has an effect on agricultural growth in a short run, thus, ARDL equation was applied to capture both short-run effects and short-run's disequilibrium speed of adjustment towards a long-run equilibrium, which is called ECM.

Table 4: F-Bounds Test for Co-integration Model II

Null Hypothesis	F-Statistic	Critical Value		t-Statistic	Critical Value	
		Lower bound $I(0)$	Upper bound $I(1)$		Lower bound $I(0)$	Upper bound $I(1)$
$k = 2$	9.848***	2.86	4.01	-3.187	-2.86	-3.99

Source: Author's Calculations from Data
Note: ** and *** indicates the rejection region of null hypothesis at 0.05 and 0.01 level of significance respectively

4.3. Long-run Relationship

In Table 5, the model estimates the results of the ARDL model's long-run relationship coefficients. The significance levels are denoted by symbols such as *, **, and *** representing 5, 2.5, and 1per cent, respectively. The table includes coefficient estimates, standard errors, t-statistics, and p-values. The interpretation for the long-run relationship can be done as follows, given that both coefficients are statistically significant at a 5 per cent level of significance:

i.) If the coefficient is statistically significant and positive, there is a positive long-run relationship between the corresponding variables. This means that an increase in one variable will lead to a proportional increase in the other variable in the long run.

© 2025 Published by The University of Dodoma https://doi.org/10.58548/2025jaep32.94114

ii.) If a coefficient is statistically significant and negative, there is a negative long-run relationship between the corresponding variables. This implies that an increase in one variable leads to a proportional decrease in the other variable in the long run.

iii.) The p-value associated with each coefficient indicates the probability of observing such a relationship by chance if the true coefficient were zero. A p-value less than the chosen significance level (e.g., 0.05) suggests that, the coefficient is statistically significant and provides evidence against the null hypothesis of no relationship.

Therefore, based on the statistically significant coefficients in Table 4, one can interpret the direction and strength of the long-run relationship between the variables under consideration, thus, providing valuable insights into the dynamics of the system being studied.

Table 5: Long-run Relationships

Variables	Agr_gdp			
	Coefficient	**Stand. error**	**t**	**P>|t|**
Agr_rcrnt	0.1469*	0.0714	2.06	0.064
$lnirrgtn$	10.9822*	5.4184	2.03	0.068
$lnR\&D$	-9.0801**	3.5387	-2.57	0.026
$fertliser\&subs$	-4.2457***	1.1334	-3.75	0.003
Cons	68.1195	69.6496	0.98	0.349

Source: Author's Calculations from Data

It was revealed that, on average, for a unit percentage increase in agricultural expenditure on fertilizer and subsidies reduces growth percentage points by 4.2457 ceteris paribus. This is the case since the estimated coefficient is statistically significant with P-values less than 0.05. Also, the coefficient of research and development is statistically significant at 5 per cent level but it is negatively related to agricultural growth entailing, on average, a unit percentage increase in research and development reduces agricultural growth by 9.0801 percentage points ceteris paribus. Moreover, at 10 per cent level of significance agricultural recurrent and irrigation expenditures have a positive effect on agricultural growth. This implies that on average, a unit percentage point increase in agricultural recurrent expenditure ratio to its budget will increase agricultural growth by 0.1469 per cent ceteris paribus. Also, a unit percentage increase in irrigation expenditure is associated with 10.98 per cent increase in agricultural growth since their P-values is less than critical 0.10.

4.4. Estimates of Short-run Coefficients and Long-run Dynamics

Table 6 provides estimates of short-run coefficients and the speed of adjustment towards the long-run equilibrium as per any short-run distortions. In this case, the lagged first difference coefficient of research and development expenditure as well as the lagged first and second difference coefficients of fertilizer expenditures are statistically significantly different from zero at a 5 per cent level. This implies that,

research and development expenditure have positive short-run effects on agricultural growth, also fertilizer and subsidies expenditure have positive effects on agricultural growth ceteris paribus. Moreover, the coefficient of error term which measures the speed of adjustment is negative and statistically significant at 5 per cent level and lays between 0 and -1, which is a good correction of short run shocks. This means that, all short-run shocks can be absorbed back to long-run equilibrium and the model will not explode.

