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Research Article

Is Public Financial Resource Allocation to Agriculture Enough to Ensure Sustained Supply of Subsidized Chemical Fertilizer? Evidence from Nepal

Arjun Prasad Khanal[1]*, Rishi Ram Kattel[1], Shiva Chandra Dhakal[1], Ganesh Raj Joshi[1]

[1]Department of Agricultural Economics and Agribusiness Management, Agriculture and Forestry University (AFU), Chitwan, Nepal

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***Corresponding author**
Arjun Prasad Khanal,
Department of agricultural economics and agribusiness management, Agriculture and Forestry University (AFU), Chitwan, Nepal
Email: khanalarjunprasad@gmail.com

Abstract

This study investigates whether public financial resource allocation to agriculture is sufficient to ensure sustained supply of Subsidized Chemical Fertilizer (SCF) in Nepal between 2014 and 2024. Despite a consistent annual average growth (AAGR) of 9.41% in budget allocation to agriculture (BAA), SCF supply exhibited significantly lower growth (3.95% AAGR) and high volatility (Coefficient of Variation = 8.38), indicating a weak coupling between fiscal commitments and actual fertilizer availability. The analysis reveals substantial mismatches, as evidenced by 20.45% budget increase in 2021 coinciding with a 39.91 % decline in SCF supply in the same year, which reflects inefficiencies of government in procurement and distribution of chemical fertilizer. Correlation and elasticity analyses further demonstrate differential responsiveness across the different types of fertilizer. Urea showed a moderate positive correlation (r = 0.50) and potash exhibited a negligible negative correlation (r = -0.03) with BAA. These results suggest that increased public spendings alone does not guarantee a reliable supply of SCF. Hence, policy makers should shift from budget-based targets to quantity-based targets to ensure a sustainable supply of SCF.

Keywords: Budget allocation; growth; elasticity; subsidized chemical fertilizer

Introduction

Agriculture is the oxygen of Nepalese economy, contributing 24.01% of gross domestic product (GDP) and providing employment to 53.6 % of population (Ministry of Agriculture and Livestock Development, 2025). The Government of Nepal (GON) has allocated NRs 57.48 billion to the agriculture sector out of the total projected government expenditure of NRs 1964. 11 billion in the current fiscal year (FY) 2025/26 (Ministry of Finance, 2025). It was around NRs 57.29 billion out of total government expenditure of NRs 1860.30 billion in previous FY 2024/25 (Ministry of Finance, 2024).

The GON has committed to spend NRs 28.82 billion in procurement and distribution of subsidized chemical fertilizer in current FY 2025/26 (Ministry of Agriculture and Livestock Development, 2025). This budget is more than half (50.14 %) of the total budget allocated for agriculture. This clearly reflects that Nepal's government has given high priority to subsidized chemical fertilizer (SCF) in its agricultural budgeting policy. However, the supply of SCF is very low compared to the effective demand of chemical fertilizers in Nepal. According to the Investment Board Nepal (2021) the effective annual demand for chemical fertilizers in Nepal is approximately 700-800 thousand Mt but the GON has been able to supply only 458 thousand Mt in FY 2023/24 (Ministry of Agriculture and Livestock Development, 2025). Nepal is still facing an annual demand-supply gap of approximately 242-342 thousand Mt. This shortage of chemical fertilizer in Nepal's market has boosted the illegal smuggling of chemical fertilizers from the southern porous Nepal- India border (Gautam *et al*., 2022a; Panta, 2018; Bista *et al*., 2016; Shrestha, 2010). In this context, Adhikari (2015) claims that, the main reason behind this is the tendency to allocate a disproportionately low budget to the agriculture sector compared to other sectors by the GON, despite the agriculture sector being the largest contributor of Nepal's GDP. Another reason for the persistent shortage of chemical fertilizer in Nepal is the lack of chemical fertilizer plants in Nepal (Gautam *et al*., 2022a; Panta, 2018) and lack of awareness among farmers for balanced nutrient management (Kishore *et al*., 2021). In this context, this study is focused on examining how critical the budgeting factor is for sustainable chemical fertilizer availability in Nepal through Average Annual Growth Rate (AAGR), Compound Average Growth Rate (CAGR), volatility and elasticity assessment based on evidence generated from historical Budget allocation to Agriculture (BAA) from 2014 to 2024. In simple language, it wants to empirically test whether the budgeting policy issue can solve all problems related to the supply chain of subsidized chemical fertilizer in Nepal.

Materials and Methods

Data Collection

In this study, annual time series data of BAA and supply of SCF in Nepal from 2014 to 2024 were taken. Data on the allocation of budgets allocated in agriculture were collected from the official government of Nepal (GON) annual budget speech published by the Ministry of Finance, Singhadurbar, Kathmandu. Similarly, data on the supply of subsidized chemical fertilizers were collected from the statistical book entitled Statistical Information on Nepalese Agriculture (SINA), which is published annually by the Ministry of Agriculture and Livestock Development (MOALD), Singhdurabar, Kathmandu, Nepal. The time series in these sources is published in the fiscal year (FY) format. For an accurate and consistent assessment of the trends in BAA and SCF, the year in which the FY ends was taken as the time unit. The collected data were analyzed by using Microsoft excel 365 and R version 4.5.1. This study aimed to analyze the growth, elasticity and relationship between BAA and SCF.

Computation of Annual Growth Rates (AGR) and Average Annual Growth Rate (AAGR)

The AGR measures the percentage change in the value of a variable from one year to the next, indicating how much it has increased or decreased over that period. Similarly, AAGR represents the arithmetic mean of year over year percentage changes in variables across multiple periods, providing straightforward measures of its average yearly growth. This arithmetic averaging method aligns with approaches observed in different empirical studies. Kumari *et al*., (2025) adopted it to examine of growth in Indian vegetables production. He *et al*., (2020) used it to calculate the annual growth rate of fertilizer use in China from 2000 to 2007.In this study, year-over-year (YOY) annual growth rates (AGR) were computed for each variable in the following ways:

$$G_t(X) = \frac{X_t - X_{t-1}}{X_{t-1}} \times 100$$

where, $G_t(X)$ is the annual growth rate of the variable (X) in year (t). This was expressed as a percentage.

In this study, the annual growth rate of BAA was estimated as below

$$G_t(BAA) = \frac{BAA_t - BAA_{t-1}}{BAA_{t-1}} \times 100$$

where, $G_t(BAA)$ is the annual growth rate of BAA in year (t).

Similarly, the annual growth rate of SCF was estimated as below

$$G_t(SCF) = \frac{SCF_t - SCF_{t-1}}{SCF_{t-1}} \times 100$$

where, $G_t(SCF)$ is the annual growth rate of SCF in year (t)

Similarly, AAGR is estimated as below:

$$AAGR(X) = \frac{1}{n}\sum_{t=1}^{n} g_t\,(X) = [\frac{X_t - X_{t-1}}{X_{t-1}} \times 100]$$

where, $AAGR(X)$ is the average annual growth rate of variable (X)

In case of BAA, the average annual growth rate is estimated as below

$$AAGR(BAA) = \frac{1}{n}\sum_{t=1}^{n} g_t\,(BAA) = [\frac{BAA_t - BAA_{t-1}}{BAA_{t-1}} \times 100]$$

where, $AAGR(BAA)$ is the average annual growth rate of BAA

Similarly, the average annual growth rate of SCF is estimated as below

$$AAGR(SCF) = \frac{1}{n}\sum_{t=1}^{n} g_t\,(SCF) = [\frac{SCF_t - SCF_{t-1}}{SCF_{t-1}} \times 100]$$

Where, $AAGR(SCF)$ is the average annual growth rate of SCF

Computation of Compound Average Growth Rate (CAGR)

The compound average growth rate (CGAR) is a constant annual growth rate that takes a starting value to an ending value over a given time, assuming that growth is compounded each year. In the context of agricultural research, Rani *et al*. (2017) adopted it to estimate of the compound growth rate of cotton in Bangladesh. Similarly, Joshi *et al.* (2021) computed the annual growth and instability perspectives for major agricultural crops in Nepal.

In this study, the compound average growth rate was estimated as below:

$$CAGR(X) = \left(\frac{X_T}{X_t}\right)^{\frac{1}{T-t}} - 1$$

where, $CAGR(X)$ is the compound average annual growth rate of variable (X) from the initial time (t) to the ending time (T).

In this study, the CGAR of the BAA was estimated as follows.

$$CAGR(BAA) = \left(\frac{BAA_{2014}}{BAA_{2024}}\right)^{\frac{1}{2024-2014}} - 1$$

where, $CAGR(BAA)$ is the compound average growth rate of BAA from 2014 to 2024

Similarly, the CGAR of the SCF was estimated as follows.

$$CAGR(SCF) = \left(\frac{SCF_{2014}}{SCF_{2024}}\right)^{\frac{1}{2024-2014}} - 1$$

where, $CAGR(SCF)$ is the compound average growth rate of SCF from initial time 2014 to 2024

Computation of Growth Volatility

Growth volatility measures how the variable growth rates fluctuate over time. This helps us to understand the degree of stability and instability in growth. This methodology aligns with established practices in agricultural economics. Dhungana *et al*., (2024) computed CV to assess the instability of large cardamomum production in Nepal. Similarly, Joshi *et al*., (2021) analyzed the instability in the area, production and productivity of major crops in Nepal by calculating CV. Karla and Srivastava (2023) examined growth patterns and volatility in soybean cultivation across Indian states, incorporating CV along with other indices

It is estimated as below.

$$CV(X) = \frac{\sigma\big(g_t(X)\big)}{\mu\big(g_t(X)\big)}$$

where, $CV(X)$ is the coefficient of variation of variable (X), $\sigma\big(g_t(X)\big)$ and $\mu\big(g_t(X)\big)$ indicates the standard deviation and mean of the growth rates of variable $\big(g_t(X)\big)$. In this study, we analyze the volatility of the two cases as follows:

Case I: The volatility in the growth of the BAA is estimated as follows:

$$CV(BAA) = \frac{\sigma\big(g_t(BAA)\big)}{\mu\big(g_t(BAA)\big)}$$

where, $CV(BAA)$ is the coefficient of variation of BAA, $\sigma\big(g_t(BAA)\big)$ and $\mu\big(g_t(BAA)\big)$ indicate the standard deviation and mean of the growth rates of variable $\big(g_t(BAA)\big)$.