Table 6: Short-run Relations

Variables	$First\ Difference\ of\ Agr_gdp$			
	Coefficient	**Stand. error**	**t**	**P>|t|**
ECT_{t-1}	-0. 6611***	0.2075	-3.19	0.009
ΔAgr_gdp_{t-1}	0.2416	0.2141	1.13	0.283
ΔAgr_rcrnt_t	0.0971	0.0332	2.92	0.014
$\Delta lnR\&D_t$	-1.9226	1.1345	-1.69	0.118
$\Delta lnR\&D_{t-1}$	4.7596***	1.5090	3.15	0.009
$\Delta lnirrgtn_t$	0.0049	1.354	0.00	0.997
$\Delta lnirrgtn_{t-1}$	-2.2906*	1.1169	-2.05	0.065
$\Delta lnfertliser\&subs_t$	-1.3018	1.4484	-0.90	0.388
$\Delta lnfertliser\&subs_{t-1}$	5.7857***	1.2926	4.48	0.001
$\Delta lnfertliser\&subs_{t-2}$	2.8462***	0.8882	3.20	0.008
No. of obs	25			
R-Squared	0.7773			

Source: Author's Calculations from Data

Note: ** "0.05" and *** "0.01" indicates the rejection regions of null hypothesis at respective levels of significance

4.5. Diagnostic Tests

In Model post-estimation tests for heteroskedasticity, serial correlation, and parameter stability of the model showed that the estimates were robust with no serial correlation. The Durbin-Watson *d*-statistic being 2.0972 compared to the critical values (upper and lower bounds), which is supported by Breusch-Godfrey LM test for autocorrelation up to higher order of three, revealed statistically insignificant results, which implies that, the null hypothesis of no serial correlation cannot be rejected (Table 7).

Table 7: Breusch-Godfrey LM test for Autocorrelation

Lags(p)	Chi2	Degree of freedom	Prob > chi2
1	25.00	24	0.4058
2	11.28	13	0.5872
3	1.17	1	0.2796

Source: Author's Calculations from Data

Note: ** and *** indicates the rejection region of null hypothesis at 0.05 and 0.01 level of significance respectively

$$H_0: No\ serial\ correlation$$

© 2025 Published by The University of Dodoma https://doi.org/10.58548/2025jaep32.94114

In this regard, the test statistics are not statistically significant given their P-values are greater than 0.05, which implies the null hypothesis of no serial correlation cannot be rejected (Table 7). Furthermore, the test statistic shows that the model has constant variance (Homoscedasticity) provided the test statistic of Breusch-Pagan/Cook-Weisberg test for heteroscedasticity as well as Cameron and Trivedi's decomposition of IM-test being not statistically significantly different from zero, hence the null hypothesis of constant variance cannot be rejected, which implies that there is no heteroscedasticity problem supported also by white's test for heteroscedasticity (Table 8).

Table8: Cameron & Trivedi's decomposition of IM-test

Source	Chi2	Degree of freedom	Prob > chi2
Heteroskedasticity	25.00	24	0.4058
Skewness	11.28	13	0.5872
Kurtosis	1.17	1	0.2796
Total	**37.45**	**38**	**0.4947**

Source: Author's Calculations from Data

Note: ** and *** indicates the rejection region of null hypothesis at 0.05 and 0.01 level of significance respectively

$$H_0: Homoskedasticity$$

Based on Table 8, the general test statistics for a null hypothesis in favour of homoscedasticity showing that it is not significant at 5per cent level since the P-values are greater than 0.05, this implies that the null hypothesis cannot be rejected and hence the model has constant variance. Furthermore, post estimation check for model II was processed through the test for model stability using cumulative sum plot, which shows to be stable within confidence intervals at 95 percent indicating that there is no structure brake. Table 9 and Figure 4 present the rejection of null hypothesis since the test statistic is less than critical values at 5per cent level and implies no structure break.

Table 9: Cumulative Sum (CUSUM) Test for Parameter Stability

Statistic	Test Statistics	1% Critical Value	5% Critical Value	10% Critical Value
OLS	0.4874	1.6276	1.3581	1.224
Number of observations		25		

Source: Author's Calculations from Data

Note: ** and *** indicates the rejection region of null hypothesis at 0.05 and 0.01 level of significance respectively