Case II: The volatility in the growth of the SCF is estimated as follows:

$$CV(SCF) = \frac{\sigma\big(g_t(SCF)\big)}{\mu\big(g_t(SCF)\big)}$$

where, $CV(SCF)$ is the coefficient of variation of SCF, $\sigma\big(g_t(SCF)\big)$ and $\mu\big(g_t(SCF)\big)$ indicate the standard deviation and mean of the growth rates of the variable $\big(g_t(SCF)\big)$. A higher CV value indicates very unstable growth, and a low value of CV indicates stability in growth.

Decomposition of SCF Growth

Decomposition helps us to understand which fertilizer contributes the most to the growth of total fertilizer each year. The method is based on weighted contributions, where each fertilizer's growth rate is weighted by its share in the previous year's contribution to the total supply.

It was estimated as below.

$$Contrib_{i,F} = w_{F,t-1} \times g_t(F)$$

Where, $Contrib_{i,F}$ *is the* contribution of the fertilizer (F) to the growth of total fertilizer, $w_{F,t-1}$ is the share of fertilizer (F) in the previous year and $g_t(F)$ is the growth rate of fertilizer (F)

So, Total fertilizer growth

$$Total\ fertilzer\ Growth_t = \sum Contrib_{i,F}$$

In this method, component growth is weighted by its prior period share which is consistent with the index decomposition techniques commonly used in empirical studies. Qu and Han (2021) used index-based decomposition techniques to disentangle the driving factors behind changes in fertilizer use intensity using prior years shares to allocate contributions among factors such as inputoutput ratio, labor productivity and labor input per area. Similarly, Luan *et al.*, (2013) decompose the increase in chemical fertilizer usage in China by attributing growth components such as intensity and cultivation area to each factor over time.

Estimation of Correlation Between Growth of BAA and SCF

The Pearson correlation coefficient (r) was calculated to identify the strengths and direction of the linear relationship between the growth of BAA and SCF. Its value ranges from -1 to +1, where +1 indicates a perfect positive relationship, -1 indicates a perfect negative relationship and o indicates no linear relationship. The formula for the Pearson correlation coefficient is as follows:

$$r = \Sigma(x_i - \bar{x})(y_i - \bar{y}) / \sqrt{[\Sigma(x_i - \bar{x})^2 \cdot \Sigma(y_i - \bar{y})^2]}$$

Where, x_i is the individual values of variable X, y_i is the individual values of variable Y, $\bar{x}$ is the mean of variable X, $\bar{y}$ is the mean of variable Y, $(x_i - \bar{x})$ is the deviation of each X value from the mean, $(y_i - \bar{y})$ is the deviation of each Y value from the mean, $\Sigma(x_i - \bar{x})(y_i - \bar{y})$ is the covariance between X and Y, $\sqrt{[\Sigma(x_i - \bar{x})^2 \cdot \Sigma(y_i - \bar{y})^2]}$is the product of standard deviations of X and Y. This methodology has been well established in agricultural and biological research. For example, Jat *et al*. (2024) used Pearsons's correlation to explore relationships between fruit yield and various agronomic quality attributes in apple cultivars. Additionally, Ghulam *et al*., (2022) studied variability and correlation traits in bread wheat and applied Pearson's correlation coefficient to examine the relationships between growth traits under non-stress conditions.

Estimation of Budget Elasticity

Budget elasticity quantifies the responsiveness of fertilizer growth to changes in budg*et al*locations. It was calculated by first determining the percentage change in fertilizer growth between consecutive years, followed by calculating the percentage change in the budget for the same periods. The elasticity is then derived as the ratio of these two percentage changes specifically, the percentage change in fertilizer growth divided by the percentage change in budget. This measure indicates the sensitivity of fertilizer growth to budget fluctuations. A budget elasticity greater than one ($\text{BE}_t > 1$) suggests high responsiveness, an elasticity of one ($\text{BE}_t = 1$) indicates a proportional change, less than one ($\text{BE}_t < 1$) implies low responsiveness and a negative ($\text{BE}_t < 0$) elasticity signals that fertilizer growth decreases as the budget increases. This approach is analogous to elasticity assessment in agriculture economics, in which elasticity is measured through the ratio of percentage changes. Abdoulaye and Sanders (2005) examined the fertilizer demand elasticity to identify fertilizer usage responsiveness to income and price across African agriculture. Jabbar and Islam (1981) estimated the price elasticity of fertilizer consumption using the percentage change in fertilizer usage to percentage change in price.