$$H_0: No\ structural\ break$$

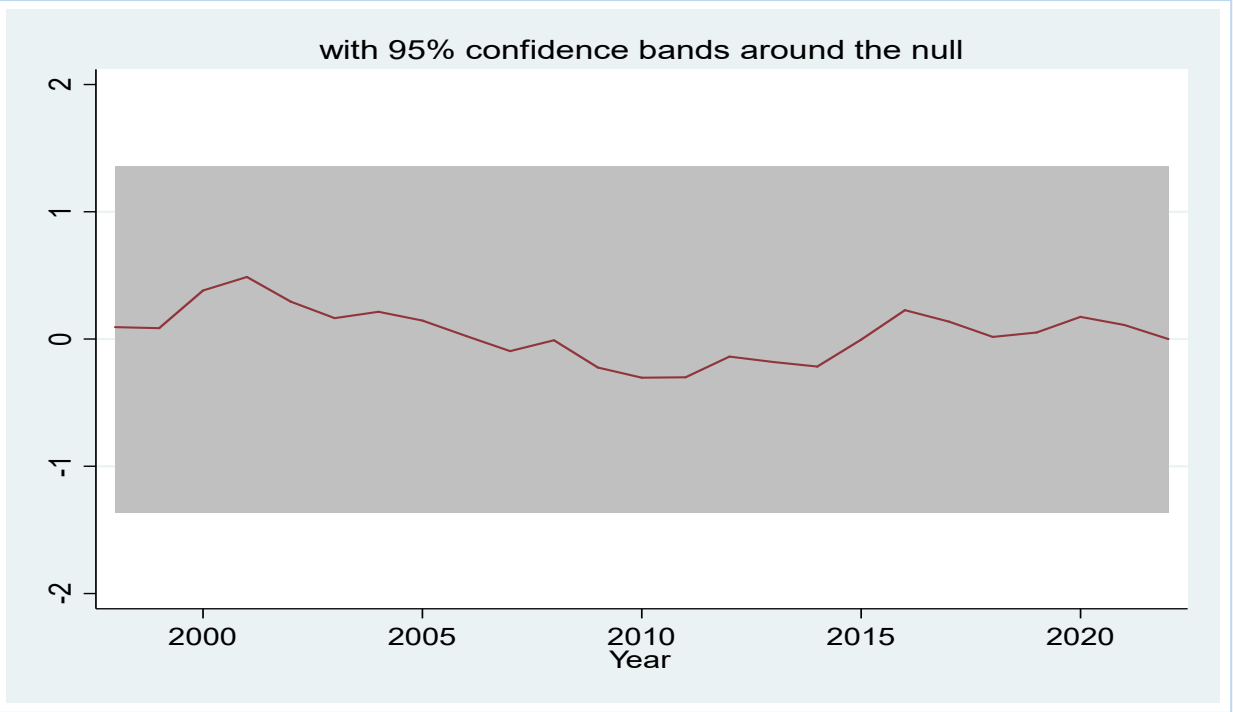


Figure 4: Models Cumulative Sum (CUSUM) Plot for Parameter Stability

4.6 Discussion

Public financing in the agricultural sector plays a significant role in enhancing agricultural productivity and fostering agricultural growth. These findings align with the conclusions drawn by Sikwese et al. (2022), who found that public expenditure facilitates agricultural growth by implementing various recurrent and development interventions within the sector.

Moreover, public investment in fertilizer subsidy programs attracts many farmers to participate in both food and cash crop production. This initiative not only increases agricultural productivity but also improves the welfare of farmers and promotes national food security (URT, 2023b).

However, it is worth noting the contrasting findings highlighted by Yovo (2018), who discovered that while public expenditure has a positive impact on agricultural growth, it has a negative impact on fertilizer subsidy. This underscores the complexity of the relationship between public financing and agricultural outcomes, suggesting the need for further research and nuanced policy considerations in this area.

Furthermore, the study reveals that public expenditure on agricultural input subsidies plays a crucial role in increasing agricultural production, controlling agricultural crop prices, and enhancing food availability and security. This observation is supported by Gilbert et al. (2013), who found that input subsidy programs led to a reduction in maize prices in Malawi and Zambia. However, there is a contrasting perspective highlighted by Yovo and Ganiyou (2023), suggesting that while public agricultural expenditure has a positive trickle-down effect on agricultural growth, this effect is not observed with fertilizer subsidies.

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

In the context of developing countries such as Tanzania, public expenditure on agricultural inputs is deemed essential as it ensures food security and helps to control food inflation. As evidenced by URT (2022), the Tanzanian Government facilitated the distribution of 347,985 tons of fertilizer through subsidy programs, amounting to TZS 348,659,843,486.00 benefiting approximately 790,922 farmers across the country. These findings underscore the significance of targeted public expenditure in promoting agricultural growth and food security, while also highlighting the importance of considering the diverse impacts of different types of agricultural subsidies.

Additionally, the study highlights that public expenditure in the agricultural sector, particularly through fertilizer subsidy programs, has led to increased agricultural productivity and food security, thus promoting agricultural growth (Reuben, 2020). However, these findings contrast with the conclusions drawn by Azuma and Zakaria (2019), who found that fertilizer subsidies have a negative and significant impact on rice productivity.

Moreover, public expenditure on fertilizer subsidy programs ensures that rural farmers have access to fertilizers and can fully participate in agricultural production. This initiative not only increases household agricultural production but also improves the welfare of farmers, thereby reducing rural poverty (URT, 2022). Consequently, increasing cash and food crops production enhances food availability and security, benefiting both farmers and the wider population. These contrasting findings highlight the complexity of the relationship between public expenditure, fertilizer subsidies, and agricultural outcomes. It underscores the need for further research to understand the various factors at play and to inform more effective agricultural policies and interventions.

Moreover, farm input subsidies have a positive impact at the household level by ensuring an increase in food crops production, household food availability, and food security throughout the year, consequently reducing household food poverty (Sibande et al., 2016). Jayne and Rashid (2013) also reported that agricultural input subsidies, especially fertilizer subsidies, increase agricultural production, thereby controlling food prices and alleviating household poverty.

In the context of Tanzania, it is important for fertilizer subsidy programs to be correlated with soil tests based on agricultural ecological zones to ensure the effective utilization of fertilizer towards increasing agricultural production. This argument is supported by the findings of Ashari et al. (2023), who concluded that fertilizer subsidy programs have a positive impact on farmers by providing affordable prices, facilitating increased agricultural production, and guaranteeing farmers' access to fertilizer every season. Additionally, it has been revealed that Savings and Credit Cooperative Societies (SACCOS) play a significant role in increasing agricultural productivity by supplying and guaranteeing farmers' access to agricultural inputs, especially fertilizer. These findings are consistent with the findings in a study by Nlebem and Raji (2019), which found that SACCOS have a positive impact on agricultural inputs.

In alignment with the findings of Zafar et al. (2023), agricultural input subsidies have a positive impact on agricultural productivity, thereby stimulating agricultural growth. Therefore, public-private partnerships in agricultural input subsidies, particularly fertilizer subsidy programs in Tanzania, have the potential to accelerate agricultural productivity and promote food security.

Moreover, Gilbert and Jayne (2016) have confirmed that fertilizer subsidies have a positive impact on maize production in Malawi. The program empowered farmers who benefited from fertilizer subsidy programs to have the capacity to purchase commercial fertilizers, thus stimulating agricultural production.

Additionally, according to Allotey et al. (2019), fertilizer subsidy programs have a significant impact on the relationship between beneficiaries of fertilizer subsidies and maize income in Ghana. This strengthens fertilizer subsidy programs by encouraging majority participation in farming activities for the production of cash and food crops, consequently increasing farmers' income. These studies (i.e., Zafar et al., 2023; Gilbert & Jayne, 2016; Allotey et al., 2019), collectively underscore the importance of fertilizer subsidy programs in enhancing agricultural productivity, improving food security, and increasing farmers' income. They highlight the potential benefits of well-designed and effectively implemented subsidy programs in driving agricultural development and poverty reduction in various contexts.

Furthermore, microfinance institutions can play a significant role in promoting fertilizer subsidy programs and enhancing agricultural performance by guaranteeing input loans, thus increasing agricultural productivity and sector growth (Uremadu et al., 2018). In the context of Tanzania, microfinance institutions and commercial banks have been successful in promoting and guaranteeing farmers' access to agricultural inputs, thereby contributing to agricultural sector growth.

However, the study also revealed that the success of fertilizer subsidy programs in reaching farmers across the country was attributed to 914 active agro dealers who efficiently and timely supply fertilizer to farmers, resulting in increased agricultural production and growth (URT, 2022). These findings contrast with those of Imoru and Ayamga (2015), who found that fertilizer subsidy programs were affected by factors such as farm size, fertilizer subsidy price, and distance to access agro dealers.

Furthermore, the study revealed that 8 regions out of 26 regions of Mbeya, Iringa, Rukwa, Njombe, Ruvuma, Songwe, Kigoma and Kilimanjaro received about 85per cent of fertilizer subsidy and benefited 78.6per cent of farmers country wide increase agricultural production, promote the export of agricultural products hence, ensuring food security (URT, 2024).