It is estimated as below.

$$\text{Budget elasticity } (\text{BE}_t) = \frac{\text{Percentage change in } fertilzer\ Growth_t}{Percentage\ change\ in\ budget_t} x100$$

where, $\text{Percentage change in } fertilzer\ Growth_t =$

$$\frac{Fertilizer\ Growth_t - Fertilizer\ Growth_{t-1}}{Fertilizer\ Growth_{t-1}} x100$$

$$\text{Percentage change in budget } (\text{BAA}_t) = \frac{BAA_t - BAA_{t-1}}{BAA_{t-1}} x100$$

Results and Discussions

Annual Growth Rate of BAA and SCF from 2014 to 2024

The BAA exhibited a consistent growth trajectory with significant peaks in 2015 (14.6%), 2019 (16.23%), 2021 (20.45%) and 2022 (24.24%) (Table 1). This reflects GON priority in the agriculture sector for improving rural livelihoods and food security. In this context, (Fan *et al*., 2008; Jayne *et al*., 2013) claimed that such financial prioritization of agriculture can be commonly observed in developing countries to stimulate rural growth and resilience. Despite budgetary commitments, the growth of SCF supply was found to have considerable volatility and misalignments with budgetary trends. For example, sharp declines in total fertilizer supply were observed in 2021 (decline of -36.28%, -44.87%, -48.96% and -39.91% respectively for urea, DAP, potash and total SCF respectively) irrespective of the increase in 20.45% budget than previous year 2020. However, in 2024 the decline in the BAA (-2.87%) showed corresponding decline in SCF. Similarly, budget growth in 2015, 2019 and 2023 showed a corresponding increase in the supply of SCF and fluctuating relationships can be observed in other years (Table 1). This divergence reflects the fact that increased fiscal allocation did not translate into enhanced input delivery. Similar dynamics have been observed in Nigeria and Ethiopia, where fertilizer subsidy programs often fail to achieve intended distribution outcomes due to procurement inefficiencies, leakage and institutional weakness (Takeshima & Nkonya,2014; Rashid *et al*.,2013). In a global scenario, fertilizer distribution is highly vulnerable to global price volatility, foreign exchange rate and logistical disruptions that cannot be resolved by budgetary expansion alone (Jayane & Rahid,2013).

Table 1: Annual growth rate of BAA (%) and SCF (%)

A. BAA and supply of SCF

Year	BAA (in Billion NRs)	SCF (Mt)			
		Urea	DAP	Potash	Total
2014	23.28	190.6	101.8	6.72	299.12
2015	26.68	213.06	107.12	7.34	327.52
2016	27.43	205.42	114.8	7.99	328.21
2017	30.4	235.3	105.62	7.81	348.73
2018	29.94	215.73	120.89	7.38	344
2019	34.8	224.7	160.3	9.6	394.6
2020	37.4	225.18	140.98	12.99	379.15
2021	45.05	143.48	77.72	6.63	227.83
2022	55.97	226.15	110.12	6.46	342.73
2023	58.98	259.54	184.05	14.73	458.32
2024	57.29	146.12	81.74	5.02	232.88

B. Annual growth rate of BAA and SCF

Year	BAA (%)	SCF (%)			
		Urea	DAP	Potash	Total
2014	-	-	-	-	
2015	14.6	11.78	5.23	9.23	9.49
2016	2.81	-3.59	7.17	8.86	0.21
2017	10.83	14.55	-8	-2.25	6.25
2018	-1.51	-8.32	14.46	-5.51	-1.36
2019	16.23	4.16	32.6	30.08	14.71
2020	7.47	0.21	-12.05	35.31	-3.92
2021	20.45	-36.28	-44.87	-48.96	-39.91
2022	24.24	57.62	41.69	-2.56	50.43
2023	5.38	14.76	67.14	128.02	33.73
2024	-2.87	-43.7	-55.59	-65.92	-49.19

At the disaggregated level, urea, DAP and potash exhibited heterogeneous growth trajectories with fluctuations. For instance, potash supply grew dramatically in 2023 (128.02%) before contracting steeply in 2024 (-65.92%). Such volatility is consistent with evidence from Kenya and Ghana, where fertilizer targeting procurement practices led to erratic availability of specific fertilizer types reflecting governments' reactive planning rather than strategic planning (Mather & Jayne, 2018; Pauw,2022). These mismatches reflect weak procurement mechanisms and inefficiency in the supply chain of chemical fertilizers.

These findings show a weak coupling between fiscal allocation and effective fertilizer supply. This suggests that unless the fertilizer supply is paired with a robust procurement and distribution system, the budgetary allocation alone may fail to deliver the intended productivity and food security (Xu *et al*., 2009; Sheahan *et al*. 2013).

AAGR, CAGR and Growth Volatility of BAA and SCF

In this study, AAGR and CAGR of the BAA were found 9.41% and 8.79% respectively which reflect sustained budgetary commitment of GON to agriculture sector in the period of 2014 to 2024. In contrast, total fertilizer supply exhibited much lower growth with an AAGR of 3.95% and a CAGR of 3.12% (Table 2) showing a substantial gap between budgetary allocations and effective supply of SCF in that period. Similar disparities have been found in other South Asian countries. Megbowon *et al*., (2022) found that current levels and patterns of government agricultural expenditure in developing countries often cannot stimulate the desired economic growth and prosperity suggesting that spending alone does not guarantee proportional outcomes in agricultural productivity. According to the GOI (2025) India is the second largest consumer and third largest producer of fertilizer globally and has substantial subsidies for increasing farmer access to fertilizer at affordable price. However, even with a significant increase in the budget (approximately USD 23 billion) for fertilizer subsidies, inefficient fertilizer distribution and delivery mechanisms prevented the optimal utilization of funds. Among individual fertilizers, urea caused minimal growth (AAGR 3.91% and CAGR 2.99%), DAP showed moderate growth (AAGR 8.53% and CAGR 7.95%) and potash demonstrated the highest growth (AAGR 12.46% and CAGR 10.11%), indicating differential expansion across types of SCF (Table 2). This situation can be compared with the study by Priya *et al*., (2024) in India where they claimed that the minimal growth of urea may be due to the increasing concern in balanced nutrient application to mitigate the environmental impacts from the excessive use of nitrogen. Nepal's fertilizer supply challenges align with the findings of Gautam *et al*., (2022b) who estimated that fertilizer supply was only 60% of total effective demand in the country. This 40% deficit provides context for understanding why higher budg*et al*locations have not been translated into proportional fertilizer availability.The agricultural sector of Nepal was found with a consistent budget increase with mean growth of 9.41 % annually with low volatility (CV =0.93) (Table 2). It shows stable government commitments to the agriculture sector which supports the claim of Gautam *et al*., (2022a) in their study. However, the fertilizer supply, which is crucial for agricultural productivity, showed far lower mean growth of 3.95% but with extremely high volatility (CV = 8.38), particularly for urea (CV = 9.03%), potash (CV =5.26%) and DAP (CV = 4.98%). This discrepancy arises from Nepal's heavy reliance on imports, with the government directly engaged fertilizer procurement and subsidy distribution, limiting private sectors participation and causing frequent supply delays during the cropping seasons (Panta, 2018, Gautam *et al*., 2022a). The chronic fertilizer shortage problem is further exacerbated by budg*et al*locations delays and global supply shocks as identified by Sarah (2022) where involvement of private sectors and government to government (G2G) agreements were emphasized to stabilize the supply of fertilizer. In a similar context, Bista (2016) suggested that growing subsidy expenditure, but limited supply demands the need of improved subsidy plan in the country to address this problem. The government plans to establish chemical fertilizer plants to help reduce the import dependency and supply volatility of chemical fertilizers in the country (Ministry of Finance, 2025; Investment Board of Nepal, 2021).

Decomposition in the Growth of SCF

The decomposition of subsidized chemical fertilizer (SCF) growth in Nepal showed urea and DAP as the main contributors to fertilizer growth while potash played a minimal role. Urea shows strong but highly volatile contributions with substantial growth in 2022 (30.53%) and 2023 (10.81%) offset by sharp fall in 2024 (-28.31%), reflecting irregular supply and distribution patterns (Table 3). DAP exhibited a more moderate but still fluctuating contribution, positively influencing total growth in 2019 (10.42%), 2022 (19.88%), and 2023 (19.83%), while registering negative contributions in 2017 (-2.12%), 2020 (-3.35%), and 2024 (-19.96%). Potash contributions were comparatively small, occasionally positive, as in 2020 (3.31%), but largely negligible in most years. These patterns align with findings from neighboring countries such as India and Bangladesh where urea and DAP are primary fertilizer with similar volatility issues tied to supply chain disruptions and policy shifts (Randive *et al*., 2021; Sharama and Thaker, 2011; Hossain *et al*., 2021). Nepal's fertilizer supply system suffers from import dependency, constrained government procurement capacity and irregular distribution reflecting representative challenges of other South Asian countries where supply inconsistency undermines agricultural productivity (Bista *et al*., 2016, Joshi, 2010). Efforts to stabilize fertilizer supply through private sector engagement and improved import logistics are suggested for Nepal which they can learn from African experiences of public private partnerships that helped them to moderately reduce the volatility of fertilizer supply volatility (Sarah, 2022).

Table 2: AAGR and CAGR of BAA and SCF (%)

A. AAGR and CAGR of BAA and SCF (%)					
Attributes	BAA	Urea	DAP	Potash	Total SCF
AAG	9.41	3.91	8.53	12.46	3.95
CAGR	8.79	2.99	7.95	10.11	3.12
B. Growth volatility of BAA and SCF					
Attributes	BAA	SCF			
		Urea	DAP	Potash	Total SCF
Standard Deviation (%)	8.78	35.28	42.48	65.47	65.47
Coefficient of Variation (CV)	0.93	9.03	4.98	5.26	5.26

Table 3: Decomposition of SCF

Year	Urea Contribution (%)	DAP Contribution (%)	Potash Contribution (%)
2015	7.48	2	0.01
2016	-2.27	1.97	0.51
2017	10.46	-2.12	-0.09
2018	-6.54	2.87	-0.14
2019	1.61	10.42	2.68
2020	0.08	-3.35	3.31
2021	-22.85	-15.55	-1.51
2022	30.53	19.88	-0.01
2023	10.81	19.83	3.09
2024	-28.31	-19.96	-0.92

Relationship Between the Growth of BAA and SCF

This study showed a moderate positive correlation (r =0.5) (Table 4) between the growth of budg*et al*locations to agriculture (BAA) and subsidized urea supply, indicating that increased public funding is associated with a higher use of urea (Figure 1). This finding aligns with global patterns where urea as a primary source of nitrogen often receives a disproportionate policy focus because of its immediate impact on crop yields and food security goals (Tian *et al*.,2022). For example, studies in Asia have highlighted how subsidy programs prioritize nitrogen-based fertilizers to address yield gaps, although this can lead to regional nutritional imbalances (Gao *et al*., 2024; Ludemann *et al*., 2024).