Moreover, the study found that the Tanzanian Government collaborates with 28 super agro dealers, 3,263 small agro dealers, and 3 fertilizer manufacturing industries across 26 regions to enhance an increase in food and cash crop production(Matovu & Chamwali, 2024). Additionally, it was emphasized by Upadhyay et al. (2019) that fertilizer price,

© 2025 Published by The University of Dodoma *https://doi.org/10.58548/2025jaep32.94114*

subsidy schemes, and arable land have a positive impact on fertilizer utilization. Thus, collaboration in fertilizer manufacturing, distribution, and supplying contributes to increased agricultural productivity, ensuring food availability and security, and alleviating rural poverty (URT, 2023b). Overall, these findings underscore the importance of effective collaboration between various stakeholders, including government agencies, agro dealers, and financial institutions in promoting fertilizer subsidy programs and enhancing agricultural development and food security.

5.0 Conclusion and Recommendations

The agricultural sector in Tanzania plays a crucial role in economic growth by providing industrial raw materials, employment opportunities, and ensuring food availability and security. Public expenditure in the agricultural sector is therefore essential for achieving agricultural growth and, consequently, overall economic growth. Financing agricultural inputs, specifically through fertilizer subsidy programs, is crucial to facilitating improvements in agricultural production and productivity.

To effectively implement fertilizer subsidy programs and increase the production of food and cash crops, the government should collaborate with private sectors to ensure smooth implementation and efficient utilization of fertilizer subsidy programs. Furthermore, the study recommends that the government should address other factors of production, such as agricultural technology, irrigation infrastructure, and research and development. Enhancing these means of production will contribute to the effective utilization of fertilizer subsidy programs and ultimately leading to higher productivity in agriculture. Tanzania fertilizer subsidy expenditure increased at the rate from TZS 12 billion in 1995 to TZS 130 billion in 2024 with effective supply and distribution of fertilize subsidy from 150,000 tons to 902,194 tons regional wide respectively.

In summary, the government's investment in the agricultural sector, particularly through fertilizer subsidy programs and collaboration with the private sector, is crucial for achieving sustainable agricultural growth and economic development in Tanzania. Additionally, enhancing other factors of production will further improve the effectiveness of fertilizer subsidy programs and contribute to higher agricultural productivity in the country.

References

Allotey, S., Hamza, A. and, & Zakaria, H. (2019). Impact of Fertilizer Subsidy Programme on Maize Income in the Northern Region of Ghana. *American Journal of Biomedical Science and Research*, 5(2), 124–130. https://doi.org/10.34297/AJBSR.2019.05.000884.

Ashari, H., Fahmid, I., Ali, M. and, & Useng, D. (2023). Study of subsidized fertilizer distribution system in Karawang Regency, West Java-Indonesia. *Advanced Zoology*, *44*(4), 300–310. https://doi.org/10.17762/jaz.v44i4.203.

Azuma, S., & Zakaria, A. (2019). Fertilizer subsidy and rice productivity in Ghana: A microeconomic study. *Journal of Agricultural Studies*, *7*(1), 82–102. https://doi.org/10.5296/jas.v7i1.14229.

Benin, S., Mogues, T., & Fan, S. (2009). Public expenditure and agricultural productivity growth in Ghana. In T. Mogues & S. Benin (Eds.), *Public expenditures for agricultural and rural development in Africa* (pp. 26–67). Routledge. https://doi.org/10.4324/9780203157732.

Food and Agriculture Organization of the United Nations (FAO). (2020). *FAO statistical yearbook 2020: World food and agriculture*. https://doi.org/10.4060/cb1329en.

Food and Agriculture Organization of the United Nations (FAO). (2021). P*ublic expenditure on food and agriculture in sub-Saharan Africa: Trends, challenges and priorities.* https://doi.org/10.4060/cb4492en.

Gilbert, J., & Jayne, T. S. (2017). Estimating the enduring effects of fertiliser subsidies on commercial fertiliser demand and maize production: Panel data evidence from Malawi. *Journal of Agricultural Economics*, *68*(1), 70–97. https://doi.org/10.1111/1477-9552.12161.

Gilbert, J., Mason, N. M., Jayne, T. S., & Darko, F. A. (2013). What are the effects of input subsidy programs on equilibrium maize prices? Evidence from Malawi and Zambia. *Agricultural Economics, 44*(6), 671–716. https://doi.org/10.1111/agec.12084.

Imoru, J. A., & Ayamga, M. (2015). Fertilizer subsidy effects on fertilizer use in the northern region of Ghana. *African Journal of Agricultural Research, 10*(53), 4926–4936. https://doi.org/10.5897/AJAR2015.10327.