The weaker positive correlation (r = 0.39) (Table 4) for total subsidized chemical fertilizer (SCF) suggests that budget increases may not uniformly benefit all fertilizer types which is supported by the findings of (Abay *et al*., 2025; Schnitkey *et al*., 2022) where they found subsidy policies often favoring nitrogen-based fertilizers over phosphorous and potassium-based fertilizers in other regions of the world. Specifically, the weak correlation (r = 0.19) for DAP (Diammonium Phosphate) and negligible correlation (r = -0.03) (Table 4, Fig. 1) for potash indicate that budget growth has minimal influence on these fertilizers as claimed by (Ludemann *et al*., 2024; Paulson *et al*., 2023; Schnitkey *et al*., 2022) which may be due to several factors such as higher costs, lower farmer awareness of balanced nutrition and policy biases towards short term yield gains rather than soil sustainability. Similar findings were reported in a study of Indian subsidy schemes, where urea consumption surged while phosphorous and potassium consumption stagnated leading to soil degradation over time (Ludemann *et al*., 2024). Additionally, economic shocks such as the global fertilizer price crises of 2020-2022 may have further exacerbated these disparities as governments may prioritize subsidizing cheaper nitrogen fertilizer to mitigate farmer distress and ignore long-term agronomic needs (Paulson *et al*., 2023; Abay *et al*., 2023). These differential impacts underscore the need for integrated policy reforms that promote balanced fertilizer use through evidence-based budgeting and coupling subsidies with soil testing programs or ecological incentives (Gao *et al*., 2024; Tian *et al*., 2022).

Table 4: correlation between the growth BAA and SCF

Fertilizer variables	Correlation coefficient (r)	Strength of relationship
Urea Growth	0.5	Moderate Positive
DAP Growth	0.19	Weak Positive
Potash Growth	-0.03	No Correlation (Slight Negative)
Total Fertilizer (SCF) Growth	0.39	Weak to Moderate Positive