Jayne, T. S., & Rashid, S. (2013). Input subsidy programs in sub-Saharan Africa: A synthesis of recent evidence. *Agricultural Economics, 44*(6), 547–562. https://doi.org/10.1111/agec.12073.

Matovu, I., & Chamwali, L. (2024). Implementation of subsidized fertiliser programme in Tanzania and its effect on maize productivity in Mbeya Rural, Tanzania. *African Journal of Empirical Research, 6*(1), 658–667. https://doi.org/10.51867/ajernet.6.1.51.

Mogues, T. (2012). *What determines public expenditure allocations? A review of theories, and implications for agricultural public investment* (FAO-ESA Working Paper No. 12-06). Food and Agriculture Organization of the United Nations. http://www.fao.org/3/ap808e/ap808e.pdf.

Musgrave, R., & Musgrave, P., (1989). Public finance in theory and practice (5th ed.). New York: McGraw-Hill Book Co.

Nlebem, B. S., & Raji, W. I. (2019). Impact of agricultural cooperative societies on farmers' productivity and rural transformation in Etche Local Government Area of Rivers State. *Global Scientific Journals, 7*(10), 353–367.

Reuben, A. (2020). *The impact of agricultural public expanditure on agricultural productivity in Nigeria*.

Sibande, L., Bailey, A., & Davidova, S. (2016). The impact of farm input subsidies on household welfare in Malawi. *Agricultural Economics, 48*(2), 197–209. https://doi.org/10.1111/agec.12324.

Sikwese, N., Mmasa, J., & Mwinuka, L. (2022). The effect of recurrent budget expenditure on the growth of agricultural sector in Tanania. *Tanzania Journal of Agricultural Sciences*, *21*(1), 138–148. https://www.ajol.info/index.php/tjags/article/view/234567.

Stefan, K., Kassie, M., & Qaim, M. (2017). The influence of farm input subsidies on the adoption of natural resource management technologies. *Australian Journal of Agricultural and Resource Economics, 61*(4), 539–556. https://doi.org/10.1111/1467-8489.12220.

United Republic of Tanzania (URT). (2017). *Agricultural sector development programme phase two (ASDP II)*. Dodoma, Tanzania: Government Printer.

United Republic of Tanzania (URT). (2022). *Implementation guideline plan on fertilizer subsidy programme 2022/2023*. Dodoma, Tanzania: Government Printer.

United Republic of Tanzania (URT). (2023a). *Mwongozo wa utekelezaji wa mpango wa ruzuku ya mbolea msimu wa 2023/24.* Dodoma, Tanzania: Government Printer.

United Republic of Tanzania (URT). (2023b). *Speech by the Minister for Agriculture, Hon. Hussein Mohamed Bashe (MP), presenting to the National Assembly the estimates of government revenue and expenditure for 2023/2024*. Dodoma, Tanzania: Government Printer.

United Republic of Tanzania (URT). (2024). *Fertilizer subsidy distribution report.* Dodoma, Tanzania: Government Printer.

Upadhyay, N., Bhandari, N., Gairhe, S., Kafle, N., & Sapkota, M. (2019). Fertilizer subsidy policy and its economic implication in Nepal. *The Journal of Agriculture and Environment, 20*, 100–116. https://doi.org/10.3126/aej.v20i0.25045.

Uremadu, S. O., Ariwa, F. O., & Uzochukwu, C. (2018). Impact of government agricultural expenditure on agricultural productivity in Nigeria. *Journal of Applied Economics and Business, 6*(3), 23–36. https://www.aeaweb.org/articles?id=10.1257/j.ae.6.3.23.

United Republic of Tanzania (URT). (2022). *Speech by the Minister for Agriculture, Hon. Hussein Mohamed Bashe (MP), presenting to the National Assembly the estimates of government revenue and expenditure for 2022/2023*. Dodoma, Tanzania: Government Printer.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5, Part 2), S71-S102.

Yovo, K. (2018). Agriculture public expenditures and growth: The case of Togo. *International Journal of Economics and Financial Research, 4*(1), 7–12. https://doi.org/10.32861/ijefr.41.7.12.

Yovo, K., & Ganiyou, I. (2023). Impact of Fertilizer Price Subsidy on Agricultural Growth in Togo. *Applied Economics and Finance, 10*(1), 24–37. https://doi.org/10.11114/aef.v10i1.5864.

Zafar, S., Aarif, M., & Tarique, M. (2023). Input subsidies, public investments and agricultural productivity in India. *Future Business Journal, 9*, Article 54, 1–12. https://doi.org/10.1186/s43093-023-00232-1.