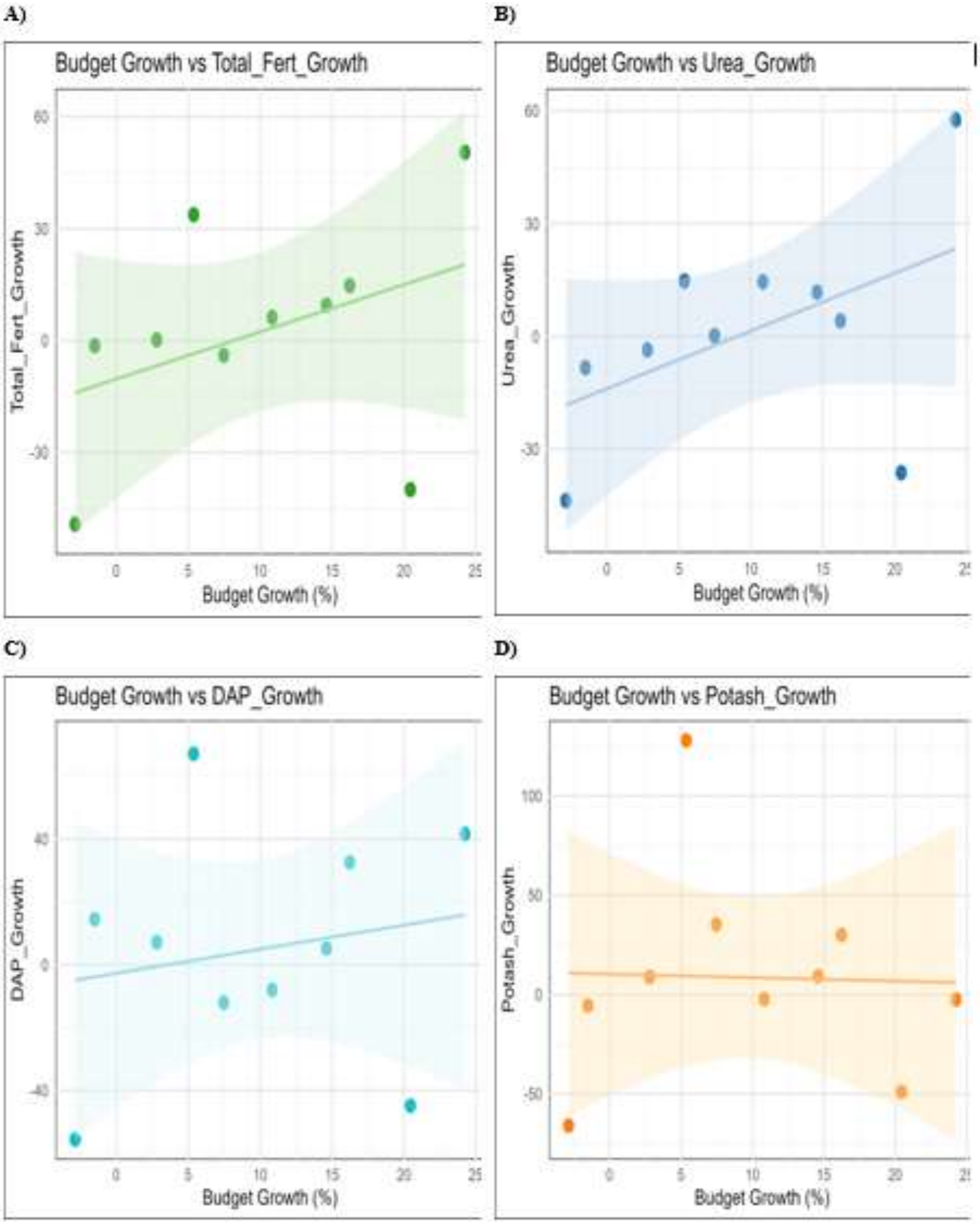

Fig. 1: Scatter plots showing the correlation between the annual growth of budget and SCF: A) Total fertilizer, B) Urea C) DAP and D) Potash

Annual Budget Elasticity of Fertilizer Growth

The budget elasticity of fertilizer growth indicates how responsive fertilizer usage is to changes in government budg*et al*location. Urea showed relatively moderate elasticity in most years, but with high responsiveness in 2024 (15.25), implying that a 1% increase in budget corresponded to 15.25% increase in urea growth in that year. In contrast, negative elasticity in 2016 (-1.28) and 2021 (-1.77) suggests a disconnect between budg*et al*location and actual usage, possibly due to non-budgetary constraints such as supply bottlenecks or policy shifts (Table 5). A similar situation was observed in Ghana, where global supply chain disruptions, domestic policy shifts and payment arrears disrupted the linkage between budg*et al*location and the actual supply of fertilizers to farmers in planting time (Godson, 2023). DAP displays extreme elasticity swings, with a sharp negative value in 2018 (-9.55) and very high positive responses in 2023 (12.48) and 2024 (19.40), reflecting a highly unstable pattern of responsiveness to budgets. Potash follows a similar trend of increasing sensitivity, with elasticity reaching 23.80 in 2023 and 23.01 in 2024, indicating that potash consumption has become highly budget-dependent in recent years (Table 5). This pattern aligns with global studies indicating that fertilizer responsiveness is influenced by the complex interplay of policies targeting supply chain stability and external economic shocks (Myers, 2023; Abay *et al*, 2025).

Similarly, total fertilizer growth showed moderate elasticity in the earlier years, with values generally below 1, indicating limited responsiveness. However, this shifted sharply in 2023 (6.27) and 2024 (17.17), where the elasticity ratio suggests a strong overall sector response to budget increases (Table 5; Fig. 2). This trend of rising budget elasticity supports the study by Theriault *et al*., (2018) who found economic incentives to use fertilizer on maize in Burkina Faso to improve the profitability of farmers. In a similar context, Komarek *et al*., (2017) found 52% income in the household's income of the farmers in central Malawi when the fertilizer price is reduced to zero. These findings collectively suggest that the supply of fertilizers has become increasingly sensitive to budg*et al*locations over time. This rising elasticity trend reflects improved subsidies targeting small farmers who require financial support from the government for agriculture inputs including agriculture.

Table 5: Annual budget elasticity of subsidized chemical fertilizer

Year	Urea	DAP	Potash	Total chemical fertilizer
2015	0.81	0.36	0.63	0.65
2016	-1.28	2.55	3.15	0.07
2017	1.34	-0.74	-0.21	0.58
2018	5.5	-9.55	3.64	0.9
2019	0.26	2.01	1.85	0.91
2020	0.03	-1.61	4.73	-0.52
2021	-1.77	-2.19	-2.39	-1.95
2022	2.38	1.72	-0.11	2.08
2023	2.75	12.48	23.8	6.27
2024	15.25	19.4	23.01	17.17

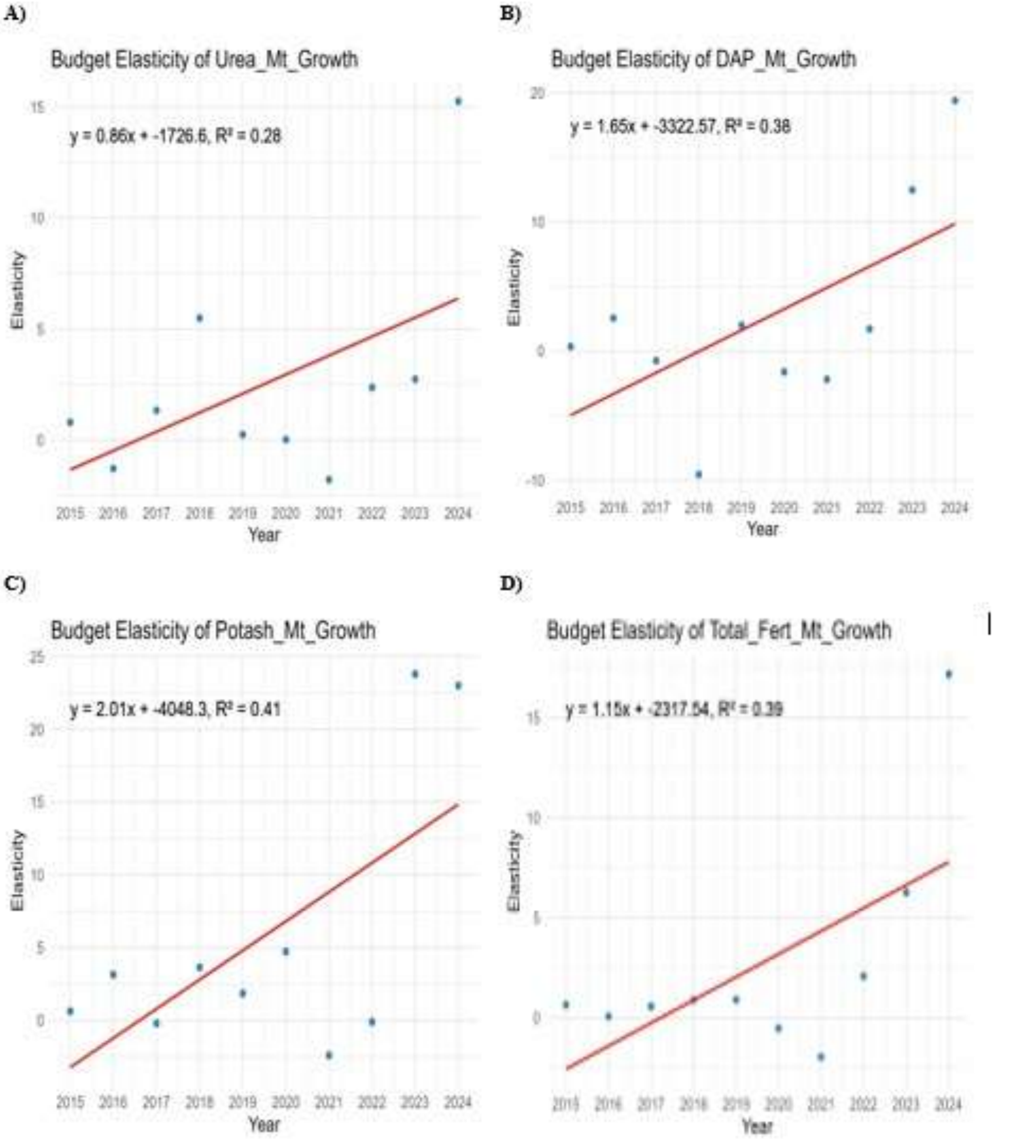

Fig. 2: Budget elasticity plots. A) Urea, B) DAP, C) Potash and D) Total fertilizer (Total SCF). The data of 2013 for each variable is required to assess the budget elasticity of 2014. As this study is based on the data from 2014 to 2024 (decade period) only, the scatter plots above do not contain the budget elasticity value of 2014.

The elasticity plots demonstrate a clear upward trend in fertilizer responsiveness to budg*et al*location, as reflected by their positive regression slopes. Urea shows moderate growth in elasticity with a slope of approximately 0.62, whereas DAP exhibits a steeper, though more volatile, increase with a slope approximately 0.97. Potash displayed a sharp rise in elasticity, with a slope near 1.91, indicating a rapidly growing sensitivity to budget changes. Total Fertilizer elasticity also rises steadily with a slope close to 0.96, suggesting a broad-based increase in supply responsiveness. This finding is in line with a study by Ashari *et al*., (2024) who found that subsidized fertilizer enhanced farmer welfare and crop competitiveness through better access to fertilizer in West Java. Collectively, these trends imply that fertilizer supply has become more sensitive to budg*et al*location over the years which may be driven by stronger financial linkages and policy interventions.

Conclusion

This study revealed that higher public spending on agriculture alone is insufficient to guarantee a consistent supply of subsidized chemical fertilizers in Nepal. Although the agriculture budget has grown steadily, fertilizer supply remains unstable and poorly aligned with fiscal allocations. The weak correlation between increase in budget and fertilizer availability showed inefficiencies in government procurement, distribution, and monitoring systems. To ensure a sustainable and timely supply of fertilizers, policy attention should shift from expanding budgets to improving implementation efficiency and strengthening supply chain governance.

Authors contribution

Arjun Prasad Khanal contributed to conceptualization, data curation, formal analysis, fund acquisition, investigation, methodology, writing original draft, revision and finalization of the manuscript; Rishi Ram Kattel contributed to conceptualization, writing original draft, revision and finalization of the manuscript; Shiva Chandra Dhakal contributed to conceptualization, data collection, writing original draft, revision and finalization of the manuscript; Ganesh Raj Joshi contributed to conceptualization, data curation, writing original draft, revision and finalization of the manuscript. Final form of the manuscript is approved by all authors.

Conflict of Interest

The authors declare that they have no conflict of interest.

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